EURASIA JOURNAL OF MATHEMATICS, SCIENCE AND TECHNOLOGY EDUCATION

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Challenge House Business Centre

VOLUME 14 ISSUE 3 CONTENTS (MARCH 2018)

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A Confirmatory Factor Analysis of Mathematics Teachers' Professional Competences (MTPC) in a Mongolian Context

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ABSTRACT

This study aimed to determine and validate a version of the MTPC with 4 belief, 4 knowledge, 4 practice, and 3 attitude items. The sample size of the study was 218 participants. Structural equation modeling (SEM) was used to analyze research data. The results of the study revealed that after deleting 3 items of attitude, a 3-factor model was validated and well fit the research data. Therefore, the model best fits the Mongolian context in comparison to other models.

Keywords: Mathematics Teachers' Professional Competences (MTPC), Mongolia, 3-factor correlated model for MTPC

INTRODUCTION

There has been a great deal of interest that in model to cognitive and affective domain in the education of teachers over many years. Perhaps a critical moment in the attention and study of affect was associated with the investigation of issues related to professional knowledge of teachers starting in the middle 1980's (e.g. Leinhart and Smith, 1985; Shulman, 1986). Shulman (1986) defined the professional knowledge of teachers as four facets: content knowledge, pedagogical content knowledge, curricular knowledge and generic pedagogical knowledge.

The broader and more comprehensive term as "teachers' professional competence" is now more commonly used. There are many different kinds of competences in the research (Gupta, 1999; Weinert, 2001; Deakin, 2008). A competence is described as "a complex combination of knowledge, skills, understanding, values, attitudes and desire which lead to effective, embodied human action in the world, in a particular domain" (Deakin, 2008). Teacher's competences imply systemic view of teacher professionalism, on multiple levels – the individual, the school, the local community and professional networks. … Components of teacher's competencies define - knowledge and understanding, skills and dispositions (OECD, 2013). Teacher's competence is defined as a combination of professional knowledge, skill, experience and attitude for teaching. It is divided into three components as follows individual, professional and social. The general framework related to teacher's professional competencies is explained based on three fields such as learning and teaching, communication, and research competencies (Munkhjargal, 2013).

In this study the factors that MTPC were determined and explored. This study sought to answer the following research question: What are the suitable model those factors of MTPC?

A LITERATURE REVIEW

At the beginning of this century, "Mathematics Teacher Tetrahedron" model was developed based on the Theory of Learning (Luvsandorj et al., 2003). The model consists of side competences, which are disposition, introduction to mathematics, introduction to mathematics didactics, and teacher professional knowledge. They believed that the content of potential was comprised of only knowledge, and the content of knowledge was comprised of only skills and abilities.

Döhrmann et al. (2012) considered mathematics teachers' professional competencies in terms of cognitive and affective-motivational facets. They divided cognitive abilities (professional knowledge) into three sections as *content knowledge, general pedagogical knowledge* and *pedagogical content knowledge* (PCK), and affective-motivational characteristics into two sections as teachers' professional beliefs and, motivation and self-regulation. Given

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Contribution of this paper to the literature

- This study aims to investigate the suitable model of mathematics teacher in the Mongolian context.
- In this study framework MTPC were determined and explored.
- Results of analysis looked that 3-factor correlated model for MTPC is best fit with the Mongolian context: teacher knowledge, teacher belief and teacher practice.

framework became theoretical basis of the international study called "Teacher Education and Development Study in Mathematics (TEDS-M)".

Moreover, there are many research papers about knowledge, skill, attitudes and practices related to mathematics teacher's professional competencies (Ernest, 1989; Grossman, 1990; Fennema and Franke, 1992; Koehlor and Grouws, 1992; An et al., 2004; Attoprs, 2006; Sandt, 2007; Ball, 2009; Leong, 2013; etc.).

Koehlor and Grouws (1992) proposed framework on mathematics teacher behavior. Based on their works, Sandt (2007) revised and developed the framework. They note that teacher's behavior is influenced by the three factors: teacher knowledge, teacher attitudes and beliefs about teaching and mathematics. Each factor consists of many components. Four components distinguished in teachers' knowledge consist of teacher's knowledge of student learning, subject content knowledge, pedagogical knowledge and curriculum knowledge. Teachers' belief is the second factor and consists of four components: learning of mathematics, teaching of mathematics, nature mathematics and students as learners. Teachers' attitude is the third factor and consists of a teacher's attitude towards mathematics, teaching of mathematics and teacher's attitude towards students.

Leong (2013) divided different kinds of knowledge are needed by teachers to be effective such as: 1) content knowledge (Shulman, 1986); 2) pedagogical content knowledge (PCK) (Shulman, 1986); 3) theory of knowledge (Schoenfeld, 1998); 4) teacher knowledge and its impact (Fennema and Franke, 1992); and 5) mathematics knowledge for teaching (Ball & Bass, 2004) and for elementary school teachers and their content knowledge (Ball, 2004, 2007; Brown and Borko, 1992; Ma, 1999).

Ball and Sleep (2007) developed the notion of mathematical knowledge for teaching (MKT) a practice-based framework focused on both what teachers do as they teach mathematics, and what knowledge and skills teachers need in order to be able to teach mathematics effectively. MKT defined as "mathematical knowledge needed to carry out the work of teaching mathematics" (Ball, 2009) to bridge the gap in good teaching. The researchers divided MKT into two broad categories – subject matter knowledge (SMK) and pedagogical content knowledge (PCK). SMK has been divided into common content knowledge, specialized content knowledge, and horizon content knowledge. And PCK comprised of divisions knowledge of content and students, knowledge of content and teaching and knowledge of content and curriculum. Each division refers to a hypothesized type of mathematical knowledge that is needed by teachers.

AAMT (2006) described the knowledge, skills and attributes required for good teaching of mathematics and developed Standards for Excellence in Teaching Mathematics in Australian School. The standards are organized into three domains: professional knowledge, attributes and practice.

MATHEMATICS TEACHERS' PROFESSIONAL COMPETENCES (MTPC)

The MTPC, based on Döhrmann's et al., (2012) theories, are presented from four factors: teacher knowledge, teacher beliefs, teacher attitude and teacher practice. First three factors, which are teacher knowledge, teacher beliefs and teacher attitude, were proposed by Sandt (2007) and other one, teacher practice, was proposed by AAMT (2006).

Teacher Knowledge

The author agreed with Sandt (2007) that teacher knowledge is a large, integrated, functioning system and is an important indicator of overall teacher effectiveness. The knowledge divides into four components: mathematics content knowledge, pedagogical content knowledge, curricular knowledge and teachers' knowledge of student learning.

The first component, *mathematics content knowledge,* is knowledge of the subject and its organizing structures (Shulman, 1987). Leong (2013) believes (according to the National Council of Teachers of Mathematics, 1991), mathematics content knowledge is described as: "The content and discourse of mathematics, including mathematical concepts and procedures and the connections among them; multiple representations of mathematical concepts and procedures; ways to reason mathematically, solve problems, and communicate mathematics effectively at different levels of formality".

Table 1. Categories of teacher beliefs (Beswick, 2005)

Beliefs about the nature of mathematics (Ernest, 1989)	Beliefs about mathematics teaching (Van Zoest et al. 1994)	Beliefs about mathematics learning (Ernest, 1989)
Instrumentalist	Content focused with an emphasis on performance	Skill mastery, passive reception of knowledge
Platonist	Content focused with an emphasis on understanding	Active construction of understanding
Problem solving	Learner focused	Autonomous exploration of own interests

The second component, *pedagogical content knowledge,* the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations — in a word, the most useful ways of representing and formulating the subject that make it comprehensible to others... Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons (Shulman, 1986).

The third component, *curricular knowledge*, is knowledge of texts and scheme used to teach mathematics, their contents and ways to use them; school produced curriculum materials; other teaching resources and teaching apparatus; examinations; tests and syllabi (Turner-Bisset, 2001). Curriculum knowledge is explicitly added to the model as knowledge of the subject content (concepts, procedures) and knowledge of different ways of presenting the content (pedagogical knowledge) does not guarantee knowledge of different and effective teaching and assessment resources such as computer software (Sandt, 2007).

The fourth component, *knowledge of students* (teachers' knowledge of student learning), is conceptions, learning difficulties, styles, misconceptions and errors (Ball & Bass, 2000).

Teacher Beliefs

Beliefs defined as one's personal views, conceptions and theories (Thompson, 1992). Teacher beliefs are crucial for the perception of classroom situations and for decisions on how to act (Schoenfeld, 2010). Teacher beliefs consist of nature of mathematics, mathematics teaching, mathematics learning and students as learners (Sandt, 2007).

Ernest (1989) defined teachers' beliefs about the *nature of mathematics* are conscious or subconscious beliefs, concepts, meanings, rules, mental images, and preferences concerning the nature of mathematics. He described three categories of teacher beliefs about the nature of mathematics. In Instrumentalist view, mathematics is seen as "an accumulation of facts, skills and rules to be used in the pursuance of some external end". The Platonist view sees mathematics as a static body of unified, pre-existing knowledge awaiting discovery. In the problem solving view in which mathematics is regarded as a dynamic and creative human invention. Beswick (2005) summarized connections among Ernest's (1989) categories of beliefs about the nature of mathematics, an adaptation of the corresponding categories that he proposed for beliefs about mathematics learning, and Van Zoest, Jones and Thornton's (1994) categories relating to mathematics teaching – as presented in **Table 1**.

Sandt (2007) describes a component of students as learners. The component includes beliefs about differences in individuals or groups of learners regarding the learners' talent for mathematics and learners' intellectual abilities to successfully learn mathematics.

Teacher Attitude

Attitudes are defined as internal beliefs that influence personal actions. The attitude is learned indirectly through one's experience and exposures (Schunk, 1996). Teachers' attitude consists of a teachers' attitude to mathematics, the teaching of mathematics and towards students (Sandt, 2007). Teachers' attitudes to *mathematics* may influence their enthusiasm and confidence to teaching the subject. This in turn may affect the classroom ethos and consequently affect their students' perceptions of mathematics (Ernest, 1989). Teachers' attitude to the *teaching of mathematics* include liking, enjoyment and enthusiasm for the teaching of mathematics, and confidence in the teacher's own mathematics teaching abilities (Ernest, 1989). Attitude *towards students* is attitudes teachers towards individual learners, groups or classes of learners (Sandt, 2007).

Teacher Practice

In factor of teacher practice, AAMT (2006) defined that excellent teachers of mathematics are purposeful in making a positive difference to the learning outcomes, both cognitive and affective of the students they teach. They are sensitive and responsive to all aspects of the context in which they teach. This is reflected in the learning environments they establish, the lessons they plan, their uses of technologies and other resources, their teaching practices, and the ways in which they assess and report on student learning. The teacher practice includes four components: the learning environment, planning for learning, teaching in action and student assessment.

Table 2. Demographical Data

Variable	Description	Number	Percentage
Sex	Male	69	31.9%
	Female	147	68.1%
Education degree	Doctor	10	4.6%
	Master	65	30.1%
	Bachelor	141	65.3%
Teacher experience (year)	Above 26	24	11.1%
	Between 21 – 25	24	11.1%
	Between 16 – 20	20	9.3%
	Between 11 – 15	42	19.4%
	Between 6 – 10	49	22.7%
	Between 2 – 5	43	19.9%
	Between 0 – 1	14	6.5%
Geographics of teacher work	Capital (Ulaanbaatar)	96	44.4%
	City (Center of Province)	68	31.5%
	Sum (village)	52	24.1%

METHODOLOGY

Population and Sample

The secondary mathematics teachers, specialists of mathematics in provinces, specialists Mongolian Institute for Educational Research, Teachers Development Center and lecturers of mathematics education of universities with mathematics teachers' preparation programs in Mongolia constitute the population. Present time in Mongolia are working 2449 secondary mathematics teachers (in 22 provinces), 22 specialists of mathematics in provinces and 69 mathematics lectures of university with mathematics teachers' preparation programs in Mongolia constitute the population (MECS, 2016). The sample of the study includes 198 secondary mathematics teachers of 21 provinces, 11 specialist and 7 lecturers. To promote the generalizability of results from the sample to secondary mathematics teachers in population in each province in Mongolia were chosen for study. The background of participants summarized in **Table 2**.

Instrument

The survey tool was two sections, section A covers demographic data and section B comprises 15 items. The section A asked participants to identify their sex, education degree and teacher experience, geographic of teacher work. The section B of the questionnaire was composed of the 15 items that measured four factors: teacher knowledge, teacher beliefs, teacher practice and teacher attitude. **Table 3** lists the dependent variables and the items measuring these variables. Responses to these items were measured using a 7-point Likert scale anchored between (1) strongly disagree to (7) strongly agree.

Table 3. Descriptive statistics of MTPC items

Number Items	Note Items	Variable	M	SD	SKEW	KURT
	Teacher knowledge					
1.	K1	Mathematics content knowledge	6.58	0.53	-0.695	-0.746
2.	K2	Pedagogical content knowledge	6.62	0.54	-1.027	0.014
3.	K3	Curricular knowledge	6.41	0.64	-0.736	0.042
4.	K4	Knowledge of student learning	6.40	0.62	-0.550	-0.608
	Teacher beliefs					
5.	B1	Nature of mathematics	6.53	0.62	-1.089	0.682
6.	B2	Learning of mathematics	6.46	0.62	-0.803	0.275
7.	B3	Teaching of mathematics	6.47	0.65	-0.839	-0.379
8.	B4	Students as learners	6.32	0.74	-0.739	-0.313
	Teacher practice					
9.	P1	Learning environment	6.32	0.68	-0.663	0.107
10.	P2	Planning for learning	6.58	0.59	-1.087	0.190
11.	P3	Teaching in action	6.62	0.57	-1.352	1.641
12.	P4	Student assessment	6.44	0.68	-0.987	0.449
	Teacher attitude					
13.	A1	Attitude towards mathematics	6.65	0.57	-1.527	2.190
14.	A2	Attitude to the teaching mathematics	6.64	0.54	-1.180	0.410
15.	A3	Attitude towards students	6.57	0.56	-0.917	-0.161

Data Collection Procedures

Data were collected in June and August 2016. The study was carried out in different phases. First, sample of the study were selected. Then, in June data collected from specialists and lecturers of mathematics education and in August from secondary mathematics teachers. Each participant in survey was to filled instrument and conducted in paper version. Next, the instrument filled out by each participant was coded. One numerical code was assigned to each participant. Later, the data entered into SPSS and in line with research questions, appropriate statistical procedures were applied.

Data Analyses

The study used descriptive statistics and confirmatory factor analysis to validate the underlying hypothesized factor structure of MTPC. The items of the MTPC were represented by measured or observed variables.

RESULTS

Descriptive Statistics of MTPC Items

A descriptive statistics was performed using SPSS 21.0. The MTPC items were treated as observed variables. First, the data were subjected to tests of multivariate normality. The skewness and the kurtosis of the distribution ranged from – 1.527 to – 0.550 and from – 0.726 to 2.190 respectively. These satisfy the working guideline that the absolute values of skewness and kurtosis are less than 3 and 8 respectively (Kline, 2010). Missing responses were less than 3%, and to avoid considerable loss in sample size in this multivariate setting and to maintain the consistence of the sample base, missing responses were replaced by the mean values of the corresponding items. We consider, that if mean value is equal or greater than 5.8, which means 80%, as a good mean.

There were four items in the teacher knowledge factor, relate to subject content knowledge, pedagogical content knowledge, curricular knowledge and teachers' knowledge of student learning. The means, are good indicators, suggest that the participants were clearly aware and convinced of the knowledge.

The four items in the teacher beliefs included to beliefs about the nature of mathematics, the learning of mathematics, the teaching of mathematics and their students as learners. The participants showed an inclination to respond to this category with means, were good indicators, with the exception of item B4. B4 had the lowest mean, and participants generally beliefs about their students as learners did low influence in teacher beliefs.

There were four items in the teacher practice, and they referred to learning environment, planning for learning, teaching in action and student assessment. The means of items of teacher attitude ranged from 6.32 to 6.62 and there were had high index. Participants were given a high priority to these items.

Table 4. Fit Indices for Eight Models

	χ^2	df	χ^2/df	RMSEA	GFI	CFI	AGFI	TLI
Single factor	219.0	90	2.2	0.076	0.885	0.863	0.847	0.841
Single factor (deleted 3 items of attitude)	114.8	54	2.1	0.072	0.912	0.903	0.874	0.881
3 factor correlated (deleted 3 items of attitude)	73.5	51	1.4	0.045	0.943	0.964	0.913	0.953
3 factor uncorrelated (deleted 3 items of attitude)	247.0	54	4.6	0.129	0.837	0.691	0.764	0.623
3 factor correlated (a factor with belief and attitude)	159.7	87	1.8	0.062	0.907	0.911	0.871	0.893
3 factor uncorrelated (a factor with belief and attitude)	365.6	90	4.1	0.119	0.814	0.664	0.752	0.608
4 factor correlated	133.1	84	1.6	0.052	0.921	0.940	0.887	0.925
4 factor uncorrelated	385.2	90	4.3	0.124	0.783	0.640	0.711	0.580

The teacher attitude factor with means in the ranged from 6.57 to 6.65. In general, these participants showed high attitude to continue studying it.

Reliability

To assess internal consistency, Cronbach's alpha coefficients for the subscales were estimated using SPSS 21.0. These values were larger than the cut-off point of 0.70 for reliability (Hair et al, 2010). Cronbach's alpha values were obtained for the overall scale (0.857) and all the subscales: Knowledge (0.747), Belief (0.719), Practice (0.717) and Attitude (0.629).

Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) is often employed to test whether a hypothesized factor structure is supported by the data. The simplest structure is the one-factor model, when the observed variables load onto a single factor, but alternative structures are also tested to find a good model to fit the data (Abdul et al., 2013).

In this study, the three subscales of MTPC were an acceptable value of internal consistency. Hence, a 3-factor correlated (deleted items of attitude) model was tested. This model was compared to 2 single-factor models, a 3-factor uncorrelated model, and 2 four-factor correlated and uncorrelated models (**Table 4**).

Seven indices are commonly used to examine model fit, and these are shown in **Table 4**: χ^2 (chi-square), χ^2/df (chi-square with degrees of freedom), RMSEA (root mean square error of approximation), GFI (goodness-of-fit index), CFI (comparative fit index), AGFI (adjusted goodness-of-fit index) and TLI (Tucker-Lewis index). There is disagreement in the literature about the criteria used to establish goodness of fit (Hooper, Coughlan and Mullen, 2008). Among these criteria are the following.

The Chi-Square value is assesses the magnitude of discrepancy between the sample and fitted covariance matrices (Hu and Bentler, 1999). χ^2/df ratio recommendations range from as high as 5.0 (Wheaton et al, 1977) to as low as 2.0 (Tabachnick and Fidell, 2007). Siti et al. (2011) suggested the relative chi-square (χ^2/df) must be between 1 and 5. Steiger (2007) suggested RMSEA of 0.07 or lower, while Hu and Bentler (1999) required an RMSEA of 0.06. Then Schumacker and Lomax (2010) considered RMSEA value must be lower than 0.08. The GFI, CFI, AGFI and TLI values should be in range of 0 to 1. Bentler and Bonett (1980) suggested GFI and CFI of 0.90 and AGFI of 0.80, while Hu and Bentler (1999) noted the value of 0.95 for CFI and GFI. Arbuckle (2009) suggested that GFI, TLI and CFI should be equal or close to 0.90. Likewise, the respective TLI, CFI and CFI value must exceed 0.90 in order to obtain an acceptable fit with the data (Schumacker and Lomax, 2010). The article of Hooper, Coughlan and Mullen (2008) summarized fit indices and their acceptable thresholds: RMSEA values less than 0.07, the respective GFI, AGFI, TLI and CFI values must greater than 0.95, 0.90, 0.95 and 0.95 in order.

The indices shown in **Table 4** suggest that the 3-factor correlated model (deleted 3 items of attitude) is the best fit with the data, which conducted in Mongolian context when compared to the alternative models. As seen in **Figure 1**, the 3-factor correlated model for MTPC specifies the relations between observed variables and latent variables.
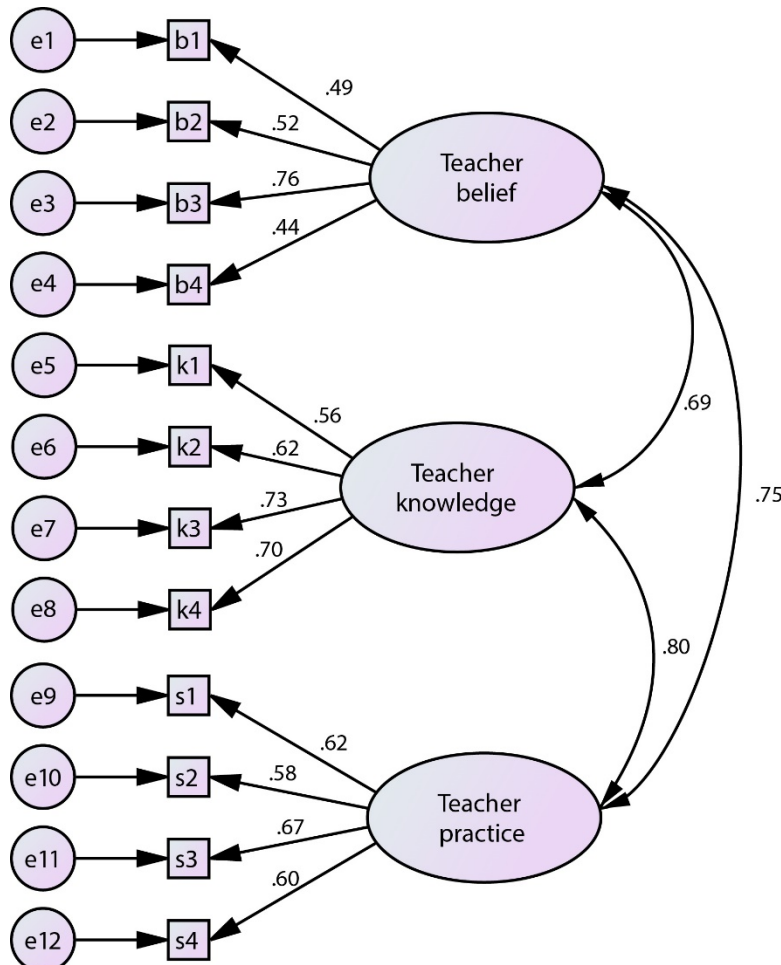
Figure 1. 3-factor correleted model for MTPC

The observed variables and the latent variables are represented by the boxes and the ellipses respectively. The value of .40 is a common cut-off value which is typically used in any factor analyses and the double-headed row represents the covariance, which also can be interpreted as correlation (Hair et al., 2010). Factor loadings provide evidence for the extent to which an item relates to the underlying latent factor. The factor loadings shown in **Figure 1** were quite high, ranging from 0.44 to 0.76.

CONCLUSION

The aim of the paper was to assess the reliability and validity of a version of the MTPC with 4 belief, 4 knowledge, 4 practice, and 3 attitude items. Results of the CFA support a 3-correlated factor model. In addition, the items showed good internal consistencies and displayed Cronbach's alphas similar to those obtained for the 3-correlated factor model. The model (deleted 3 items of attitude) is most suitable when compared to the alternative models. Thus, this study has validated a version of MTPC for the Mongolian context.

DISCUSSION

The author believes that teacher knowledge, teacher beliefs and teacher practice are emphasized almost equally. However, when author divided those factors into its more detailed components it was that fields of teacher development are stressed differently.

For example, excellent teachers of mathematics establish an environment that maximizes students' learning opportunities. The psychological, emotional and physical needs of students are addressed and the teacher is aware of, and responds to, the diversity of students' individual needs and talents (AAMT, 2006). In other word, the learning environment of teacher practice is highly dependent on the teacher's experience.

Koponen et al. (2017) divides teacher knowledge into six components, three of which are mathematical (subject matter). Based on their results, Common content knowledge is clearly the most strongly emphasized component of

Subject matter knowledge in the studied teacher education program. According to the perceptions of both groups, the graduated teachers had learned pure mathematical issues better however, there were some exceptions, such as statistics, which does not belong to the present teacher education program.

Therefore, further research is study on the correlation between teacher development and components of MTPC.

A paper by Beswick (2012) suggests that beliefs about mathematics can usefully be considered in terms of a matrix that accommodates the possibility of differing views of school mathematics and the discipline.

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Virtual Learning Environments to Enhance Spatial Orientation

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ABSTRACT

The spatial orientation skill allows us to determine our location in relation to the environment. It can be developed through specific training, and is a competence to be acquired in STEM university degrees related to geospatial information. In addition to map reading, an activity that provides the spatial orientation skill is wayfinding. While wayfinding the information obtained from successive views of the environment provides spatial orientation. This research presents an immersive orientation experiment, in which an urban environment is displayed through a Smartphone installed in VR 3D glasses. The motion direction is controlled with a joystick. In the experiment 32-second year engineering students from La Laguna University participated, and the average gain in spatial orientation skill was of 12.81°, measured with the Perspective Taking Spatial Orientation Test. No gender differences detected. This gain is less than that obtained in previous experiments with GISc, Geoportals and Augmented Reality resources.

Keywords: science and engineering education, immersive environment, spatial orientation, virtual learning environments, virtual reality 3D

INTRODUCTION

Spatial reasoning enables us to behave, interact and orient ourselves in the environment where we live. Spatial cognition is acquired through information from successive views of activities at the ground level. This is known as wayfinding or route based learning: it is the intellectual process used to establish the route to get from point A to point B. Wayfinding, the cognitive element of navigation, has been a relevant element in spatial cognition research (Patel and Kumar, 2010). In these wayfinding activities, the spatial orientation skill is needed. (Howard and Templeton, 1966; Hill 1998; Gonzato et al., 2011; Gonzato and Godino, 2011).

The Spatial orientation skill is defined as the ability to remain oriented in a spatial environment when the objects in this environment are viewed from different positions (Fleishman and Dusek, 1971; Kozhevnikov and Hegarty, 2001), the three-dimensional orientation in space during movement or the ability to orient oneself towards the environment and to be aware of one's position in space (Reber, 1985), or the ability to physically or mentally orientate in space (Maier 1998). There are different classifications of spatial skills in which spatial orientation appears (Smith, 1964; Linn and Petersen, 1985; Maier, 1998; Hegarty and Waller, 2004), and in the classifications of Bodner and Guay (1997) and Tartre (1990, a, b), spatial orientation is one of the main components of spatial skills. Spatial orientation is a subject that awakes great interest in teaching institutions such as the National Council of Teachers of Mathematics (NCTM, 2000), which contemplates the development of spatial orientation as one of the sources to describe and to model the physical world. The research in didactics of mathematics contemplates teaching-learning environments for spatial orientation (Battista, 2007; Presmeg, 2006). In the European Space for Higher Education, spatial orientation as a kind of spatial skill is a competence to be acquired in a large number of university degrees (Spanish Cabinet Office, 2007a, b).

While navigating (the aggregate task of wayfinding and motion), orientation is acquired through the information obtained from successive views where movement causes the point of view to change continuously. Wayfinding involves mental representations, route planning and estimation of distances. In maps, orientation is established through the geographic north, but while wayfinding there is not a north, and the orientation is established through the images of the environment (Lynch 1960). In the wayfinding process, the user perceives

Contribution of this paper to the literature

- Research questions: Study the acquisition of the spatial orientation skill in a virtual learning environment through route-based learning activities.
- Employed methods: Virtual Learning Environment performed with Google Street View and VR glasses. Two groups with different levels of spatial orientation carried out the experiment.
- Findings: The VR orientation strategy performed developed the spatial orientation skill of the students. This gain was significantly higher for those participants who had a lower level of spatial orientation skill. No gender differences were found. The gain obtained is less (although not significantly) than that obtained with previous experiments carried out to enhance spatial orientation.

surrounding space and acquires spatial knowledge and orientation about it, known as cognitive mapping, defined by Downs and Stea (1973) as the acquisition, composition and maintenance of spatial information and spatial knowledge. This spatial knowledge, also called spatial reasoning, contains elements such as the identification of spaces, reference points and routes between different places, directions, angles and distances, among others. A cognitive map is the internal cartographic representation by a person of the surrounding environment. These cognitive maps make it easy to find a route in a real-world environment or virtual environment, and also help us to remember the route from one point to another if we are asked for directions (Patel and Vij, 2010).

There is research on spatial orientation development in real-world environments (Montello et al., 1999; Hegarty et al., 2006), and through virtual navigation in a 3D scenario created by computer (Dahmani et al., 2012; Lin et al., 2014; Carbonell, 2017). But real-world environments pose substantial and logistical problems (to transport the participants, weather conditions…) and even risk if there are participants with some degree of disability. Virtual environments can be a good alternative to avoid these risks (Darken and Banker, 1998). McKinnon and North (2004) concluded that users felt better within virtual environments than in real ones, because in virtual environments the users felt that they had better control over the space that surrounded them.

There are researches in the field of spatial skills in virtual environments: McComas et al. (1998), Wilson et al. (1996), and Rose et al. (2000) affirm that VR training allows the transfer of spatial knowledge to real-world environments, and conclude that training in a virtual world is equivalent (in cognitive load) to training in a real environment. Related to wayfinding, Farrell et al. (2003), Waller et al. (2004), Schinazi et al. (2009), and Rodrigues et al. (2010) claimed that spatial knowledge acquisition while navigating in a virtual environment is easily transferable to the real world. In terms of spatial orientation skill, Richardson et al. (1999) said that the cognitive process to be oriented in a real environment is also used when we are in a virtual environment. Waller, Hunt and Knapp (1998) concluded that for navigation in virtual and real-world environments the same skills are needed. Later, Düsner et al. (2006) affirm that spatial orientation in extensive environments can be carried out using Virtual Environments. Most recently, Kuliga et al. (2015) found that there is almost no difference in route-based learning (or wayfinding) between virtual and real-world environments.

Regarding virtual environments and spatial orientation, in previous research Carbonell (2017) presented an experiment in which the students worked with the Google Street View application displayed on a screen of a computer, among other resources such as orthophotos, maps and cartographic information. Thus, spatial orientation acquisition was analysed through route-based learning (Google Street View app) and survey learning (maps, cartography and orthophotos). The route-based learning activities were performed in a virtual environment, so it was really a virtual-route based learning activity. One of the future works proposed in that previous research was to study spatial orientation skill enhancement in a real-world environment activity. The present research, conducted with 32 engineering students, also studies spatial orientation skill development but from a different approach. Firstly, no maps are used (no survey learning acquisition), so the impact on the spatial orientation skill is analysed exclusively from route-based learning. Secondly, although the application is the same as the one used in the previous research (Google Street View), in this case a version for virtual reality is used. The immersive VR environment is created with the Google Street View app in smartphones connected to virtual reality glasses and locomotion sensors.

INNOVATIVE EDUCATIONAL TECHNOLOGY: VIRTUAL ENVIRONMENTS AND VE-BASED SPATIAL LEARNING

A virtual environment (VE) is a computer generated 3D environment that the user accesses through virtual reality. The user's view represents the view he or she would have if he or she were in the real environment represented (Allahyar and Hunt, 2003). Virtual environments are used in fields such as safety training simulation, engineering and manufacturing, architecture, healthcare, layout planning, education and entertainment among others (Barfield and Baird, 1998; Uddin, 1999; Rafi and Karboulonis, 2000).

Pantelidis (1995) defined virtual reality (VR) as an interactive 3D environment in real time in which the user becomes an active subject within that virtual environment. Virtual reality, therefore, is composed of a series of technologies and interfaces that allow the user(s) to interact with a computer-generated 3D environment, all in real time. Due to advances in hardware and software in this field, virtual reality can become a powerful tool for the training of spatial skills (Domínguez et al., 2013). VR creates a sensation of immersion, navigation and interaction (Helsel, 1992) and is divided into three main categories: text based, desktop and immersive VR. In text based the communication with the environment is via text. Desktop VR incorporates 3D images, but in a non-immersive mode. Immersive VR enables the user to interact with the computer generated 3D environment (Loeffer and Anderson, 1994). The 3D immersive virtual worlds (3D IVWs) arouse great interest in teachers and educational researchers (Mayrath et al., 2011; Johannesen, 2013). Oh and Nussli (2014) claim to integrate the 3D IVWs in teaching, and affirm: "The potential for this technology in a classroom setting seems limitless."

Immersive environments through VE, also called *immersive on-line real-time 3D environments* (Stock et al., 2008), provide a first person experience, which allows the users to feel immersed while interacting with the environment by using, for example, VR glasses and motion sensors. In this research the participants navigate in an urban VE using 3D VR glasses and a motion sensor. The Google Street View application installed on a smartphone provides the urban VE environment (this VE environment is a virtual environment generated by scenes obtained from the real world, it is not a virtual scenario generated by some CAD system or similar). The smartphone is inserted in the VR glasses (**Figure 1**). In this way, the user has a presence in the represented virtual world that simulates their physical presence (Björk and Holopainen, 2004). The participant, using virtual reality and interfaces like virtual 3D glasses and a remote control for movement, experiences a sensation of immersion (Wu et al., 2015).

Figure 1. Left. Woxter Neo VR glasses. Bluetooth remote control with joystick. Right: Virtual urban environment generated.

Exploratory navigation requires real time interaction (Riva 2006). A hand-held mouse or joystick, which provides the user the feel of an immediate return of their movements and position, usually does navigation through VEs. In the present research, the participant moves through the streets using a joystick that he/she uses with his/her hand and that allows him/her to advance, turn left, right and go back (motion direction). This output device is known as the locomotion interface. Waller (1999) affirms that navigation through VEs may depend on the user's ability to manipulate the locomotion interface. In this sense, the joystick allows a very intuitive and low price hand-on training setup for educational purposes.

Virtual environments allow the user to acquire spatial knowledge of a real architectural environment (Darken et al. 1999), like that represented by the Google Street View application. Waller (1999) states that the estimation of the distance during a process of immersion in a virtual world is similar to that obtained in a real-world environment. Moreover, Witmer et al. (1995), Bliss et al. (1997), and Koh et al. (2000) concluded that, for the acquisition of spatial knowledge, immersive VE environments are as effective as real-world environments. Spatial knowledge acquisition depends on the fidelity of the environments, the interfaces to these systems and the methods of training. In this connection, MacEachern and Kraak (2001) concluded that the development of tools and methods to assist navigation and preserve orientation in virtual environments was a major challenge for researchers. For this reason, the present research performs an orientation activity with a virtual environment generated through VR and Google Street View. This spatial navigation model provided by the Google Street View application in VR corresponds to the Multiscale Progressive Model (Zhang, 2008). This model considers that navigation with orientation is a process in which navigation tasks are redefined step by step, such as when you are looking for a street, and in order to find it, it is necessary to transit through other streets. The navigation is composed of a series of subtasks at different levels in which to perform a subtask it is necessary to finish the previous one. To complete these subtasks in the search for a street we need spatial orientation, through which we plan the objective, the path to be followed and a continuous evaluation of the results. In the wayfinding process the environment is perceived

and our spatial perception is updated, so that if a subtask has not been completed, more movement is needed. "Spatial knowledge guides movement, and movement updates spatial knowledge" (Patel and Vij, 2010). This author proposed a list of quality factors for VR-based spatial learning techniques: "Speed of learning" (speed in the realization of cognitive maps), "Navigation Efficiency" (it is more efficient when fewer steps are taken and less distance is travelled to complete a task), "Accuracy" (nearness to the desired goal), "Spatial Awareness" (orientation and constancy of position within the environment during and after navigation), "Ease of Learning" (the ease of the user to deal with the technique), "Ease of Use" (the complexity of the technique perceived by the user), "Information Gathering" (the user's ability to obtain information about the environment while navigating), "Presence" (perception by the user of the immersive process in the environment), and finally, "User Comfort" (the possible effect of nausea or dizziness on the user).

In the experiment carried out in this research, VR Google Street View meets all quality factors except the last one. At the end of the present experiment the participants responded a questionnaire in which they were asked if they had been dizzy using VR glasses: 50% responded that they had not become dizzy, but 15% got a little dizzy, 12.5% got dizzy, 10% got relatively dizzy and 12.5% got very dizzy.

THE EXPERIMENT

Design

In the present experiment, the participants navigated along three predesigned routes using virtual reality 3D glasses, and completed a psychometric measure of spatial orientation before and after this training.

There are numerous applications and games in VR that occur in vehicles, but this experiment arises from the perspective of a user who is walking through a 3D urban environment looking for certain places. In this sense, Patel and Vij (2010) suggested that the estimation of distances and orientation is better achieved by walking than driving a vehicle. The urban environment is coincident with the "Landmark-Route-Survey" (or LRS) model of spatial knowledge representation, described by Siegel and White (1975), and Thorndike and Godin (1983). Objects typical of urban environments allow the construction or decomposition of any locality: significant milestones or signals, routes or paths that connect the landmarks and nodes (interchanges or junctions between routes).

In the present research, the user experiences a sensation of immersion in a 3D virtual environment through the smartphone integrated in 3D glasses, and moves around the environment (exploratory navigation) thanks to a joystick with Bluetooth connection. It is an experiment in VE as a preparation aid for real world navigation tasks.

Materials

The urban environment was displayed through the Google Street View application on Smartphones. The hardware for the experiment was 15 Woxter Neo VR glasses equipped with a joystick each one for remote control. The participants used their own Smartphone devices.

The spatial orientation skill can be measured through a test (Alinas et al., 2002), and in this research the Perspective Taking Spatial Orientation Test was used. This test was designed by Kozhevnikov and Hegarty (2001), and used by others such as Hegarty and Waller (2004), Carbonell et al. (2011, 2015), Carbonell (2017), and Carbonell and Bermejo (2017) in workshops similar to the one carried out in this research in which other technologies and methodologies for the development of spatial orientation have been used.

Completed using paper and pencil, it consists of 12 exercises, each on one page, to be done in 5 minutes. The participant sees a picture of a group of six objects in the top half of the page (cat, house, stop sign, car, stop light, tree and flower), and imagines that he or she is standing by one object (station point) and facing towards another object. The score for each item is the absolute deviation in sexagesimal degrees between the answer given for the participant and the correct direction to target. The total score is the average deviation across all items, so the lower the score obtained, the greater success rate.

In order to measure the gain obtained by the students in spatial orientation skill performing the workshop, the participants completed the test before (pre-test) and after (post-test) the activity.

Also, in order to know if the students felt dizzy when using the virtual reality glasses, the participants answered a questionnaire.

Participants

The participants were 32-second year engineering students from La Laguna University (19 males, 13 females) with a mean age of 21.5 and a standard deviation of 1.85, from the 2016-17 academic course. None of them had prior training in spatial orientation in VR environments. All participants signed a document called "informed

consent" on the experiment to be performed, according to the 95/46/CE European Directive and Organic Law 15/1999 of the Spanish Cabinet Office number 298.

At the University of La Laguna there have been workshops for the development of the spatial orientation skill from the 2010-11 to the 2015-16 academic course, in which, as in this case, students from the second engineering course participated. These workshops had included a control group in each of them. A total of 95-second year engineering students belonged to these control groups. The control group captures what could have been the outcome if the activity had not been complemented. It serves, in turn, to know if the possible improvement obtained is due to the effect of the training or is due to the so-called recall effect of the test. The research conducted with these workshops (Carbonell, 2017; Carbonell and Bermejo, 2017) has shown that students who did not participate in the workshops did not achieve a statistically significant gain in their spatial orientation skill. The gains and *p*-values obtained where 5.29º degrees (*p*-level = 0.113) and 2.62º degrees (*p*-level = 0.202) respectively. Therefore, in the activity performed in this research no control group has participated because it has been sufficiently demonstrated that the spatial orientation skill does not experience a significant increase in students who do not participate in specific training.

Procedure

The activities to be carried out in the present workshop are based on previous research on spatial orientation with navigation in immersive virtual environments (Witmer et al., 1995; Waller et al., 1998; Koh et al., 2000; Darken and Peterson, 2001).

In the first phase (½ hour): students were provided with 30 minutes to connect the smartphone to the 3D VR glasses, and connect the joystick through Bluetooth. Once all the connections work, students familiarize themselves for a while with the interface. Prior to the activity participants were told to install the 3D Street View Application on their smartphones.

In the second phase (½ hour): this phase is performed without using the virtual reality glasses. A predefined two routes were given to the participants in a sketch. The two routes are from point A to point B (going) and from point B to point A (return) by different paths. They were instructed to remember the routes and the related information (streets, landmarks, turns…). They were told that once the process of learning the routes on the sketch were completed, they could not consult or display this information again.

In the third phase (1 hour): students put on virtual reality 3D glasses, started from the point of origin and followed the routes proposed according to the information acquired in the previous phase. Each time they reached a crossroad they had to turn to go to the next direction. In each route they were asked for successive control points, details (landmarks) that appeared on the route, like for example the colour of a house, the name of one street or the name of a shop. To get to the target, spatial orientation was acquired through the information obtained from successive views at the ground level perspective in a 3D urban environment. While navigating, students perceive surrounding space and they construct their own cognitive map (the internal cartographic representation that each person makes of the environment). In this process they identify places and landmarks, directions, routes and distances, among others. During the experiment, the instructor was listening the verbal reports of the participants on the landmarks, to verify if the route taken was correct. If the landmarks were not correct, the instructor would communicate it to the student in order to repeat the navigation until finding the correct landmark and thus continue the correct navigation task. All students completed the two routes, but some took longer time than others. No student exceeded the one-hour of phase 3 assigned to do it.

DATA ANALYSIS

The effect of the experiment carried out on the spatial orientation skill was analysed by the paired samples *t*-test since the assessment test provided a single score. The working hypothesis was: Urban virtual environments displayed with the VR Street View Application develop the spatial orientation skills of university students. Note that the lower the score the greater the success obtained, given that the score is the difference in degrees between the correct answer and the one given by the participant (**Table 1**).

Table 1. Perspective Taking/ Spatial Orientation Test average values

Perspective-Taking Spatial Orientation Test Average values and level of significance				
Participants	Pre Mean Score (s.d.)	Post Mean Score (s.d.)	Gain	*p*-level
N=32	47.21 (28.43)	34.39 (22.18)	12.81 (13.97)	0.000006<0.01

s.d. Standard deviation

According to the *t*-test, the participants developed their spatial orientation skill in 12.81º sexagesimal degrees. The significance level (*p*-level<0.01) did not reach 1%, therefore the null hypothesis was rejected and stated, with a significance level over 99,9%, that the gain was statistically significant.

The average score in the Pre-test is 47.21. Therefore, taking into account that according to the score of the test, the higher score the lower spatial orientation skill, two groups (High level < 47.21 and Low level > 47.21) were considered according to their initial spatial orientation score (Pre). (**Table 2**).

Table 2. High / Low spatial orientation level (pre-test) groups

High / Low spatial orientation level (pre-test) groups				
Spatial orientation pre-level group	Pre Mean Score (s.d.)	Post Mean Score (s.d.)	Gain	*p*-level
High spatial orientation level (*Pre*-score <47.21) N=17	24.56 (8.39)	17.18 (7.62)	7.38 (4.84)	0.0000<0.01
Low spatial orientation level (*Pre*-score >47.21) N=15	72.87 (19.52)	53.90 (15.97)	18.97 (18.14)	0.001<0.01

s.d. Standard deviation

Both groups, High and Low spatial orientation level, developed their spatial orientation skills in 7.38 (*p*-level = 0.0000) and 18.97 (p-level = 0.001) respectively. The difference in the gain between the two groups was significant (*p*-level = 0.0082), which allows us to state that Low spatial orientation level group improved more their spatial orientation skill than High spatial orientation level group in this experiment.

By gender (**Table 3**), both, males and females, developed their spatial orientation skill after the training session: 14.19 (*p*-level = 0.00178) and 10.80 (*p*-level = 0.00026), respectively. Males obtained a higher gain than females, although the difference was not significant (ANOVA results: *f*-ratio=0.44736, *p*-level = 0.509). This coincides with the experiment carried out by Carbonell et al. (2011), Carbonell et al. (2012), and Carbonell and Bermejo (2017).

Table 3. Perspective Taking/ Spatial Orientation Test average values by gender

Perspective-Taking Spatial Orientation Test Average values and level of significance by gender				
Participants	Pre Mean Score (s.d.)	Post Mean Score (s.d.)	Gain	*p*-level
Male N=19	42.10 (30.71)	27.91 (17.36)	14.19 (16.89)	0.00178<0.01
Female N=13	54.67 (23.91)	43.88 (25.57)	10.80 (8.29)	0.00026<0.01

s.d. Standard deviation

Results of Previous Experiments for Spatial Orientation Skill Development

In order to contextualize these data, results of three workshops specifically designed for the improvement of the spatial orientation skill are described.

The participants who performed these workshops were second year engineering students of La Laguna University, such as those who participated in the experiment carried out in this paper. In addition, the measurement was performed with the Perspective Taking-Spatial Orientation test. In all of them the students took the test before the workshops (pre-test) and at the end of the workshops (post-test). The results of these workshops are in **Table 4**.

Table 4. Previous experiments for spatial orientation skill development

Previous experiments for spatial orientation skill development					
Technology	Perspective Taking/Spatial Orientation Test				Spatial Orientation acquisition by:
	N	Pre-test (s.d.)	Post-test (s.d.)	Gain (s.d.)	
SDI Geoportal	248	46.93 (25.29)	27.72 (18.91)	19.21 (15.54)	- Survey learning (map reading)
GISc Spatial Thinking	158	44.55 (21.74)	25.49 (16.73)	19.06 (16.13)	- Survey learning (map reading) - Wayfinding
Augmented Reality	63	46.01 (13.65)	25.87 (14.73)	20.14 (14.80)	- Survey learning (map reading) - Landform interpretation
Total	469	46.01 (23.42)	26.72 (17.68)	19.28 (15.62)	

s.d. Standard deviation

SDI Geoportal Workshop (Carbonell et al., 2015): the experiment was conducted during four academic years 2009-2010, 2010-2011, 2011-2012 and 2012-2013. The methodology employed to develop the spatial orientation skill was as a Geoportal: The Spatial Data Infrastructure (SDI-Workshop). In the instruction of the SDI-Workshop the participants determined locations and perspectives in urban environments using maps, plans, orthophotos and 3D displays.

GISc Spatial Thinking Workshop (Carbonell, 2017): carried out with 158 engineering students, using the geographic information science GISc resource, during the 2010-2011, 2011-2012, 2012-2013 and 2013-14 academic years. In this case, students performed activities related to spatial-thinking acquisition: survey learning (with maps) and route-based learning (with the Street View application on a pc screen).

Augmented reality Workshop (Carbonell and Bermejo, 2017): done with Augmented Reality technology and tablets with 63 engineering students during the 2014-15 academic year. Participants determined locations from landforms using their spatial orientation skill to make a 2D/3D interpretation through visualizing the appearance of scenes from different points of view.

The gain obtained in the present research using VE (12.81, 13.97 s.d.) is less than that obtained with the SDI resource (19.21, 15.54 s.d.), the GISc resource (19.06, 16.13 s.d.) and Augmented Reality technology (20.14, 14.80 s.d.). The results of the ANOVA analysis shows that these differences in gains are not significant at $p<0.01$ (*f*-ratio=1.80622, *p*-value=0.14507). In the SDI workshop participants developed their spatial orientation skill through map reading. With the GISc resource the spatial orientation acquisition was made through map reading and route based learning. For route based learning, the participants used the Google Street View app, in which the interface to the virtual environment was a desktop display with a keyboard and one mouse. It is the most similar experience to that performed in the present research, because the same app was employed but in a different virtual environment display. In the third case, the students worked with landforms represented in 2D (conventional relief representation with traditional cartographic techniques like contour lines, among others) and in 3D with augmented reality (in addition to map reading and wayfinding, other authors like Nardi et al. (2010), Newcombe and Shipley (2015), and Carbonell and Bermejo (2017) consider landform interpretation as an activity for which spatial orientation is necessary).

DISCUSSION, CONCLUSIONS AND FUTURE WORK

Planning an orientation activity in a real-world open environment is complex. It takes a lot of time to do it (participants 'round trip to where they are going to do the activity) and this is complex to fit into the students' academic schedules. In addition, it could be difficult by factors such as weather conditions and the level of disability that a student might present. The present research describes a Teaching/Learning strategy in a virtual urban environment using the VR Innovative educational technology as a training aid for real world navigation tasks.

Virtual Reality may be useful for training the spatial orientation skill. Virtual urban environments displayed with the VR Google Street View Application developed the spatial orientation skill of university students in 12.81° sexagesimal degrees (13.97 s.d.). The gain in spatial orientation was significantly higher (*p*-level = 0.0082) for those participants who had a lower level of spatial orientation skill at the beginning of the experiment (Pre-test). Virtual reality training, therefore, appears to be more effective for those with less spatial orientation skill compared to those with a higher spatial orientation skill. This could also be due to the fact that those with a higher level of spatial orientation have a lower profit margin. There is no research on this subject, so as a future work this issue could be studied. On the other hand, and also as future work, an additional post-test could be performed some weeks after the intervention to check if there is persistence in the results. In this way it could be known the long-term reach of this technology for the improvement of spatial abilities.

In relation with previous experiments, the average gain 12.81° (13.97 s.d.) obtained in the workshop carried out in the present research is less (although not significantly: *f*-ratio=1.80622, *p*-value=0.14507) than that obtained with other resources and/or technologies to enhance spatial orientation, with an average gain of 19.28° (15.62 s.d.). The common denominator of this 19.28° average gain is the use of maps along with other technologies and/or resources like GISc, Geoportals and Augmented Reality. The use of maps, therefore, continues to be a great complement along with other technologies for the development of spatial orientation, since in the present experience no maps have been used and the gain has been less.

This conclusion is similar with that obtained by Waller et al. (1998), who said that VR training is not more efficient than map reading for the acquisition of spatial orientation, although we must consider that virtual reality techniques are now much more advanced than in 1998. Most recent research (Roca-González et al., 2017) on the development of the spatial orientation skill, in which the use of maps was combined with VR, showed similar gains as those obtained with the SDI, GISc and AR workshops. This, together with the results obtained in the present research, confirms the importance of cartography as a complement to virtual reality and another methodologies and techniques for the acquisition of spatial ability.

Analysing the results by gender, there are no statistically significant differences in gain in spatial orientation obtained by women and by men after specific training (f-ratio=0.44736, p-level = 0.509). Some references have been cited in which the result by gender is similar (Roca-González et al., 2017; Carbonell et al., 2011; Carbonell et al., 2012; Carbonell and Bermejo 2017), although there is also other research that concluded otherwise (Carbonell, 2017). Liu et al. (2011) found, in study of gender with different orientation strategies, that there was no difference in tasks related to spatial orientation like landmark recognition and left-right orientation, and that males were better than females in path reversal and cognitive maps. They concluded that differences in gender might be due to operating with the orientation material provided. Other research (Coluccia and Louse, 2004; Coluccia et al., 2007) corroborates this claim. Therefore, for a gender study on spatial orientation, specific analysis should be carried out for each of the orientation activities and for each technology used.

As future work, pedestrian VR interfaces such as the treadmill-style interface or robot tiles with actuated shoes could be analysed from two points of view. One, to analyse their impact on spatial orientation and two, to study if they provoke dizziness in users, as in the case of the present research, in which 50% of participants felt dizzy, and even 12,5% got very dizzy during the experiment using VR glasses.

ACKNOWLEDGEMENTS

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Effects of Hands-on Activities on Conservation, Disgust and Knowledge of Woodlice

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ABSTRACT

Although hands-on activities significantly improve achievement and attitudes toward animals, the use of the aesthetically unpleasant is questionable. We investigated whether the use of woodlouse, as an example of an unpopular animal, alters children's conservation attitudes, disgust for and knowledge of woodlice. The experimental group (n = 116), but not the control group (n = 110), achieved a better woodlouse conservation score with hands-on activities, but the intentions for woodlouse conservation were not generalized for conserving other animals. Disgust for woodlice was not influenced by the treatment, but females, albeit more disgust sensitive than men, showed higher conservation scores than men. Woodlouse knowledge scores significantly increased in both groups. In summary, this study demonstrates both the benefits and limits of using animals which are aesthetically unpopular, but essential parts of biodiversity and food chains.

Keywords: achievement, emotion, pupils, woodlice

INTRODUCTION

One of consequence of the current environmental crisis is deforestation and biodiversity loss around the globe (Betts et al., 2017; Wang and Loreau, 2016). A critical task of biology and science educators is to develop students' positive attitudes toward living organisms (Iozzi, 1989; Tomažič et al., 2017) which may be crucial in their pro-environmental decisions later in life (Kellert, 1997). The use of typical flagship species (Clucas et al., 2008; Senzaki et al., 2017), however, does not guarantee any changes in attitudes toward less popular, but equally important animals in ecosystems (Douglas and Winkel, 2014; Thomas-Walters and Raihani, 2017). Thus, a focus on perception of unpopular animals is required.

Invertebrates traditionally meet with a negative perception by people, irrespective of age or gender (Borgi and Cirulli, 2015; Kellert, 1993; Schlegel and Rupf, 2010; Wagler, 2010; Wagler and Wagler, 2011). Indeed, invertebrates receive lower conservation support (Black et al., 2001; Cardoso et al., 2011) and less attention by scientists in respected wildlife journals (Grodsky et al., 2015) than vertebrates. The assumed reasons for disliking invertebrates lie in their high phylogenetic distance, small size and morphological/behavioural dissimilarity with humans (Kellert, 1993). The ultimate reasons may stem in disease avoidance. Many invertebrates can be found, for example, in neglected places, and, thus, could be associated with dirt (Davey, 1994). Indeed, attitudes toward invertebrates are predominantly influenced by the emotion of disgust (Davey, 1994; Lorenz et al., 2014; Prokop and Jančovičová, 2013; but see Breuer, 2015) which evolved in order to protect ourselves against a potential pathogen threat (Curtis et al., 2004; Oaten et al., 2009; Tybur et al., 2013).

Research on the views of students revealed that invertebrates are heavily underestimated parts of ecosystems, although they are an essential part of biodiversity and food chains (Snaddon and Turner, 2007; Yli-Panula and Matikainen, 2014). Guidance on how to implement invertebrates into science education has been published (Matthews, Flage, and Matthews, 1997) and research on hands-on activities has emerged. It has been shown, for example, that hands-on activities improve both attitudes to and knowledge of invertebrates (Klingenberg, 2014; Prokop and Fančovičová, 2017; Randler, Hummel, and Wüst-Ackermann, 2013). Surveys have demonstrated a positive association between knowledge of insects and attitudes toward them (Kellert, 1993; Silva and Minor, 2017). These delicate relationships, however, could easily be broken due to negative experiences with invertebrates

Contribution of this paper to the literature

- Hands-on activities with aesthetically unpleasant, unpopular animals positively influenced children's willingness to protect them, particularly with females.
- Disgust sensitivity remained unchanged even after manipulation with woodlice in the experimental group.

(Schonfelder and Bogner, 2017; Silva and Minor, 2017) and elicit disgust which inhibits intrinsic motivation (Randler et al., 2013). This is particularly important when considering females who are more disgust sensitive than males (e.g., Curtis et al., 2004; Oaten et al., 2009, Prokop and Fančovičová, 2010) and dislike unpopular animals more than males (Bjerke, Østdahl, and Kleiven, 2003; Jimenez and Lindemann-Matthies, 2015; Lindemann-Matthie, 2005; Prokop et al., 2009a; Prokop et al., 2009b; Prokop and Tunnicliffe, 2010; Prokop and Fančovičová, 2010).

In the present study we investigated how hands-on activities influence knowledge of and attitudes to woodlice, one of the least popular animals (Randler, Hummel, and Prokop, 2012; Randler, Hummel, and Wüst-Ackermann, 2013). These creatures are very advantageous, however, from the view of educational needs, being common, widespread, and easily observed, and not subject to significant seasonal variation (Hawkey, 2001). Our research questions were: Do hands-on activities with woodlice enhance participants' attitudes toward animal conservation? Do hands-on activities with woodlice improve participants' knowledge of them? Are there any gender differences in attitudes to and knowledge of woodlice?

MATERIALS AND METHODS

Participants

Research was conducted at Varín primary school with 226 participants of the age of 10 – 15 (grades 5 – 9). The survey sample consisted of a total of 10 classes, 5 groups constituting an experimental group (116 students) and five classes of a control group (110 students). The control group did not work with the woodlouse *Porcelio scaber*, and the experimental group worked with the animal during the lessons of biology within the experiment.

Research Instruments

We used a questionnaire as a research tool which contained statements about knowledge of woodlice. The questionnaire was anonymously distributed in September 2016 as a pretest and in October 2016 as a posttest. The same questionnaire was completed by the control and experimental groups before the experiment and after the treatment. The total time needed to complete the tests was ~ 20 minutes.

The questionnaire consisted of similar items as in Prokop and Fančovičová (2017). The validity and reliability were sufficient. The first part was related to gender and individual signs for matching tests. The second part was made up of statements relating to measuring animal conservation (one item: "It is important to protect all animals"), measuring woodlice conservation (six items, example: "Protection of woodlice is very important", pre-test Cronbach's $\alpha = 0.75$), measuring disgust for woodlice (seven items, example: "It is disgusting to handle woodlice", pre-test Cronbach's $\alpha = 0.84$) and measuring knowledge of woodlice (11 items, example: "Woodlice breathe with their gills", pre-test Cronbach's $\alpha = 0.45$). Pathogen Disgust, which refers to disgust elicitors caused by sources of various pathogens, was adopted from Tybur et al. (2009). This domain consists of seven Likert scale items (pre-test Cronbach's $\alpha = 0.77$). All items were rated by children on the Likert scale (1 = completely disagree, 5 = absolutely agree). We calculated the individual scores of all the scales by averaging the responses to the constituent items. The negative statements were scored in reverse.

Procedure

Students gained new knowledge about woodlice through an active approach in the experimental group, or with a traditional transmissive way in the control group. In both groups, a 45 min long lesson was held in accordance with the educational standard. All groups were guided by the same trained teacher.

The lesson in the control group began with a discussion about animals living in human surroundings. An exposition of the lesson then followed. We specifically used methods of interpretation and description. The students were passive listeners, who occasionally answered questions. The presented information by the teacher contained the basic characteristics of life, the characteristics of the conditions necessary for life and also information about their usefulness and meaning in nature. Woodlouse images were used instead of living individuals. The children in the experimental group were divided into groups according to the number of students in each class. One group of children had a maximum of four members. Since they manipulated living organisms, they were

instructed how to carefully handle animals, with the need to return them to nature and also with safety at work. The students received the necessary tools, worksheets, and 10 woodlice placed in Petri dishes.

The children in the experimental group used worksheets in order to record the results of their research. A problem task was formulated at the beginning which students were supposed to predict. All the tasks were discussed in advance so that each student was clear about what to verify. Students then verified the predictions of all the research tasks. Finally, each task was discussed and evaluated with all the children together. The conclusions for each activity were written down.

Brief Description of the Hands-on Activities

Students gained new knowledge about woodlice through an active approach in the experimental group, or with a traditional transmissive way in the control group. In both groups, a 45 min long lesson was held in accordance with the educational standard. All groups were guided by the same trained teacher.

Morphology of the wooodlouse

The first research task was focused on an external morphological structure of the body of an adult. The role of the students was to observe morphological features using a magnifying glass. Data were recorded by the students in the table in the worksheet. After careful observation of the external construction of the body and its morphological features, the students had to draw an adult woodlouse and describe the external structure of the body.

The natural environment

The second research task was to find out what conditions are natural to the life of woodlice. The students intentionally changed the environment: temperature, light intensity, humidity, and observed the reaction of woodlice to the changes in the environment. The results of their observations were recorded in the prepared table at the end of the worksheets.

• The influence of temperature

Children divided the Petri dish in half and labelled the border with a marker. Children then put 10 woodlice in a Petri dish with warm water in half and an ice cubes in the second half of the Petri dish. The students then observed in which part of the Petri dish the woodlice were more concentrated. The observations were repeated at 1 minute intervals every 4 minutes, and the data was recorded in the worksheets.

• Light intensity

Children placed 10 woodlice on the Petri dish, with half of the Petri dish covered with black coloured paper and the other half uncovered. Similar as in the previous experiment, children recorded the number of woodlice in each half of the Petri dish within a time interval.

• Humidity

Ten woodlice were, once again, placed in the Petri dish. One half of the Petri dish was covered with a damp filter paper and the other half with dry filter paper. Children recorded the transfer woodlice movement between the dry damp filter paper at time intervals. The total number of woodlice in each type of filter paper was recorded on the worksheets.

Summary of the experiments

There was a short text about woodlice at the end of the worksheet. Students filled in the empty spaces with the text based on their observations and manipulation with the particular woodlice. The aim of the activity was to repeat and fix the knowledge acquired during the practical activities.

Statistical Analyses

Mean pre-test and post-test scores from animal conservation, woodlice conservation, disgust from woodlice, and knowledge of woodlice were defined as dependent variables in a series of Generalized Linear Models (GLM). The influence of pre-test and post-test was treated as a within-subject factor. Categorical predictors were treatment (experimental and control group), gender and grade (5 – 9). Mean Pathogen disgust (PD) pre-test score was defined as covariate.

RESULTS

Animal Conservation

Mean pre-test (M = 3.89, SD = 1.10, n = 226) and post-test (M = 4.02, SD = 0.10, n = 226) animal conservation scores suggested that children have positive attitudes toward conservation. None of the measured variables significantly influenced the mean animal conservation scores (all $p > 0.1$) except for the Test-Retest Conservation × Treatment interaction term ($F(1, 218) = 5.15$, $p = 0.02$). This result was somewhat unexpected because mean conservation post-test scores of children from the control group were significantly lower than in the pre-test scores. In contrast, children from the experimental group displayed similar mean scores in both the pre-test and post-test.

Woodlice Conservation

There were no differences in the woodlice conservation score between the experimental and control group ($F(1,218) = 1.11$, $p = 0.29$). The Test-Retest Woodlice Conservation × Treatment interaction term ($F(1, 218) = 7.54$, $p = 0.007$) suggests, however, that the mean post-test conservation score significantly increased in the experimental, but not in the control group (**Figure 1**). Females demonstrated higher conservation scores than males ($F(1,218) = 4.53$, $p = 0.03$) and younger children manifested higher conservation scores than older children ($F(1,218) = 10.44$, $p < 0.001$). The interaction term Test-Retest Woodlice Conservation × Grade means that ninth graders achieved much higher post-test scores than children from other grades ($F(4,218) = 7.36$, $p < 0.001$). The influence of pathogen disgust (covariate) approached a statistical significance ($F(1,218) = 3.46$, $p = 0.06$) suggesting that higher conservation scores correlated reversely with pathogen disgust (pre-test and post-test, $\beta = -0.05$ and 0.13, $p = 0.39$ and < 0.05, respectively). The remaining effects were not statistically significant.
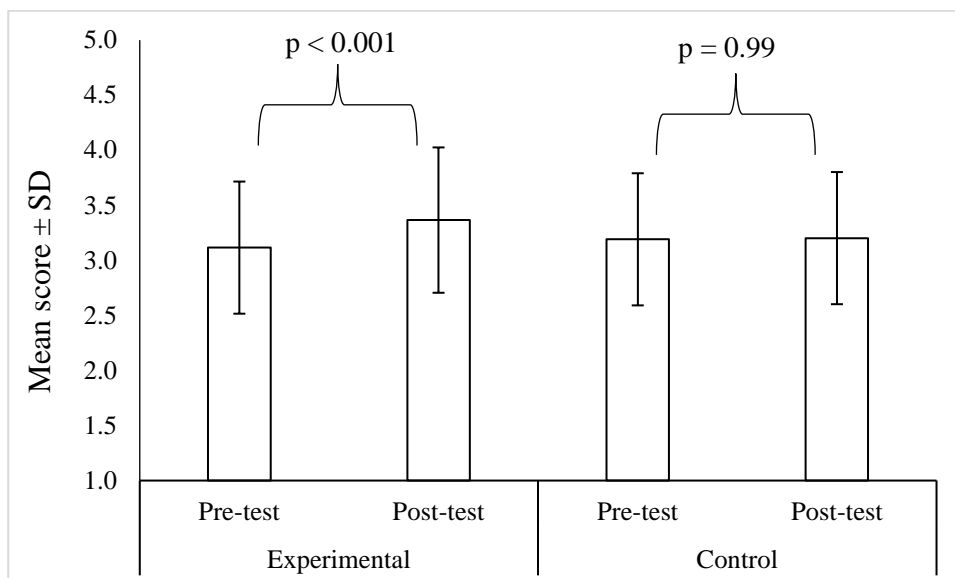
Figure 1. Differences in mean scores for woodlice conservation with respect to treatment. Differences between means were calculated with Tukey post-hoc test

Disgust for Woodlice

Females scored higher in disgust for woodlice than males (**Figure 2**). Pathogen disgust (covariate) significantly and positively correlated with disgust for woodlice ($F(1,218) = 73.6$, $p < 0.001$) both in the pretest and post-test ($\beta = 0.48$ and 0.40, both $p < 0.001$, respectively). Other effects, including interaction terms, were not statistically significant (all $p > 0.13$). Note that the exclusion of PD from the model did not influence these results.
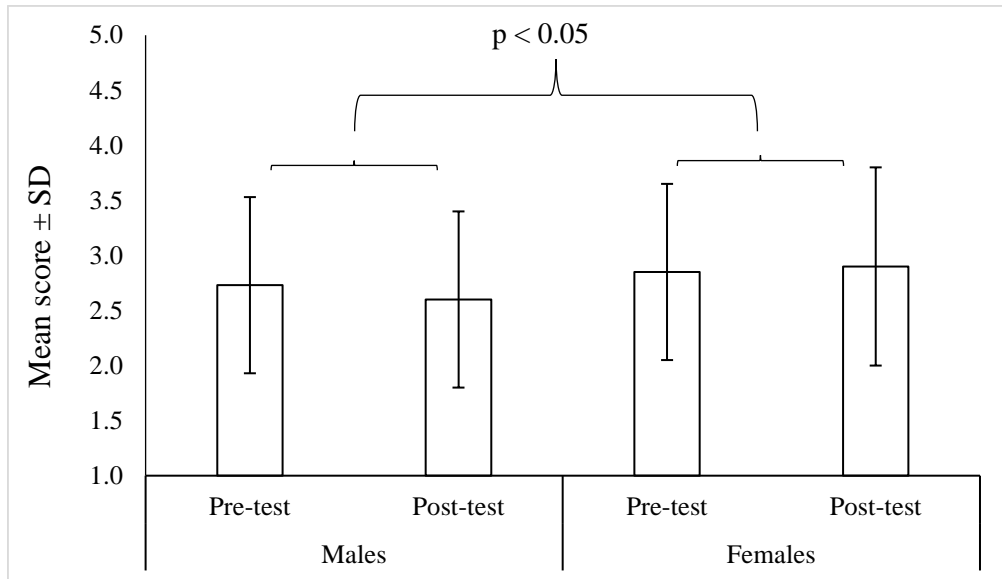
Figure 2. Gender differences in disgust from woodlice

Knowledge of Woodlice

The woodlice knowledge score was significantly influenced by the effect of grade ($F(4,218) = 10.14$, $p < 0.001$), while the effect of treatment approached a statistical significance ($F(1,218) = 3.56$, $p = 0.07$). The effect of grade is of low educational importance, because it only showed that seventh graders had higher scores than fifth, sixth and ninth graders and eighth graders displayed lower scores. Pathogen disgust (covariate) and gender were not associated with the knowledge score ($F(1,218) = 0.42$ and 1.75, $p = 0.52$ and 0.18, respectively). The post-test knowledge score significantly increased in both groups ($F(1,218) = 23.8$, $p < 0.001$, **Figure 3**), albeit somewhat higher in the experimental group (Test-Retest Knowledge × Treatment interaction term, $F(1,218) = 6.41$, $p < 0.05$). Test-Retest Knowledge × Gender interaction term ($F(1,218) = 3.97$, $p < 0.05$) suggests that the knowledge score of girls increased more than the knowledge score of boys. The remaining Test-Retest Knowledge × PD interaction term was not statistically significant ($p = 0.89$).
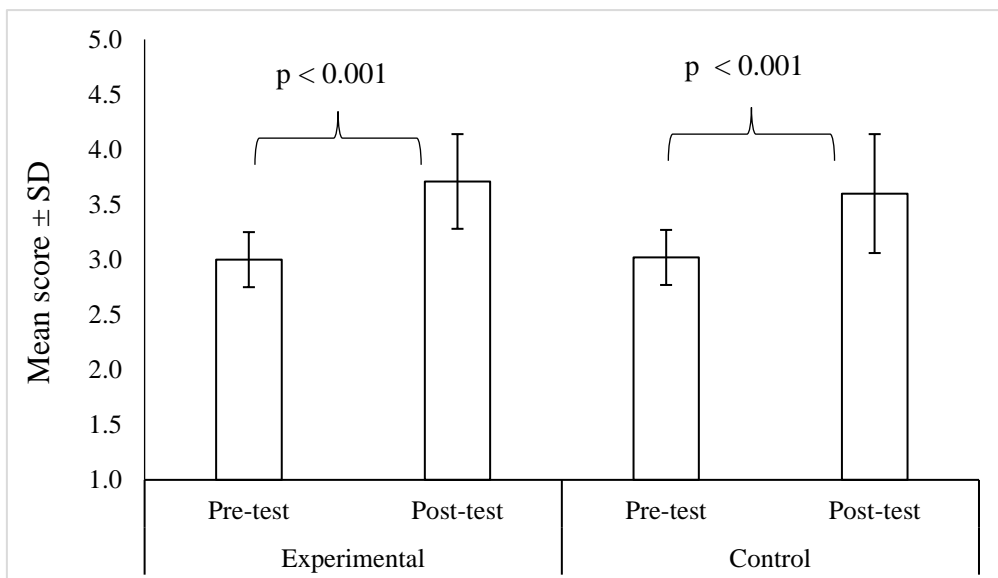
Figure 3. A comparison of knowledge scores with respect to pre-test/post-test and treatment

DISCUSSION

This study investigated the effect of hands-on activities on animal conservation, particularly woodlice, disgust and knowledge of woodlice. We found that although hands-on activities manifested positive influences on woodlice conservation and knowledge, there was not an influence on willingness to protect animals in general, nor on perceived disgust for woodlice. Females seemed to be influenced by hands-on activities more than males.

Animal / Woodlice Conservation

Animal conservation scores did not increase which suggests that hands-on activities with woodlice do not improve children's willingness to protect animals. It is possible that the influence of hands-on activities is very specific and only focused on focal animal(s), or that working with unpopular animals is not efficient in improving conservation attitudes. To support the latter, people are generally willing to protect predominantly charismatic, and aesthetically pleasant, animals (Gunnthorsdottir, 2001; Knight, 2008; Martín-López et al., 2007; Prokop and Fančovičová, 2013; Thomas-Walters and Raihani; 2017). It may be that more organisms should be involved in hands-on activities to better explain ecological relationships between the focal animal (here: the woodlouse) and its environment. Alternatively, perhaps the selection of a charismatic, flagship animal may produce different results. It should also be noted that the use of only one item scale to measure willingness to protect animals might not be sensitive enough to detect possible changes.

The mean scores for woodlice conservation, however, significantly increased in the experimental group, suggesting that although the woodlouse is an unpopular animal (Randler, Hummel, and Prokop, 2012; Randler, Hummel, and Wüst-Ackermann, 2013), attitudes toward it can be successfully improved. This result is in agreement with research showing that physical contact with animals has a positive impact on attitudes toward them (e.g., Ballouard et al., 2012; Morgan and Gramann, 1989; Randler et al., 2005; Tomažič, 2008).

Disgust Sensitivity

Conservation scores negatively correlated with pathogen disgust demonstrating that more disgust sensitive people are less willing to protect unpleasant animals. This finding extends our current knowledge about the role of disgust sensitivity in conservation attitudes (Jacobs et al., 2014; Prokop and Fančovičová, 2013; Prokop et al., 2016).

In contrast with some previous studies (e.g. Prokop et al., 2017; Randler, Hummel, and Prokop, 2012), we failed to find a decrease in disgust scores among children in the experimental group. Although this result seems to be in sharp contract with previous research, it can be explained with the relatively higher popularity of snails (Prokop et al., 2017; Randler, Hummel, and Prokop, 2012) or mice (Randler, Hummel, and Prokop, 2012) used in hands-on activities. Another possibility is that children need more time to work with woodlice to decrease disgust for them.

Gender

Females demonstrated higher disgust sensitivity to woodlice, but, paradoxically, their conservation scores increased significantly more than scores of males. A similar situation occurred in a survey on attitudes toward frogs where females were similarly more disgust sensitive, but promoted conservation more than males (Prokop et al., 2016). Interestingly, gender differences in willingness to protect animals are sometimes completely missing (Knight, 2008; Prokop and Fančovičová, 2013). It might be argued that deeper environmental concerns which were not examined in this study might be responsible for the higher willingness to protect woodlice by females. Clearly, further in-depth research in this field is required.

Knowledge

Both the experimental and control group achieved higher knowledge scores after the treatment, although previous research showed that higher achievement scores occurred predominantly in the experimental groups (e.g., Prokop et al. 2017; Randler, Ilg, and Kern, 2005). At first look, it could be suggested that hands-on activities are meaningless in this case, because certain alternatives, such as videos, can be viable alternatives to work with live animals (Sammet, Kutta, and Dreesmann, 2015). Several researchers, however, reported positive correlations between attitudes to animals and knowledge (Kellert, 1993; Prokop, Kubiatko, and Fančovičová, 2008; Silva and Minor, 2017). In our study, knowledge increased in both groups, but conservation scores increased only in the experimental group. Thus, it is possible that not knowledge *per se*, but knowledge strengthened by physical experiences improved conservation attitudes. This explanation seems to be invalid, however, because correlations between attitudes and knowledge were statistically significant in both the experimental and control group as well as for pre-test and post-test scores (results not shown). An increase in conservation attitudes seems to be independent from the influence of knowledge, at least in the present study.

Pre-test Cronbach's α for the knowledge domain was 0.45 which is below recommended minimum (Nunnaly, 1978). Lower reliabilities for knowledge domains are common in this kind of research (e.g., Prokop et al., 2007; Prokop and Fančovičová, 2008; Prokop, Fančovičová, and Kubiatko, 2009). Thus, some caution must be made when interpreting these data.

CONCLUSION

Biology lessons may benefit from inclusion of hands-on activities with living organisms, but these benefits are not limitless (Holstermann, Grube, and Bögeholz, 2010). Hands-on activities with woodlice, as an example of an unpopular, but common and easily observed animal, provide benefits in terms of improved conservation efforts, but these efforts seem to be generalized to other animals. Disgust for woodlice was not influenced by hands-on activities and the knowledge gain was similar between the experimental and control group. Further research is required to test whether the use of animals differing in popularity influences perception of other, wild animals.

ACKNOWLEDGEMENTS

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The Impact of Problem-Solving Instruction on Middle School Students' Physical Science Learning: Interplays of Knowledge, Reasoning, and Problem Solving

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ABSTRACT

The purpose of this study is to explore the impact of problem solving instruction on 126 middle school students' learning of physical science in terms of their scientific knowledge, scientific concept dependent reasoning and problem solving ability. This study used a quasi-experiment with one factorial design of instructional approaches (problem solving and traditional hands-on learning). Sixty-one students participated in problem solving while sixty-five students participated in traditional hands-on learning. Results indicate that the problem solving group significantly outperformed the traditional hands-on learning group for both immediate and retaining effect, regardless of scientific knowledge, scientific concept dependent reasoning and scientific problem solving abilities. The regression results also indicated that the scientific concept dependent reasoning test is the best predictor for scientific problem solving ability, followed by scientific knowledge itself. Our study demonstrates that students' scientific knowledge, reasoning and problem solving all are successfully improved after receiving six weeks scientific problem solving.

Keywords: physical science, scientific problem solving, scientific reasoning, scientific knowledge, problem solving instruction

INTRODUCTION

Problem solving involves "actionable knowledge" which embodies the inter-meshing of thought and action (Watts, 1994). Watts further suggested that the practical use of knowledge gives problem solving relevance and also encourages the transfer of knowledge across different subject domains and contexts (Watts, 1994). Studies have indicated that learning to solve problems in scientific domains, such as physics, requires understanding conceptual knowledge (Hambrick & Engle, 2003; Lucangeli, Tressoldi, & Cendron, 1998). Voss, Greene, Post, & Penner (1983) found that domain-specific knowledge was the best predictor of performance in solving ill-structured problems. Other studies have pointed out that reasoning is related to problem solving (Bransford, 1994; English, 1996; Lee & Jeon, 1998), and others have reported that students' reasoning ability can predict their problem solving performance (Cavallo, 1996; Sonnleitner et al., 2013). However, there is a lack of studies exploring whether students' scientific knowledge, scientific concept dependent reasoning and scientific problem solving can be improved by participating in a semester-long problem solving program. Furthermore, there is a shortage of studies that explore the relationship among scientific reasoning, scientific knowledge and problem solving. Thus, our study specifically investigated the effectiveness of problem solving in enhancing students' scientific knowledge, scientific concept dependent reasoning and problem solving ability across time, and the relationships among reasoning, scientific conception and problem solving.

Literature

Researchers have proposed different models of problem solving. Garrison's (1991) model included the phases of problem identification, problem description, problem exploration, applicability, and integration, and

Contribution of this paper to the literature

- This paper demonstrated that the problem solving group significantly outperformed the traditional hands-on learning group, regardless of immediate and retention performance of scientific knowledge, reasoning and problem solving abilities after receiving six weeks scientific problem solving laboratory across a semester.

- The inclusion of problem solving instruction in the normal classroom learning for the middle school students was considered suitable and promising.

- The scientific concept dependent reasoning test is the best predictor for scientific problem solving ability, followed by scientific knowledge itself.

emphasized students' prior knowledge and ability to use their knowledge to develop problem-solving approaches. Other researchers viewed the problem solving process as including representing problems, searching for solutions, and implementing solutions (Bransford, 1994; Jonassen, 1997; Newell & Simon, 1972). Chua et al. (2016) further connected different stages of problem solving learning (meeting the problem, problem analysis and learning issues, discovery and reporting, and solution presentation and evaluation) to different cognitive functions which mainly included looking from different views, generating ideas, making connections, and synthesis. Despite the differences, in general these models share the following attributes for problem solving: extract the given and goal information, search through the mental problem space which accesses prior domain knowledge, connect it to existing knowledge, and implement the solution-finding processes required to act on the problem.

During the construction of a problem representation which is typically the first stage of the problem solving process, certain features of the problem may activate problem-relevant knowledge in memory (Kintsch & Greeno, 1985; Wang & Chiew, 2010). A problem solver's schema containing a solution goal and features matched for that particular type of problem may then be activated. Many studies have shown that problem solving strategies are schema driven. If problem solvers recognize the problem type that they have represented, they can more easily apply the solution that is associated with the problem space (Chen, 2010; Gick, 1986; Hmelo-Silver, 2004; Kirschner et al. 2006). These studies tended to point out that activating prior knowledge and prior experience of solved problems in terms of schema is critical for solving problems successfully. All of these aforementioned studies serve as the basis for developing our problem-solving learning structure. To guide learners in solving complex problems, appropriate instructional support should be provided and integrated into the learning environment (Kirschner et al. 2006; Van Merrienboer, Kirschner, & Kester, 2003). We structured our problem solving scaffolds with five major components: identify known conceptions (search prior domain knowledge from memory) to facilitate solving proposed problem (unknown information), provide more than two possible solutions (provide detailed steps and strategies for each solution), evaluate their own solutions (decide which solution is more plausible and provide explanations), perform the experiment according to the most applicable design, and challenge students' evidence based explanations according to their results.

It has been found that expert problem solvers use strong domain-specific strategies that are also specific to the problem types, an approach which makes them more efficient (Bulu & Pedersen, 2010; Mayer, 1992; Wang et al., 2013; She et al., 2012). In addition, learning to solve problems in scientific domains, such as physics, requires conceptual knowledge (Hambrick & Engle, 2003; Lucangeli et al., 1998). Heller & Hollabaugh (1992) suggested that physics problem solving at the college level can help students learn problem solving strategies. She et al. (2012) reported that college students' chemistry problem solving abilities increased significantly after a semester of online problem solving learning. Voss et al. (1983) found that domain-specific knowledge was the best predictor of performance in solving ill-structured problems. Other studies reported that middle school students' ecology related problem solving ability was correlated with domain-specific knowledge (She et al., 2012). These studies shared similar suggestions of that domain-specific knowledge is critical for problem solving. Interestingly, most of these problem solving studies was conducted in the online learning environment. Hmelo-Silver (2004) conducted a review of problem based researches and reported that the majority of studies focus on higher education as their target but seldom on K-12 education. In short, it is hardly found any studies of problem solving that were implemented in science classrooms or laboratory at the middle school level. To address that research gap, this study specifically designed a semester-long physical science problem solving program for middle school students. The aim of the study was to explore whether problem solving can facilitate better performance among students in terms of both scientific knowledge and problem solving compared to traditional hands-on learning. Moreover, the study sought to determine whether a relationship between students' physical science knowledge and their problem solving performance could be found in a middle school physical science program.

Scientific reasoning has been reported as a core cognitive process in which learners construct scientific conceptions (Lawson & Thompson, 1988; Lawson & Worsnop, 1992; Oliva, 2003). The nature of reasoning pertains to the process of drawing conclusions from principles and evidence (Wason & Johnson-Laird, 1972), moving on

from what is already known to infer new conclusions or to evaluate a proposed conclusion. Schunk (2000, p. 289) suggested that reasoning involves identifying and formulating questions and hypotheses, analyzing elements and defining terms, using information from personal observations and previous inferences, proceeding inductively or deductively, and finally judging the adequacy of a solution. One study suggested that deductive reasoning – the process of reasoning from one or more general statements about what is known in order to reach a logically certain conclusion – is a fundamental part of problem solving (English, 1996; Johnson-Laird, 2000; Rips, 1999). Deduction implies that thinking involves combining existing information by following specific mental operations. Scientists use a general theory or idea to move through a sequence of ideas and arrive at specific conclusions. Gipson, Abraham & Renner (1989) and Lawson & Renner (1975) contended that solving and interpreting genetics problems involves formal-level operations such as combinatorial, proportional, and probabilistic reasoning, which is consistent with Piaget's developmental theory. Cavallo (1996) reported that students' reasoning ability can predict their performance in solving genetics problems. Few studies have either reported that students' earth science problem solving ability is related to their reasoning skills (Chang, 2010) or that problem-based instruction can develop students' scientific reasoning habits in problem solving skills (Becerra-Labra, Gras-Marti & Torregrosa, 2012). Even though some of the studies suggested a relationship between reasoning and problem solving, however, the existence of such a relationship remains debatable, such that more empirical evidence is needed to confirm it. Therefore, this study aims to explore the effectiveness of problem-solving tasks and traditional hands-on learning tasks in terms of students' scientific knowledge, scientific concept dependent reasoning and problem solving performance. This will allow a better understanding of how students' scientific knowledge, scientific concept dependent reasoning and problem solving performance interact with each other.

PURPOSE

Many studies have demonstrated the relationship between scientific reasoning and problem solving, or that between scientific knowledge and problem solving. However, less research has been conducted investigating the relationship among scientific concept dependent reasoning, scientific knowledge and problem solving performance. Particularly, none of the studies have examined the effectiveness of a semester-long physical scientific problem solving program versus that of a traditional hands-on learning program. In short, our research focuses on three unsolved issues: (1) whether there are any differences between scientific problem solving learning and traditional hands-on learning in terms of students' scientific knowledge, scientific concept dependent reasoning and problem solving performance; (2) whether students' scientific knowledge, scientific concept dependent reasoning and problem solving performance would be improved over time by receiving instruction in scientific problem solving; and (3) what the relationships are among students' scientific knowledge, scientific concept dependent reasoning and scientific problem solving performance.

METHOD

Participants

A total of 126 eighth graders recruited from four average-achievement classes in a middle school participated in this study. In the first two classes, consisting of sixty-one participants, received the problem solving tasks (the experimental group), and the other two classes, consisting of sixty five students, received traditional hands-on learning tasks (the control group). Classes were assigned to either the experimental or control groups based upon the students' school science achievement. An ANOVA was performed to test their school science achievement, and it showed that the two groups had an equivalent initial ability (F=0.04, p=0.884) at the beginning of this study. All of the students received a scientific knowledge test, scientific concept dependent reasoning test and problem solving test before instruction, immediately after instruction, and six weeks after instruction.

Procedure

Our study took place over two class periods for each problem solving session and one class period for each traditional hands-on session over a total of six weeks. The first week was defined as the practice task. Each class period lasted about 45 minutes. Both groups received the same traditional lecture across the six-week semester, and each received either problem solving or traditional hands-on learning tasks. Two teachers were assigned to teach in each of the two groups. For the experimental group, there were a total of 28 class periods of lecture instruction and 12 class periods of problem solving learning tasks. For the control group, students received 34 class periods of traditional lecture instruction and 6 class periods of step-by-step traditional hands-on learning tasks that covered the same physical science experiment as the experimental group.

The implementation of traditional hands-on learning tasks followed the school's mandatory laboratory textbook. The teacher guided the students to follow the step-by-step procedures in the textbook, including when, where, and how to conduct the experiment. Students followed each step, observed the phenomena, recorded data, and drew conclusions. The students who received traditional hands-on learning worked in groups from beginning to end, including above procedures and discussion. The same experiments for the traditional hands-on group were modified to problem solving tasks. The problem solving group was required to solve the problems according to the structure of problem solving: identify known conceptions (search prior domain knowledge from memory) to facilitate solving proposed problem (unknown information), provide more than two possible solutions (provide detailed steps and strategies for each solution), evaluate their own solutions (decide which solution is more plausible and provide explanations), perform the experiment according to the most applicable design, and challenge peers' evidence based explanations according to their results. When receiving instruction for a problem solving task, students basically work on individually while identifying known concepts, identifying proposed problem, providing more than two possible solutions, and evaluating their own solutions. Following these steps, the group members will get together to discuss and determine the most applicable experimental designs from a collection of their group members' plans and then perform the experiment. They will then return to working individually on the work sheet to answer application level questions which require them to use the scientific evidence they collected from the experiment. The major difference between problem solving tasks and traditional hands-on tasks is that students need to come up with their own solutions with detailed designs and procedures instead of following the textbook step-by-step procedure. Each of the step-by-step traditional learning tasks only took about one class period to finish. However, the same experiment modified to a problem solving task took about two class periods to finish. Therefore, the traditional hands-on group had more time for lecture instruction than did the problem solving group.

Development of Physical Science Problem Solving Tasks

The problem solving tasks were designed to develop students' problem solving ability. The five problem solving sessions were specifically developed to cover the content of oxidation and reduction, chemical reaction velocity, chemical reaction equilibrium, friction, and water pressure. The design of each problem solving learning task was structured into five steps to scaffold students' ability to solve the problem. The problem solving task was structured to start with identifying known conceptions - students needed to search prior domain knowledge from memory which might help solve the problem. After they identified the known conception, students needed to identify what were the possible factors causing the proposed question in order to help them to solve the problem. Once they finished these two parts, students must then provide more than two possible solutions to solve the problem solving task with proposed steps and strategies. Following that, students must evaluate their own solutions and decide which solution was more applicable, giving explanations and performing the experiment according to the most applicable design. Finally, a set of questions were designed to see whether students were able to interpret the data and results and also give explanations.

For example, one of the problem solving tasks related to oxidation and reduction is to require students to generate two possible solutions in order to identify the rank of chemical activity for three unknown elements. Carbon, three unknown elements (X, Y, Z) powders and their oxides (XO, YO, ZO) powders were given to students. Students followed the problem solving steps to solve the problem (**Appendix I**). On the other hand, the traditional hands-on learning tasks also covered the same oxidation and reduction content as the problem solving group and were asked to observe the changes of four elements (magnesium, copper, zinc, carbon) and their oxides after they were heated. The same elements and their oxides powders and their names of elements were given to students (**Appendix I**).

INSTRUMENTS

Scientific Knowledge Test (SKT)

The SKT is a multiple choice diagnostic instrument developed for this study to measure students' knowledge of physical science-related concepts before, after, and six weeks after receiving the physical science problem solving learning tasks or traditional hands-on learning tasks. The questions required students to use the knowledge they learned from the physical science. There were six items for topic 3 (chemical reaction velocity) and the other four topics each had seven items, for a total of 34 items. Students received one point for each question they answered correctly, so the highest possible score is 34. The Cronbach α of the SKT was 0.73 for the pretest, 0.90 for the posttest, and 0.89 for the retention-test.

Scientific Concept Dependent Reasoning Test (SCDRT)

The SCDRT is a two-tier multiple choice diagnostic instrument that was developed for this study to measure the correctness of students' physical science conception and their reasoning regarding the concepts relevant to the topic of the problem solving teaching before, after, and six weeks after learning. The SCDRT required students to use scientific reasoning to reason and process physical science-related concepts in order to answer both tiers correctly. There were five items for each topic, and each item contained two tiers: the first tier checked whether students had scientific concepts or alternative concepts, and the second tier required students to use scientific reasoning on physical science-related concepts. There were 25 items and each item had two tiers. Students need to answer both tiers correctly in order to receive one point, so the highest possible score was 25. The Cronbach α of ADRT was 0.71 for the pretest, 0.89 for the posttest, and 0.89 for the retention-test.

Scientific Problem Solving Test (SPST)

The SPST was developed to measure students' scientific problem solving before, after, and six weeks after problem solving/ traditional hands-on learning. The SPST consisted of five dimensions which require students to 1) identify known conceptions that might help solve the problem, 2) provide possible explanations for the problem, 3) provide two possible solutions to solve the problem, 4) evaluate their solutions and decide which one is the most applicable solution, and 5) interpret data and results. There were six problem solving tasks, and each covered one topic. Each problem solving tasks consisted of five sub-questions specifically designed to measure the five dimensions of problem solving described above. A rubric system was used to code their performance for each dimension. The rubric addressed the correctness of the known conceptions, correctness of explanations, applicability of the solutions, appropriateness of the students' evaluation, and correctness of data and results interpretation. The known conceptions were classified as correct, partially correct, or incorrect, with points awarded of one, half, and zero point. Each solution was classified as applicable, partially applicable, and non-applicable, with points awarded of one, half, and zero. The problem solving performance for each question was achieved by adding the scores of the five dimensions together. The inter-rater reliability was 0.92.

The content validities for all three instruments were established by a panel of six evaluators consisting of five middle school science teachers and a university science education professor, who together ensured that the items were properly constructed and relevant to the physical science learning materials. The expert validities were established by another experienced middle school science teacher and another science education expert.

Experimental Group Students' Scientific Problem Solving Worksheet Analysis

The experimental group's students' problem-solving performance on the scientific problem solving tasks which they worked individually to answer application level questions in the working sheets was evaluated by a rubric scoring system. The rubric system evaluates their problem-solving performance according to the following five dimensions: identify known conceptions to facilitate solving proposed problem, provide more than two possible solutions, evaluate their own solutions, design and perform the experiment according to the most applicable design, and challenge peers' evidence based explanations according to their results. The rubric combined both quantity and quality measures. For the quality, it addressed the relatedness of the known conceptions, the feasibility of the methods he/she developed, the correctness of the student's evaluation. For instance, the known conceptions were classified as related, partially related, or unrelated, with points awarded of one, half, and zero point. Each solution was classified as workable, partially workable, and non-workable, with points awarded of 1, 0.5, or 0. Each evaluation was classified as correct, partially correct, and incorrect with points awarded of 1, 0.5, or 0. Each design item was classified as workable, partially workable, and non-workable, with points awarded of 1, 0.5, or 0. Each evidence based explanations was classified as correct, partially correct, and incorrect with points awarded of 1, 0.5, or 0. For the quantity, the repeated measure of ANOVA was used to measure any increase in students' problem-solving task performance from task 1 to 5.

RESULTS

Scientific Knowledge Test (SKT)

One-factor MANCOVA was conducted to examine the effects of instructional approaches using post- and retention-SKT scores as the dependent measures, and students' pre-SKT scores as the covariate. **Table 1** summarizes the results of the one-factor MANCOVA: specifically, instructional approaches (Wilk's Λ=0.94, *p*= 0.030) had a statistically significant effect on the performance of post- and retention-SKT. Then univariate F (one-factor ANCOVA) was performed to independently examine the effect of the instructional approaches on post- and retention-SKT. This indicated that the effects for instructional approaches on both post-SKT (F=4.83, *p*= 0.030) and

Table 1. Multivariate Analysis of Covariance (MANCOVA) of Post- and Retention- of Scientific Knowledge Test (SKT) Scores, Scientific Concept Dependent Reasoning Test (SCDRT) Scores, and Scientific Problem Solving Test (SPST) Scores

Source of Variance	Wilk's Λ	Hypothesis df	Error df	Multivariate F
Scientific Knowledge Test (SKT)				
Covariates				
Pre-test scores	0.56	2	122	47.20***
Group memberships				
Instructional approaches	0.93	2	122	4.76*
Scientific Concept Dependent Reasoning Test (SCDRT)				
Covariates				
Pre-test scores	0.73	2	122	23.17***
Group memberships				
Instructional approaches	0.93	2	122	4.68*
Scientific Problem Solving Test (SPST)				
Covariates				
Pre-test scores	0.68	2	122	28.44***
Group memberships				
Instructional approaches	0.70	2	122	25.62***

Note. ***$p < 0.0001$, **$p < 0.001$, *$p < 0.01$

Table 2. MANCOVA and ANCOVA of Instructional Approaches of Post- and Retention- of Scientific Knowledge Test (SKT) Scores, Scientific Concept Dependent Reasoning Test (SCDRT) Scores, and Scientific Problem Solving Test (SPST) Scores

	Univariate F		Post-hoc
	Post-test	Retention-test	
Scientific Knowledge Test (SKT)			
Instructional Approaches	8.37**	5.56*	Post : Problem solving instruction >Conventional instruction (0.005) Retention: Problem solving instruction > Conventional instruction (0.020)
Scientific Concept Dependent Reasoning Test (SCDRT)			
Instructional Approaches	6.85*	8.43**	Post : Problem solving instruction >Conventional instruction (0.010) Retention: Problem solving instruction > Conventional instruction (0.004)
Scientific Problem Solving Test (SPST)			
Instructional Approaches	51.39***	18.78***	Post : Problem solving instruction >Conventional instruction (0.000) Retention: Problem solving instruction > Conventional instruction (0.000)

Note. ***$p < 0.0001$, **$p < 0.001$, *$p < 0.01$

retention-SKT (F=5.67, *p*=0.019) were significant. Thus, the students' post- and retention-SKT were significantly affected by the instructional approach. The post-hoc analysis for the main effect suggests that the problem solving group performed significantly better than the traditional hands-on learning group ($p_{(post)}$=0.030, $p_{(retention)}$ =0.019) on post-SKT ($p_{(post)}$=0.030) and retention-SKT ($p_{(retention)}$ =0.019) (**Table 2**). In summary, the problem solving group outperformed the traditional hands-on learning group on both post- and retention-performance of **s**cientific knowledge involving physical science.

Scientific Concept Dependent Reasoning Test (SCDRT)

One-factor MANCOVA was conducted to examine the effects of instructional approaches using post- and retention-SCDRT scores as the dependent measures, and students' pre-SCDRT scores as the covariate. **Table 1** summarizes the results of the one-factor MANCOVA: specifically, instructional approaches (Wilk's Λ=0.91, p= 0.006) had statistically significant effect on the performance of post- and retention-SCDRT. Then univariate F (one-factor ANCOVA) was performed to independently examine the effect of the instructional approaches on post- and retention-SCDRT. This indicated that the effects for instructional approaches on both post-SCDRT (F=10.43, p= 0.000) and retention-SCDRT (F=6.33, *p*=0.002) were significant. Thus, the students' post- and retention-SCDRT were significantly affected by the instructional approach. The post-hoc analysis for the main effect suggests that the problem solving group performed significantly better than the traditional hands-on learning group on post-SCDRT ($p_{(post)}$=0.002) and retention-SCDRT($p_{(retention)}$=0.013) (**Table 2**). In summary, the problem solving group

Table 3. Stepwise multiple Regression Summary for relationships among Independent and dependent variables for the experimental group

	B	SE B	β	Sign.	R	R²
Post- Scientific Problem Solving Test (SPST)						
Model 1						
(Constant)	0.48	0.90		0.590		
Post-Scientific Concept Dependent Reasoning (SCDR)	1.33	0.11	0.727***	0.000	0.73	0.53
Model 2						
(Constant)	-2.36	1.25		0.061		
Post-Scientific Concept Dependent Reasoning (SCDR)	0.72	0.22	0.390**	0.002		
Post- Scientific Knowledge Test (SKT)	0.48	0.15	0.385**	0.002	0.75	0.56
Retention- Scientific Problem Solving Test (SPST)						
Model 1						
(Constant)	-1.39	0.87		0.110		
Retention -Scientific Concept Dependent Reasoning (SCDR)	1.49	0.12	0.745***	0.000	0.75	0.55
Model 2						
(Constant)	-3.73	1.37		0.007		
Retention -Scientific Concept Dependent Reasoning (SCDR)	1.04	0.24	0.519***	0.000		
Retention - Scientific Knowledge Test (SKT)	0.37	0.17	0.260*	0.031	0.76	0.57

Note. ***p＜0.0001, **p＜0.001, *p＜0.01

outperformed the traditional hands-on learning group on both post- and retention-performance of scientific concept dependent reasoning involving physical science.

Scientific Problem Solving Test (SPST)

One-factor MANCOVA was conducted to examine the effects of instructional approaches using post- and retention-SPST scores as the dependent measures, and students' pre- SPST scores as the covariate. **Table 1** summarizes the results of the one-factor MANCOVA: specifically, instructional approaches (Wilk's Λ=0.91, p= 0.006) had statistically significant effect on the performance of post- and retention-SPST. Then univariate F (one-factor ANCOVA) was performed to independently examine the effect of the instructional approaches on post- and retention- SPST. This indicated that the effects for instructional approaches on both post-SPST (F=10.43, p= 0.000) and retention-SPST (F=6.33, p=0.002) were significant. Thus, the students' post- and retention-SPST were significantly affected by the instructional approach. The post-hoc analysis for the main effect suggests that the problem solving group performed significantly better than the traditional hands-on learning group on post-SPST ($p_{(post)}$=0.002) and retention-SPST ($p_{(retention)}$ =0.013) (**Table 2**). In summary, the problem solving group outperformed the traditional hands-on learning group on both post- and retention-performance of scientific problem solving involving physical science.

Stepwise Multiple Regression Analysis among Problem Solving, Scientific Knowledge, and Scientific Concept Dependent Reasoning for the Experimental Group

The stepwise multiple regression method was used to explore whether scientific knowledge and scientific concept dependent reasoning would predict students' scientific problem solving. The first model indicated that the post-scientific concept dependent reasoning was the only significant factor for predicting their post-scientific problem solving performance (β=0.73, p < 0.000). The second model indicated that the post-scientific concept dependent reasoning was the primary significant factor for predicting their problem solving performance (β=0.390, p =0.002), followed by post-scientific knowledge (β=0.385, p = 0.002) (**Table 3**). Similar pattern was found for the retention-scientific problem solving, the first model indicated that retention-scientific concept dependent reasoning was the only significant predictor for retention-scientific problem solving (β=0.745. p<0.000). The second model indicated that the retention-scientific concept dependent reasoning was the primary significant factor for predicting their problem solving performance (β=0.519, p < 0.000), followed by retention-scientific knowledge (β=0.260, p = 0.031) (**Table 3**).

Experimental Group's Students' Laboratory Scientific Problem Solving Performance

The repeated measures of ANOVA were conducted to examine the effect of the five problem solving tasks on the problem-solving performance across six dimensions, known knowledge, methods, explanations for a method, experimental design, estimating the experimental results, and assessment to given results. Results indicated that

Table 4. The Repeated measure of ANOVA in students' problem-solving task performance from task 1 to 5 for the experimental group

	Mean	SD	F value of repeated measures ANOVA	Post-hoc comparisons
Identify known Conception				
Task 1	0.38	0.24	57.77*** (0.000)	2>1 (0.000)、2>3 (0.000)、2>4 (0.000)、2 >5 (0.000)、3>1 (0.000)、3>4 (0.002)、3> 5 (0.022)、4>1 (0.000)、5>1 (0.000)
Task 2	3.23	1.58		
Task 3	1.64	1.11		
Task 4	1.12	0.72		
Task 5	1.14	0.95		
Provide Solutions				
Task 1	0.62	0.42	38.40*** (0.000)	2>1 (0.000)、2>3 (0.000)、2>5 (0.000)、3 >1 (0.000)、3>5 (0.000)、4>1 (0.000)、4> 3 (0.009)、4>5 (0.000)
Task 2	1.86	0.49		
Task 3	1.36	0.74		
Task 4	1.77	0.71		
Task 5	0.65	0.94		
Evaluate Solutions				
Task 1	0.53	0.34	49.83*** (0.000)	2>1 (0.000)、2>3 (0.000)、4>1 (0.000)、4 >2 (0.000)、4>3 (0.000)、4>5 (0.014) 、5> 1 (0.000)、5>2 (0.001)、5>3 (0.000)
Task 2	0.90	0.40		
Task 3	0.61	0.36		
Task 4	1.55	0.57		
Task 5	1.29	0.61		
Design and Perform Experiment				
Task 1	0.48	0.33	50.26*** (0.000)	2>1 (0.000)、2>3 (0.000)、3>1 (0.000)、4 >1 (0.000)、4>3 (0.000)、5>1 (0.000)、5> 3 (0.000)
Task 2	2.71	1.04		
Task 3	1.72	1.29		
Task 4	2.92	1.07		
Task 5	2.89	1.49		
Evidence Based Explanations				
Task 1	0.47	0.63	47.29*** (0.000)	2>1 (0.000)、2>3 (0.000)、3>1 (0.000)、4 >1 (0.000)、4>2 (0.002)、4>3 (0.000) 、4> 5 (0.006)、5>1 (0.000)、5>3 (0.000)
Task 2	2.29	1.04		
Task 3	1.78	1.44		
Task 4	3.16	1.69		
Task 5	2.56	1.34		

the five different tasks have a statistical significant effect on the problem-solving performance across all six dimensions (**Table 4**). The post hoc showed that the mean score of the 1st task is significantly lower than that of the 2th to 5th tasks across all six dimensions. The problem-solving performance of the 1th to 5th tasks fluctuated but revealed a significant progress as compared to the 1nd task.

DISCUSSIONS

Our results demonstrated that the problem solving group performed significantly better than the traditional hands-on learning group on their immediate and retention performance of scientific problem solving. The possible explanation is that the problem solving tasks were developed and modified from many previous theories proposed in problem solving studies (Chua et al., 2016; Gick, 1986; Hmelo-Silver, 2004, 2007; Kirschner et al. 2006; Simon, 1978). The design of problem solving task required each learner to conduct the following cognitive processes on an individual basis except when performing the experiment: identifying known conceptions - students need to search prior domain knowledge from memory which might help solve the problem; identifying the possible factors causing the proposed question in order to help them solving the problem; providing more than two possible solutions to solve the problem solving task with proposed steps and strategies; evaluating their own solutions and deciding which solution is more applicable with explanations; performing the experiment according the most applicable design; answering a set of questions designed to see whether students were able to interpret the data and results with explanation. Our study demonstrated that well-designed and theory-based design problem solving tasks indeed successfully fostered their problem solving performance which is consistent with previous studies involving web-based biological and chemistry problem solving learning (She et al., 2012; Yu et al., 2010). We also went one step beyond our previous studies, insofar as this study actually required students to design and perform a real experiment in a laboratory in order to test and prove their solutions. That is, they had to conduct the experiment to see whether or not their best solution would actually work, rather than just generating more than

two solutions and evaluating those solutions conceptually. Our results further demonstrated that the inclusion of problem solving learning in the normal classroom learning for the middle school students was considered suitable and promising. This conclusion is also supported by several previous studies that found that problems with more than one solution can help students to develop their problem solving strategies (Klegeris et al., 2016; Mann et al., 2016; Tao, 2001). Some previous studies suggested that successfully solving a problem requires certain skills and abilities, such as the ability to understand the problem, the skill to apply and synthesize prior knowledge about the problem, the ability to make decisions about how to proceed, the knowledge of how to access the measures taken in the resolution processing, and being able to analyze the results (Harskamp & Ding, 2006; Hmelo-Silver, 2007; Maloney, 1994), all of which we include in our design to scaffold students' learning. One possible argument might arise that the problem solving group outperformed the traditional hands-on group because the problem solving group has taken two classes and traditional hands-on group has taken one class period. However, the control group receives six more lectures than did the experiment group. Due to such limitations as both group receiving different amount of hands-on classes and lectures, further research might be needed for clarification.

Our findings provide convincing evidence that the problem-solving learning group performed significantly better than the traditional hands-on learning group on their immediate and delay scientific knowledge performance. It indicated that receiving six problem solving tasks would efficiently promote students' science concept construction as compared to the traditional hands-on learning even though traditional hands-on learning group received six more traditional lecture classes than the problem solving group. This is also supported by Tao's (2001) study that found problems with multiple solutions can help students to develop their understanding of physics concepts. Previous studies suggested that learning to solve problems successfully in scientific domains, such as physics, requires understanding prior conceptual knowledge (Hambrick & Engle, 2003; Lucangeli, et al., 1998). Problem solving would enhance students' ability to reorganize their prior scientific knowledge and help them to consolidate their knowledge efficiently into their long term memory. This supports the idea of the construction of a problem representation, in which certain features of the problem may activate and link knowledge in memory (Kintsch & Greeno, 1985; Kirschner, 2006; Wang et al., 2013). The schema for that particular type of problem may then be activated and reorganized. As they go through problem solving tasks each semester, they are not just promoting their problem solving abilities; they are also developing better understanding of science knowledge. Our study provides evidence of problem solving indeed promotes students' domain specific knowledge, which was unclear before.

Our findings demonstrated that the problem solving group outperformed the traditional hands-on learning group on both immediate and retaining performance of scientific concept dependent reasoning involving physical science through receiving six times of problem solving. It is consistent with a previous study that reported problem based structure instruction can develop students' scientific reasoning habits and problem solving skills (Becerra-Labra et al., 2012). Our design requires students to search their prior knowledge for information relevant to the new problem, identify the possible factors relevant to the proposed question from their long-term memory, develop two possible solutions, and evaluate possible solutions, all of which heavily involves reasoning ability. This supports the previous study that reasoning pertains to the process of drawing conclusions from principles and from evidence (Wason & Johnson-Laird, 1972), moving on from what is already known to infer new conclusions and to evaluate a proposed conclusion. Our design of problem solving tasks prompts each individual student to use their scientific reasoning throughout the process, which is why the problem solving group performed significantly better than the traditional hands-on learning group on their scientific concept dependent reasoning.

Our stepwise regression results indicated that the best predictor for immediate scientific problem solving performance was their immediate scientific concept dependent reasoning performance and followed by their immediate scientific knowledge. In addition, the best single predictor for delayed scientific problem solving performance was delayed scientific concept dependent reasoning performance and followed by their delay scientific knowledge. Previous studies have reported t reasoning is strongly correlated with problem solving (Chang, 2010; Lee & Jeon, 1998; Sonnleitner et al., 2013), however, our results move one step further to indicate that scientific reasoning is highly correlated with problem solving and also is the best predictor for problem solving. Our result further confirms that scientific concept dependent reasoning is critical for physical science problem solving. Moreover, our results somehow resemble the report of Voss et al. (1983) that domain-specific knowledge was the best predictor of performance in solving ill-structured problems, except that our study found that scientific knowledge is a second good predictor for students' problem solving performance. Our study further implies that scientific concept dependent reasoning is a better predictor than scientific knowledge for problem solving regardless of immediate or delayed performance.

Within the problem solving group (experimental group), our results indicated that the students' problem-solving performance reached a statistical significant progress across all of the five dimensions including identify known conceptions to facilitate solving proposed problem, provide more than two possible solutions, evaluate their own solutions, design and perform the experiment according to the most applicable design, and challenge students'

evidence based explanations according to their results. The problem-solving tasks in this study provided students with recurrent opportunities for five tasks across a semester and significantly improved students' problem-solving performance. It clearly indicated that problem solving instruction can effectively promote students problem solving ability after a practice task and formal 1st task learning. In other words, students' problem solving ability rise up sharply right after two tasks' problem solving learning. Though it fluctuated from 2nd to 5th task which might due to the content difficulty are varied from task to task. However, the mean score of 1st problem solving performance was at the lowest point comparing to the latter tasks. The results were in line with some studies showing that problem-solving can be efficient under an instructional design with well-constructed scaffolds (Kim & Hannafin, 2011; She et al., 2012).

In summary, when given repeated opportunities to learn by problem solving, students can reason based on their prior knowledge to connect their past experiences with new situations and can engage in the scientific practices of questioning, inferring, making inquiries, evaluating and explaining in order to learn content knowledge. This study demonstrated empirically that well-designed problem solving teaching indeed improved students' performance in terms of content knowledge, reasoning and problem solving and thus suggests that problem solving teaching is suitable for inclusion in the normal curriculum for middle school students.

ACKNOWLEDGMENTS

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APPENDIX I

Examples of Problem solving and traditional hand-on learning

	Problem solving	**Tradition hands-on learning**
Topic	• Please generate two possible solutions in order to identify the rank of chemical activity for three unknown elements.	• Observed the changes of four elements and two oxides after heating.
Related materials were given	• Carbon, three unknown elements (X, Y, Z) powders and their oxides (XO, YO, ZO) powders.	• Four elements (Magnesium, copper, zinc, carbon) and carbon dioxide, copper oxide
Instructional steps	*Step1. identify known conceptions to facilitate solving proposed problem* Please provide what are the possible concepts and knowledge that you have learned can help you to identify the rank of these elements chemical activity Step 2. provide more than two possible solutions What are the two solutions you can use to classify the rank of these elements chemical activity? Step3. Evaluate their own solutions Please evaluate each solutions you provided to determine which one is more workable and plausible than the other and with your explanations. *Step 4 perform the experiment according to the most applicable design* Please provide the most applicable design and perform the experiment. *Step 5. challenge students' evidence based explanations according to their results* We provide a real experiment results for students and ask students to provide their explanation and conclusions according to their experiment evidence.	• Follow laboratory book step by step • Step 1. Use alcohol burner to heat a scoop holding a slice of magnesium, and observe its changes. Step2.Use alcohol burner to heat a scoop of copper powder, and observe its changes. Step3.Use alcohol burner to heat a scoop of zinc powder, and observe its changes. Step4.Use alcohol burner to heat a scoop of carbon powder, and observe its changes. Step5 Use alcohol burner to heat a test tube with both carbon and copper oxide, and observe its changes. Step 6 Use alcohol burner to heat a scoop holding a slice magnesium then put into a jar with carbon dioxide, and observe its changes. Step 7. Compare the rank of chemical activity for these four elements: carbon, copper, magnesium, and zinc according to the experiment results.

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Effects of The Practice of Experiential Education on Employee Self-Efficacy and Organizational Commitment in Catering Industry

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ABSTRACT

Under the social pattern with gradual increase in consuming ability and the enhancement of the citizens' emphasis on leisure travel, the rapidly increasing outside dining has catering businesses move toward diversified brand management. The ratio of labor force employed in the relevant industries and catering industry in Taiwan in total labor force employed and the employment population are increasing. It becomes critical to promote the competitiveness of catering businesses through complete educational training systems. Aiming at the supervisors and employees of Wowprime Corp., total 500 copies of questionnaire are distributed and 384 valid copies are retrieved, with the retrieval rate 77%. The research results show significant correlations between 1.experiential education and elf-efficacy, 2.self-efficacy and organizational commitment, and 3.experiential education and organizational commitment. Eventually, suggestions are proposed, expecting to assist catering businesses in educating the employees, reducing costs for the enterprises, and enhancing the competitiveness.

Keywords: catering industry, experiential education, employee self-efficacy, organizational commitment

INTRODUCTION

The 21st century is an era when people enjoy information richness, technology progress, rapid social change, convenient life, and close international relationship but face fiercely international competition. "People" are the major element of the sustained management of an enterprise. It becomes an important issue for an enterprise promoting the personnel to be excellent talents. A lot of enterprises devote to developing complete educational training systems to enhance organizational personnel's productivity and job satisfaction and further promote higher job satisfaction. Meanwhile, under the social trend of low fertility and aging, personnel recruitment becomes more difficult. In addition to recruitment, employees' retention is another effort for enterprises, who expect to reduce learning obstacles and enhance employees' learning confidence through the complete educational training system, to effectively reduce the turnover rate caused by personnel's maladaptation and largely reduce the cost for enterprises. Under the social pattern with increasing consuming ability and the citizens' enhancing emphasis on leisure travel, the increasing outside dining has catering businesses gradually move toward diversified brand management, expecting to create higher operating revenue. A lot of catering brands are accordingly emerging.

Regarding education, experiential education has gradually become a primary learning method, comparing to traditional lecture-based instruction. Experiential education presents different education models from the past up-down one-way teaching, allows more learners walking out of the comfort zone, learning by doing, and learning through personal practice, and has people appear more self-awareness through guidance and reflection. Experiential education allows experiencing learning with real perception; the reflective learning process could guide learners, according to personal abilities and needs, to recombine and internalize as meaningful rewards; and, learners could seek for living meanings and goals through the activity experience. Aiming at catering industry, the effect of the practice of experiential education on employee self-efficacy and organizational commitment is researched in this study.

Contribution of this paper to the literature

- When promoting experiential education, could specially emphasize that experiential education allows pursuing individual development, understanding oneself, enhancing professional growth, perceiving interests, and searching for the direction of life.
- When practicing experiential education, catering businesses could encourage the employees to hold open attitudes toward experiences and challenges, but not escape or resist new experiences or challenges, to insist on facing difficulties and obstruction, and to grasp every learning opportunity to participate in the activity.
- The information should be embedded in the experiential situations so that the employees, who actively participate in the experience, could naturally absorb relevant information, get in the "educational experience", acquire knowledge and skills, promote the organizational commitment to catering industry, and achieve the learning objective.

LITERATURE AND HYPOTHESIS

Experiential Education

Experiential education has been popular overseas for a long time. In early research, lots of researchers regarded experiential education as the experimental result of individuals in the situation and the construction of knowledge through reflection in the process (Kraft et al., 2013). Cajanding (2017) indicated that experiential education was the process to construct knowledge through experience transfer. Apparently, experiencing activity presented learning meaning. Reddick and Holland (2015) regarded experiential education as the contact with real environment, the process to acquire learning through personal perception and experience, and the emphasis of learners' comprehensive participation in knowledge, emotion, and behavior. Hair et al. (2013) defined experiential education as a philosophical education, in which a guide had learners actively participate through various models and reflect in the experience to enhance knowledge, develop skills, clarify value, and develop individual ability. Schunk (2012) emphasized that students were the body in experiential education to construct meaningful learning through actively participation in activity and reflection. Aksoy et al. (2014) defined that experiential education mainly stressed on participants being the body of learning activity, the necessity of experience, which should be interacted with real situations, and the construction of knowledge through reflection and internalization. Zhu et al. (2015) defined experiential education as the process of an individual building knowledge, acquiring skills, and promoting value through experiencing. Such experiences were created and transformed into knowledge, skills, attitudes, value, emotion, beliefs, and perception (Gonçalves-Bradley et al., 2017). Diesing (2015) also indicated that the point of experiential education was learning by doing and guiding learners, in the reflective learning process, to engage in progressive activity according to personal abilities and needs, integrate physical and mental function, create peak experiences, and experience the meaning of life.

Li (2014) mentioned the important dimensions of "challenge", "team", and "self-reflection" for experiential education. Challenge: Activity for experiential education should contain challenging and interesting elements to attract learners' participation. Team: Experiential education is preceded with teams, and learners in the activity are the participants, who could engage in the activity according to personal abilities and needs. Self-reflection: After experiencing a series of designed activity, learners have to reflect, digest and absorb specific physical, mental, and spiritual perception and experiences, as well as recombine and internalize as meaningful rewards to change the behaviors. Such dimensions are applied to this study.

Self-Efficacy

Jennifer and Stephen (2015) regarded self-efficacy as individual belief in the ability to successfully perform tasks or behaviors, i.e. evaluation of individual performance on the action for dealing with certain situations. It was also considered that individual expectation of self-efficacy was greatly related to the effort behavior as well as individual willingness to pay efforts for certain objectives. When an individual presented proper skills and were given suitable stimulation, self-efficacy was the key factor in individual taking actions under pressure, being willing to pay efforts, and continuously making efforts in face of frustration (Goodman et al., 2013). Langhorne and Baylan (2017) defined self-efficacy as the belief in an individual being able to complete an action in specific situation. Self-efficacy referred to an individual, when encountering major conditions, believing in the ability to deal with problems and solve problems. In this case, an individual would avoid the situation when it exceeded personal ability; on the other hand, an individual would face the situation when it was controllable. Self-efficacy would affect individual efforts to put into practice and influence the insistence on dilemmas. Braet and Weltens (2016) defined self-efficacy as individual ability to judge the action; it stressed on individual judgment to complete tasks with skills, rather than

the possessed skills (Fox et al., 2013). Mari et al. (2013) indicated self-efficacy as individual ability to engage in certain work and the subjective evaluation of the work being done. DeCaporale-Ryan et al. (2014) defined that individual belief in successful performance and the strength of individual self-belief could determine the efforts to cope with difficult designated situations. Sakai et al. (2015) considered that individual belief in acquiring success was the ability judgment to complete certain work.

Wang (2014) defined that the expectation of self-efficacy was individual belief in successfully performing a task or behavior. In other words, an employee should present adequate professional knowledge, skills, and literacy for the thorough confidence and belief to perform and complete specific work. Such confidence and belief in the ability to complete specific work was "self-efficacy". The three dimensions of "interpersonal relationship", "control of goal", and "judgment of demand" are uitlized in this study.

Organizational Commitment

The idea of organizational commitment was first proposed by Whyte in the article of "Organizational man" in 1956. An organizational man worked for an organization, belonged to the organization, and believed that a group was the source of creativity and the final belonging of individuals (Kim and Park, 2014). In other words, an organizational man was not simply a person working for an organization, but was a person belonging to the organization (Franklin et al., 2014). It represented individual loyalty and contribution to the organization (Nordmark et al., 2016), in which individual affective attachment and belonging to the organization were covered (Atallah et al., 2013). It also referred to individual perceived value in the organization with the sense of belonging (Sakai et al., 2015). An individual with higher commitment to agree with the organization and be loyal to organization would regard himself/herself as a member of the organization to show lower turnover rate. Denson et al. (2013) regarded organizational commitment as employees not being willing to leave the organization because of the salary, status, or occupational autonomy, and friendship with partners. Snyder (2015) pointed out organizational commitment as individual attitudinal reaction at work. It presented the characteristics of (1) consistency between individual actual work and ideal work, (2) agreement with chosen work, and (3) unwillingness to find another work. Guthrie et al. (2012) described it as a psychological state which involved not only the consistent value between individual and organization, but was also influenced by organizational loyalty, and the desire, needs, or obligation. Zumrah et al. (2013) mentioned organizational commitment as an attitudinal concept that an individual strongly agreed with the goal and value of the organization and involved such perceived goal and value in the role in the organization.

Referring to Lau et al. (2015), organizational commitment in this study is divided into (1) value commitment, (2) effort commitment, and (3) retention commitment.

Research on the Correlation between Experiential Education and Self-Efficacy

In comparison with past traditional knowledge-delivery instruction, Cajanding (2017) agreed with the better teaching effect of experiential learning, including good benefits on knowledge, behavior, and psychology. Aksoyet al. (2014) proposed that experiential education, in the self-efficacy reinforcement process, could help adolescents enhance the self-confidence in facing difficulties, peer interaction, and problem-solving capability as well as cultivate the confidence in active learning and self-adaptation. Zhu et al. (2015) pointed out the remarkable effects of the practice of experiential science learning on pupils' scientific attitudes and scientific self-efficacy. Apparently, applying experiential learning to subject and skill education might affect learners' learning self-efficacy. The following hypothesis is therefore proposed in this study.

H1: Experiential education presents significant correlations with self-efficacy.

Research on the Correlation between Self-Efficacy and Organizational Commitment

In the research on teacher's work value, perceived self-efficacy, working pressure, and teaching commitment, Langhorne and Baylan (2017) found out the notably positive correlations between teachers' work value, perceived self-efficacy and teaching commitment and the most predictive power of "teacher's perceived self-efficacy", "teacher's work value", and "teacher's individual background" on teaching commitment. Li (2014) indicated that dropouts counseling volunteers appeared distinct self-efficacy on the working pressure and continuous service commitment, and volunteer self-efficacy showed significant correlations with working pressure and continuous service commitment. Braet and Weltens (2016) discussed the relationship among self-efficacy, job satisfaction, and organizational commitment of television station employees and revealed the remarkable correlations between employees' perceived self-efficacy and organizational commitment. Wang (2014) pointed out the notable correlation between organizational commitment, self-efficacy and corporate performance. In other words, self-

efficacy seriously affected firm performance because of the positive correlation between organizational commitment and self-efficacy. Accordingly, the following hypothesis is proposed in this study.

H2: Self-efficacy shows remarkable correlations with organizational commitment.

Research on the Correlation between Experiential Education and Organizational Commitment

Kim and Park (2014) pointed out the remarkably positive correlation between experiential education and organizational commitment of volunteers in Rainbow Family Life Education that volunteers with stronger perception to participate in experiential education would present higher organizational commitment. Nordmark et al. (2016) also discovered notably positive correlations between volunteers' organizational commitment and experiential education. Lau et al. (2015) indicated that the dimensions in experiential education showed significantly positive correlations with volunteers' "value commitment" and "effort commitment". Besides, experiential education appeared remarkable predictive power on organizational commitment. In this case, the following hypothesis is proposed in this study.

H3: Experiential education reveals notable correlations with organizational commitment.

SAMPLE AND MEASURING INDICATOR

Research Sample and Object

Aiming at Wowprime Corp., the supervisors and employees, as the research objects, are distributed 500 copies of questionnaire in this study. Total 384 valid copies are retrieved, with the retrieval rate 77%. Being a catering corporate, Wowprime Corp. is located in West District in Taichung City and established by Sheng-yi Dai, who successfully establishes 13 catering brands with more than 300 branches in the world. The restaurants cover various types, such as western styles, Japanese styles, BBQ, hotpots, and teppanyaki, and devote to multi-brand management and service innovation. With constant progress, the annual turnover exceeds USD 0.425 billion and keeps 20% growth rate annually to become the largest catering corporation in Taiwan and the benchmark in the same industry. It is the model for catering management that it is selected for this study.

Test of Reliability and Validity

Validity refers to a measuring tool being able to really measure the questions which a researcher would like to measure. Generally speaking, validity is divided into content validity, criterion-related validity, and construct validity. The questions in this study are referred to domestic and international researchers, and a pretest is preceded before the distribution of formal questionnaire that there is certain content validity. Experiential education, self-efficacy, and organizational commitment in this study are tested the overall structure causality with the Linear Structural Relation model. The data input is based on the correlation coefficient matrix of above observed variables. The analysis of the Linear Structural Relation model reveals the overall model fit achieving the reasonable range that it presents favorable convergent validity and predictive validity. According to Kerlinger's (1986) suggestion, item-to-total correlation coefficients could be used for testing the construct validity of the questionnaire content, i.e. reliability analysis; and, the acquired item-to-total correlation coefficient could be used for judging the questionnaire content. The item-to-total correlation coefficients of the dimensions in this study are higher than 0.4 that the dimensions in this questionnaire present certain construct validity.

To further understand the reliability and validity of the questionnaire, reliability and validity are analyzed. The higher Cronbach's α reveals the better reliability. When the Cronbach's α is higher than 0.7, it appears high reliability; on the contrary, the Cronbach's α lower than 0.35 should be deleted, while it in 0.7~0.98 is regarded as high reliability. Furthermore, the item-to-total correlation coefficient should be higher than 0.4, or it would be deleted. According to above standards to develop the formal questionnaire, the measured Cronbach's α appears in 0.76~0.90, obviously conforming to the reliability range.

EMPIRICAL RESULT ANALYSIS

LISREL Model Evaluation Indicator

The LISREL (linear structural relation) model combines factor analysis and path analysis in traditional statistics and includes simultaneous equations in econometrics to simultaneously calculate multiple factors and multiple causal paths. The model fit is evaluated from preliminary fit criteria, overall model fit, and fit of internal structure of model.

Table 1. Analysis result of LISREL model

Evaluation item	Parameter/evaluation standard		Result	t
preliminary fit criteria	experiential education	challenge	0.642	8.66**
		team	0.728	10.65**
		self-reflection	0.713	9.92**
	self-efficacy	interpersonal relationship	0.751	12.16**
		control of goal	0.772	16.31**
		judgment of demand	0.747	11.27**
	organizational commitment	value commitment	0.769	14.58**
		effort commitment	0.783	17.88**
		retention commitment	0.792	18.94**
internal fit	experiential education→self-efficacy		0.846	25.63**
	self-efficacy→organizational commitment		0.883	36.88**
	experiential education→organizational commitment		0.867	31.75**
overall fit	X2/Df		1.238	
	GFI		0.971	
	AGFI		0.934	
	RMR		0.006	

Table 2. Hypothesis test

Research hypothesis	Correlation	Empirical result	P	Result
H1	+	0.846	0.00	Supported
H2	+	0.883	0.00	Supported
H3	+	0.867	0.00	Supported

The data are organized in **Table 1**. Aiming at the model, the preliminary fit, internal fit, and overall fit are explained as follows.

Regarding preliminary fit criteria, challenge, team, and self-reflection show remarkable explanations on experiential education (t>1.96, p<0.05), interpersonal relationship, control of goal, and judgment of demand present remarkable explanations on self-efficacy (t> 1.96, p<0.05), and value commitment, effort commitment, and retention commitment reveal notable explanations on organizational commitment (t>1.96, p<0.05), **Table 1**. Apparently, the overall model presents favorable preliminary fit.

Regarding internal fit, experiential education presents positive and significant correlations with self-efficacy (0.846), self-efficacy shows positive and remarkable correlations with organizational commitment (0.883), and experiential education appears positive and notable correlations with organizational commitment (0.867), revealing that H1, 2, and 3 are supported.

In terms of overall model fit, the standards χ2/Df 1.238 is lower than the standard 3 and RMR 0.006, showing the appropriateness of χ2/DF and RMR. Furthermore, chi-square value is sensitive to sample size that it is not suitable for directly judging the fit. Nevertheless, the overall model fit standards GFI 0.971 and AGFI 0.934 are higher than the standard 0.9 (the closer GFI and AGFI to, the better model fit) that the mode shows better fit index. The hypothesis test results are shown in **Table 2**.

CONCLUSION

The research results reveal that employees in catering industry learn new successful experience and new knowledge through various experiential courses in experiential education and apply such successful experience to the later learning so that they do not easily give up when encountering difficulties, select to actively face problems and solve problems, and apply the learned new knowledge to the work and life. Experiential education does not simply progress and change employees' related knowledge and skills, but more importantly has them understand "responsibility for catering", "importance of responsibility", and "mind training through experience" to perceive joy in the participation process, involve in it whole-heartedly, and be glad to continue the work in the current organization. In the experiential education interaction process, employees in catering industry would precede self, life, and environment reflection through experiencing to acquire better learning effect. Such a learning method allows employees in catering industry appear profound impression on the acquired knowledge and skills, without forgetting after learning, apply what they learn to the life, and even recommend and share when they learn.

SUGGESTION

By concluding the important results and findings, practical suggestions are further proposed in this study.

1. Catering businesses, when promoting experiential education, could specially emphasize that experiential education allows pursuing individual development, understanding oneself, enhancing professional growth, perceiving interests, and searching for the direction of life. It could reinforce employees' learning motivation of "interests in seeking knowledge" and "searching meaning" to further enhance employees' involvement in the learning activity. It is suggested to make specially promotion by the end of the experiential education so that employees in catering industry, when intending to share the activity with others, could emphasize the interesting experiences and self-development experiences in the activity to attract other employees' participation.

2. When practicing experiential education, catering businesses could encourage the employees to hold open attitudes toward experiences and challenges, but not escape or resist new experiences or challenges, to insist on facing difficulties and obstruction, and to grasp every learning opportunity to participate in the activity. A guide should establish good relationship with employees during the experiential education so as to timely provide positive emotional feedback for employees with low emotion and to give challenging tasks for employees enjoying the experiential education.

3. The education contents for the practice of experiential education should be designed with different difficulties and proper challenge according to employees' gender, seniority, or capability to enhance employees' intrinsic learning motivation for autonomously involving in and maintaining the learning behavior, presenting self-capability, and appearing sense of achievement by the end of the activity in order to acquire the unforgettable experience. The information should be embedded in the experiential situations so that the employees, who actively participate in the experience, could naturally absorb relevant information, get in the "educational experience", acquire knowledge and skills, promote the organizational commitment to catering industry, and achieve the learning objective.

ACKNOWLEDGEMENTS

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Risk Based Ecological Economics to Engineering Students

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ABSTRACT

Modern ecological crisis threatens the sustainability of human civilization. Awareness and education for probable disaster risk reduction give greater urgency to the issue of decreasing industrial failure rates associated with basic manufacturing activities and, consequently, improving the training in this area. The authors have highlighted the features of modern risk based approach in engineering training based on proximity of production entities to anthropogenic factors: allocation of risks and threats in professional and personal situations or tasks; critical analysis of any industrial process and considering its consequences; using professional and personal risk response strategies; risk-based thinking as the core professional activity. The paper considers the mechanism of risk-based thinking as a necessary part of engineering students training on the basis of diversionary analysis, and gives its algorithm adapted to their learning activities. A system of professional tasks and tools to be used in the students' future job has been developed to promote their readiness and willingness to work across trades within the sphere of their technical competency. The paper is intended for researchers, practitioners, managers of enterprises dealing with ecological and economic production activities, as well as for professional training of engineers.

Keywords: risk based approach, risk-based thinking, professional and personal situations, engineering students training, risk based ecological economics

INTRODUCTION

Modern ecological crisis threatens the *sustainability of human civilization. Further degradation of natural systems leads to destabilization of the biosphere*, loss of its integrity and ability to maintain the quality of the environment. The Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework, 2016) highlights the integral importance of addressing the world community safety issues. One of the framework priorities was enhancing disaster preparedness for effective response and the phrase "Build Back Better" became the *motto* in recovery, rehabilitation and reconstruction. This approach means that there is a need to strengthen disaster preparedness for response, take action in anticipation of events, and ensure capacities are in place for effective response and recovery at all levels. The recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of the disaster, is a critical opportunity to build back better, including through integrating disaster risk reduction into development measures,

Contribution of this paper to the literature

- The stages of developing preparedness and readiness to risk management have been determined.
- The use of diversionary analysis method has been proposed to be used as the basis of risk-based ecological-and-economic training of engineering students at the university.
- Diagnostic tools to assess preparedness and readiness of university graduates for risk management have been developed to ensure pedagogical impact on the students' learning outcomes.

making nations and communities resilient to disasters. That is why another slogan "Invest Today for a Safer *Tomorrow" has a clear message:* Disaster risk reduction should be an everyday concern for everybody.

It has become possible in the modern community to claim that any human activity, any commodity or service production is accompanied by "production and risks distribution "which may be rendered in its common sense as transformation of activity objectives under uncertain conditions, the probability of hazard occurrence (Sedova, 2008, Muravyeva, 2017; Prokofieva, 2015; Cherdymova & Sorokina, 2013). Continuing increase of any power may threaten the social order; at the current moment, all social systems are becoming increasingly fragile. The most common case is the effect of industries on environment, i.e. m*ajor* environmental disasters have been caused due to industrial mishaps.

This aspect brings cognitive representation of risks, its scientific component requiring a risk analysis in the subject area to the fore; involve into discussion on risk rationale, reduction, ways and mechanisms of its stagnation. And as to the mechanism, vocational education evidently providing risk based content of the engineering courses thus prepares future professionals and managers to risk-centric industrial systems (Muravyeva & Romanovsky, 2010).

Technical university students take courses delivered by the Environment and Science departments to learn how to address environmental issues. Accredited courses in ecology provide them with a foundation in the principles of civil engineering, developing their knowledge of how to assess the environmental impact of civil engineering projects and to design environmentally friendly structures (Cherdymova, 2013; Cherdymova et al., 2017). This approach is of a great significance because of the fact that graduates of these educational institutions are "at the forefront" of the majority of the anthropogenic factors that have a particularly strong impact on ecosystems. Available multiple technologies used in training of engineering professionals is specially designed to provide understanding of risk-based thinking and the subsequent *risk* management as a component of their professional competence and contribute to maintaining harmonious relationship that exists between man and nature.

However, current understanding of a risk in terms of sociocultural factors impacting it, and admitting that risk has become an integral part of our everyday life makes modern society consider itself as a "risk society" and, thus, demands forming inevitably "reflexive" risks when faced with a global threat and danger (Ford, 2009; Gullone & Moore, 2000). This position is reflected in the international standards relating to risk management codified by the International Organization for Standardization (ISO 31000:2009, Risk management – Principles and guidelines, 2015) that provides principles, a framework and a process for managing risks and can be used by any organization regardless of its size, activity or sector. It gives a new definition of risk ('the effect of uncertainty on objectives' changing it from 'the chance of something happening that will have an impact on objectives' to 'the effect of uncertainty on objectives'). Now professionals will continue to consider the possibility of risks occurring, but they should now apply risk treatment options to ensure that the uncertainty of their enterprise meeting its objectives will be avoided, reduced, removed or modified and/or retained. Risks can have consequences in terms of economic performance and professional reputation, as well as environmental, safety and societal outcomes. Therefore, managing risk effectively helps organizations to perform well in an environment full of uncertainty.

The Sendai Framework for Disaster Risk Reduction 2015-2030 has provided disaster risk management participators with a series of new guidelines. It highlights the role and relevance of regional platforms for disaster risk reduction

To guide implementation of the priorities of action, a comprehensive framework with achievable targets, a legally-based instrument for disaster risk reduction, the use of existing training and education mechanisms to promote the incorporation of disaster risk knowledge, including disaster prevention, mitigation, preparedness, response, recovery and rehabilitation, it is recommended to use the potential of formal and non-formal education, as well as in professional education and training at all levels (Levin et al., 2012; Modarres, 2003).

The goal of this investigation was to determine the features and mechanisms for risk-based ecological-and-economic training of engineering students at the university.

The goal set is closely linked to the following objectives to be focused on:

1) the importance of a risk-based approach to engineering students at the university;
2) features of risk-based ecological and economic training courses for engineering students at the university;
3) a mechanism of risk-based ecological-and-economic training aimed at developing university graduates' preparedness and readiness for risk management;
4) a diagnostic toolkit to assess university graduates' readiness for risk management.

MATERIALS AND METHODS

Experiments for scientific research have been carried out with university students studying Chemical Technology (Kazan national research technological University), Mechanical Engineering and Technosphere Safety (Kazan national research technical University), all in all 298 students.

The Risk-Based Approach in Ecological-and-Economic Training of Engineering Students at University

Risk is most commonly interpreted as the probability of risk occurrence of under uncertainty conditions of the process or phenomenon considered (Beck, 1992).

Current understanding of risk (ISO) implies detection of the influencing uncertainties from the standpoint of negative or positive variance which is considered as a threat to the goals or probable change. A probability is the ability of an object to output which will comply with requirements to this output. Hence, it is evident that a risk may be associated with an action or inaction causing it– it all depends on the process conditions. Risk management involves the process of managing a risk with any effect possible (ISO 9001:2015) and a new term "risk-based thinking" has been introduced to ensure that risks are identified, considered and managed during the design and application of the management system in any industrial activity. Risk-based thinking is something we all do automatically and often sub-consciously to get the best result, ensures risk is considered from the beginning and throughout, makes preventive action the part of strategic and operational planning.

The risk management process is an integral part of ecologic-and-economic activities with its essential components (subject, object, environment and their interaction) in a continually changing state. Irreversible uncertainty and unpredictability come out from ever changing reality. Correspondingly, the identification of risks at production and business level leads to making balanced management decisions, i.e. use of improved methods for assessment and forecasting specific risks, introduction of analysis technology and an early warning system (Atkinson, 2008; Ayyub, 2011; Baetova, 2016).

The essence of a risk-based approach in professional training is associated with search, identification and analysis of probable industry and business risks with a view to adjusting the development strategy and management. It makes it possible to operate in high risk environments related to integration of knowledge, i.e. ecology, economy, predicting dangerous factors (risks), natural hazards, reliability of technical systems, and technogenic risks. As a result of applying this approach in university training of engineering students, their mindsets are formed on the bases of risk-assessment experience. Risk-based thinking provides a continuous simulation (pre-effect) of professional and surrounding environment, in terms of risks/probabilities. Risk-based thinking ensures that risks are identified, considered and controlled throughout the design and use of management system. Due to using risk-based thinking the consideration of risk is integral. It becomes proactive rather than reactive in preventing or reducing undesired effects through early identification and response action (Belov, 2011). Risk thinking increases the willingness and ability to achieve goals, reducing the likelihood of a negative outcome.

Modern understanding of the need to balance environmentally and economically conditions of production in the market conditions, and protection and preservation of the environment is one of the most important issues facing humankind today. It has led to creation of innovative achievements in modern science and advanced progressive technologies that, from an environmental point of view, are able to ensure the further existence and development of mankind. Training of engineering students with their concerns attached to entrepreneurial activity in the domestic and overseas markets proved to be the solution of environmental problems in any region (Kasyanenko, 2008; Krutova, 2013; Shapkin, 2010; Cai et al., 2017). These professionals must be good at solving multiple issues related to industrial activities, marketing and management for safe operation of production facilities, extending the lifetime of materials and products, using them for a new functional purpose (conversion), as well as the rational use of secondary raw materials through recycling. The question of production process analysis, introduction of industrial innovations and predictive assessment of their consequences, etc. also is related to risk-based approach and is able to provide ecologically acceptable alternative. To manage risks and thereby

facilitate graduates' adaptation they must be provided with all detailed information about the forms and types of risks that are likely to emerge in their professional activities. In this regard, we believe it necessary for university students to study decision making under risk and uncertainty, and develop their competences in making optimal decisions in uncertainty and risk situations.

Features of the Risk-based Training in Engineering Education

It was established that one of the components of a civil engineer readiness to risk management is the operational component contributing to practical preparation for risk management. Due to the fact that this component is associated with the readiness to solve professional tasks in managing all types of production risk and, consequently, possessing risk management skills, it is necessary to define a system of this kind of professional tasks in the activities of an engineer and identify relevant skills (Ayyub, 2014; Bradbury, 2016).

Taking into consideration the industry field (chemical, petrochemical, mechanical engineering) we have studied:

1) stages and content of an optimal management decision as the methodological basis to systematize this type of professional tasks;
2) stages and the content of enterprise risk management as a whole, as a substantial basis of the identified professional objectives of risk management;
3) types of business risk and business risk situations as objects of risk management, which we also consider as the specific content of risk management professional objectives;
4) types of professional tasks in engineer activity.

Professional activity is a process of solving professional tasks. A task includes demands (goal), conditions (known) and the desired (unknown) which can be formulated in a question. Based on the definition of the task as a logico-psychological category, a professional task can be defined as an activity to meet requirements of a particular profession and aimed at problem solving. The professional task in production risk management is the type of an engineer-and-manager' professional activity to meet the requirements of the profession and the risk situation at an industrial enterprise.

Thus, risk-based training features of engineering students based on enterprise proximity to anthropogenic factors are:

1. allocation of risks and threats for any professional task;
2. critical analysis of professional actions and their consequences;
3. action training of future engineers in the context of possible professional and personal risks;
4. development of a risk-thinking as the essence of professional activity of the university students intending to work at an industrial enterprise.

Mechanisms of the Risk-based Training of Engineering Students at the University

Risk-based training of the university students intending to work at an industrial enterprise includes the following steps in forming their preparedness and readiness for risk management:

1) psychological basis of willingness to risk management ensuring basic personal willingness to take risks;
2) development of risk management professional basis to ensure preparedness for profession and risk management;
3) development of a special risk management professional basis to ensure a holistic preparedness for risk management in a manufacturing enterprise (according to industry fields studied).

As a pedagogical means used to form readiness for risk management we propose:

— Organization and contents of the university syllabus according to education and selected to meet the requirements of risk management functions in the field studied;

— educational task system as preliminary desobjectivated for specific tasks and jobs selected for the relevant learning content;

— a system of methods to form preparedness and readiness for risk management meeting the requirements of the field studied.

Because the methods used to stimulate creativity are close to real production activities they positively influence the course of education; and we believe that the application of diversionary analysis method will be good for developing risk-thinking skills, allowing to use a new angle to look at the object safety. Diversionary analysis is a method that enables us to predict the appearance of harmful effects (including ecological) in our system, or its failures, and prevent them before they occur, as well as identify the causes of accidents that have already happened (Romanovsky, Muravyeva & Chabanova, 2015). The method involves implementation of two main stages/phases:

Stage one: Transformation of questions "why" or "what" (what emergencies and adverse events are possible in /with this facility? why did this emergency situation happen?, how to ruin the object?, how to ensure the emergence of the greatest number the most dangerous adverse events, how to implement in this object the emergency situation that has arisen). They enable us to know "in advance" and to prevent system failures and/or harmful effects. As a result, *c*reativity techniques are used for inventive problem solving.

Stage two: Efforts to prevent the forecasted "diversionary" problems. In "Diversionary Analysis" students use special informational funds:

- standard ways of creating adverse events and their results;
- standard dangerous areas on engineering facilities;
- resources capable of harmful effects;
- typical mistakes when creating technical systems;
- ways to enhance and correct unwanted events;
- ways to prevent unwanted events and deal with the consequences.

In the context of risk-based ecological-economic training such tasks correspond to a study method of external and internal environment of the organization from ecological and economic standpoints, and analysis of all possible risks. Diversionary analysis is based on the principle of forecasting possible operation failures through modeling the maximum number of "diversions", *sabotages,* against the enterprise considered as a sociotechnical system and taking into account the impact of typical and specific risks (strategic uncertainty).

The main purpose of using diversion analysis in ecologic and economic training of a future engineer is to enable him to be competent and reveal weaknesses of the enterprise, explore external and internal risks, develop a detailed plan of measures to protect and improve the weaknesses.

Such a broad content of training material may not be provided only by one academic discipline; therefore, the selection of the content for risk-based training requires consideration of interdisciplinary connections that ensure a holistic educational process.

A meaningful framework for learning objectives may be provided by activities specific for the job of an engineer, presented in the form of risk management professional tasks at an enterprise (according to the field studied). Learning objectives, thus, have been systematized in three types:

— learning objectives of a tentative type, adequate to the activities related to student guidelines in risk situations (description, explanation, predicting, goal setting); these tasks correspond to the first phase of the optimal management decisions in a risk situation - preparation of the solution;

— learning objectives of reflective type, adequate to the activities related to decision-making in risk situations (generation of alternatives; evaluation of outcomes, or consequences, of the decision; choosing the best decision; assessment of the decision; preparation of the implementation plan); these are the tasks corresponding to the second stage, i.e. making an optimal management decisions in a risk situation;

— learning objectives of creative (transformative) type, adequate to the activities related to the impact of the risk (transformation of a risk situation); these objectives correspond to the last stage of the optimal management decisions - implementation of the decision in a risk situation.

This system of learning objectives developed and structured in its logics to optimal management decisions is able to help the teaching staff of a university develop students 'risk-thinking, their preparedness and readiness not only to the specific activities of risk management, but also to a holistic professional readiness.

Table 1. Algorithm for solving risk-based problems used by university students

STAGES	OUTCOMES
Formulation of risk	Detection (control) risk issues
Transformation of a risk task	Gathering information about risks, hazards, vulnerability in a particular situation
Study of risk system	Information display in a convenient form
Certification of risk of resources	Analysis of information on risk situation (sources, objects of risk; possible controlling actions; forecast of their effectiveness)
Search the harmful effects	Problem definition and ranking the risks of the situation
Search the harmful effects using forecast method	Defining risk management objectives of a particular situation taking into account resources available
Search of new decisions	Development of the criteria to be used in assessing risk management effectiveness in a certain situation
Study of revealed the harmful effects	Verification and assessment of options for risk-solutions
Outcomes study and general conclusion of the results	Acceptance, registration

RESULTS

An Algorithm to Solve Risk-based Tasks

A general algorithm for solving a task (situational risk management) includes the following operations that involve identifying of enterprise ecological and economic risk (**Table 1**).

Thus "the diversionary analysis" includes pre-operations performed: formulating the "diversionary goals"; the study of the known ways to create extraordinary situations, harmful and undesirable phenomena; characterization and testing the possibilities to use existing resources for "diversion", or sabotage; identification of possible unwanted, sabotage, effects on the information funds and by means of technical creativity methods; search for means to improve and "hide" undesirable effects; study of undesirable effects identified and their improvement; opportunities to eliminate unwanted effects.

Then scenario analysis method was used as the way to test various predicted proposals for the future. It includes creation of two or three plausible scenarios, an adequate strategy to develop each of them, assessment of the likelihood of scenario implementation, and assessment of the resulting strategies. All of the above said, in our opinion, will greatly contribute to the development of professional risk-based thinking, because for "well-planned sabotage" it is necessary to have professional knowledge in the field of operation of the facility, its weak points, synergistic effects of emergencies, etc. After studying strategic diversionary, or the sabotage, analysis with the use of the above-mentioned algorithm the student can determine (predict) the optimal risk events. Students work on collecting and processing the source data and methods used to enhance their accuracy, and get grounded criteria for making effective management decisions.

The system of risk management professional tasks and relevant professional skills of a graduate student is built in this context and makes the basis for the content of university training, educational and professional tasks of its dynamic training system.

A Creative Risk-based Learning Objective: A Case Study

General statement of the problem: Study of the possibilities for a major investment project - Development of oil and gas resources in region N. The following information regarding natural factors of the region, characteristics of crude oil and gas, information on raw materials recovery, differentiation of the deposits, quality of raw materials, condition of fixed assets in oil and gas sector, and technological background have been given.

To adequately assess an ecological risk (and other risks) for major investment projects related to oil and gas resources it is needed to follow the stages in risk management (**Figure 1**). The first block: assessment stages of the ecological risk (1-5) with an ultimate goal to determine quantitative risk measures that correspond to different scenarios of adverse events and protection strategies; and stages of environmental risk management (6-8) that aim at defining events and activities to reduce the level of a risk to its "acceptable level" and control its impact. The first stage establishes a list of factors which by themselves, or in a certain combination, are able to initiate an adverse, unwanted, event; and the second one forms and analyzes the system of these factors in reality.
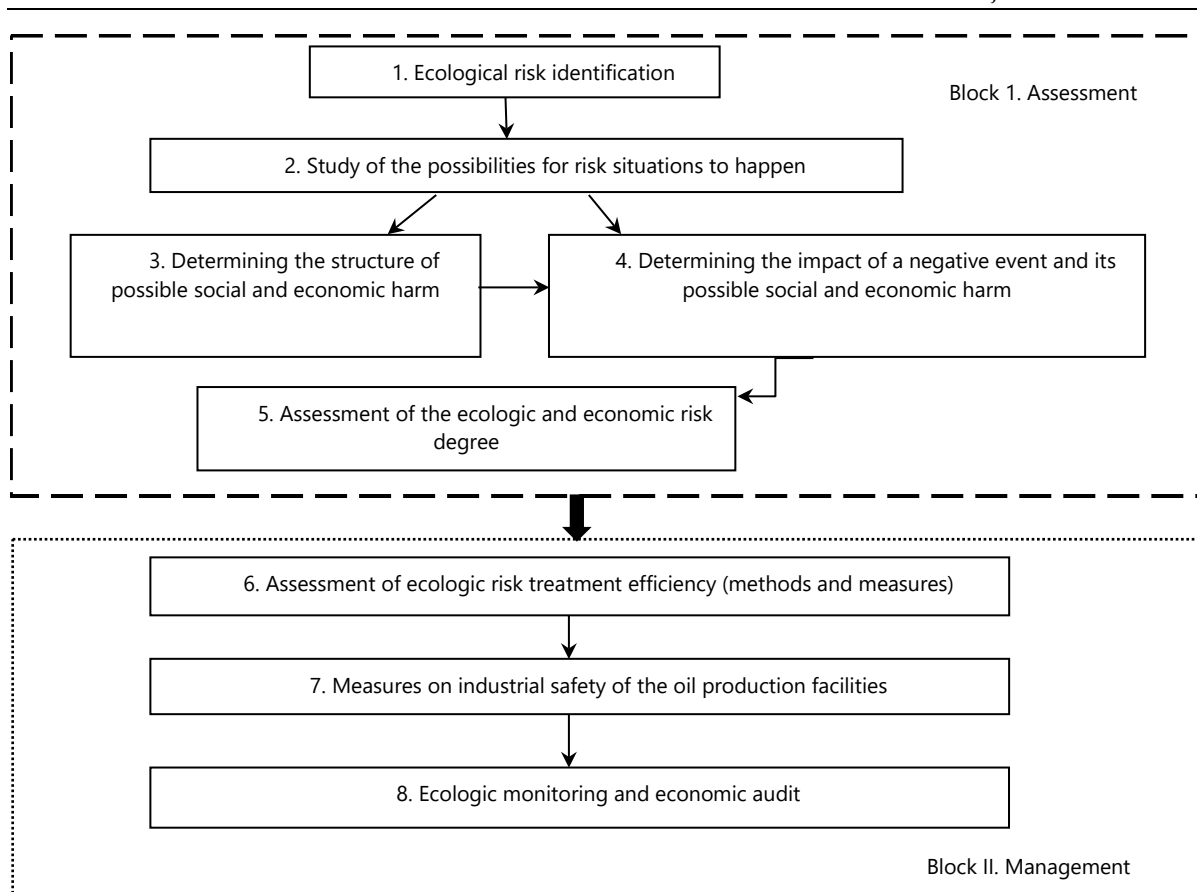
Figure 1. Block diagram of stages of risk management

An influence diagram has been used to show hazard identification. They are known as a systematic representation of the flow of events and processes that allow tracing the origin and development of conditions causing failure or the state of emergency. Such diagrams are represented as graphs, trees events, functional networks, and flow maps.

An event tree diagram has been used to identify environmental risk of the investment project. The tree is a hierarchical structure, the top level of which characterizes the consequences of adverse events (environmental pollution), and the lower level represents sets of factors and conditions under which it manifests itself. The conditions of a higher level are also represented as a tree and include factors of the lower levels.

Basically, the event tree represents an emergency scenario causing environment pollution (see **Figure 2**). A semantic model of an event tree diagram usually involves some leading events, which are connected with specific logical conditions with intermediate and initial assumptions that caused its emergence.

To build an event tree diagram for a priori quantitative estimates of environmental damage one should involve a set of iterations, and each consists of the following steps:

1) selection of oil and gas facility;
2) building models of an event tree type and their outcomes;
3) a qualitative analysis of the simulated process;
4) quantitative environmental risk assessment (average damage) expected from the analyzed accident;
5) justification of actions to decrease an ecological risk.

The process of a specific incident will be interpreted by this model as a certain signal passing from some initially assumed prerequisites that caused the signal, to the event that is considered to be its outcome. Prerequisites for the top and subsequent levels have been considered as intermediate events of the tree.

Using cause and effect models for event tree diagram that covers probable destructive outcomes it is possible to make a system of the events preceding emergency situations, place a priori estimates of the incident parameters and prevent or reduce environmental damage and environmental risk in general. The occurrence and probable preconditions for the development of the events should be systematized into project stages, as well as the types of damage and harm caused.
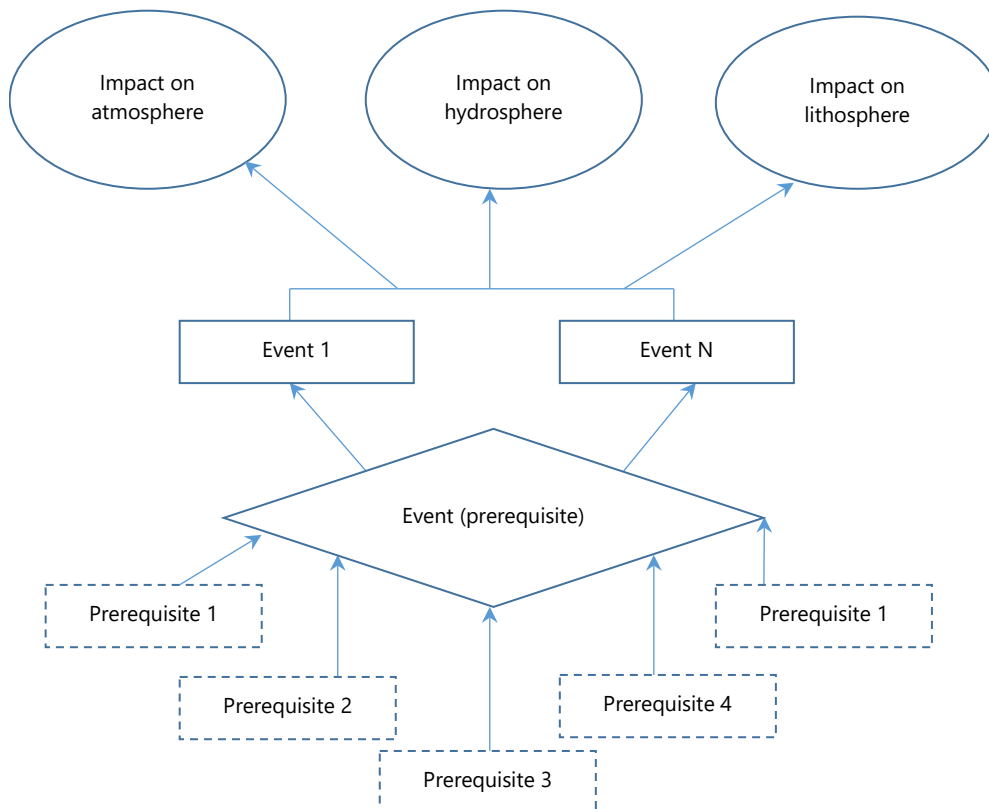
Figure 2. A common variant of an event tree for evaluating environmental risk

A generalized solution of the problem involves the formulation of environmental and economic risks, investment project risk, in the development of oil and gas resources of the region N (industrial-and-technological, ecological, geological, nature, marketing, institutional, financial), and their detailed qualitative and quantitative assessment. In the context of risk management, it is also important to assess the degree of risk acceptability (control), methods of mitigation and mitigation of consequences in the economic and environmental points of view, and in the long run analyze all the possible development alternatives for the project.

The objective achievement covers many stages and can be used as a base for a technical university course project.

Diagnostics of Engineers' Readiness to Risk-based Thinking in their Professional Activities

Thinking is a set of psychological processes, states, actions of a person to process information, such as when we form concepts, engage in problem solving, to reason and make decisions, to put forward hypotheses.

A criterion of developed risk-based thinking, in our opinion, is the ability to analyze the greatest number of possible options per unit of time and find the alternative result in the least adverse consequences. The basis of readiness to professional risk-based thinking, obviously, is professional reflection of a person incorporating the system of knowledge and practical experience analysis.

Considering the willingness to risk-based thinking as an active-and-effective state of an individual, his/her certain attitude to professional behavior, we have identified its following components:

1) *cognitive* - knowledge in the field of environment, safety, economy, engineering activities, production processes;
2) *operational* - knowledge of action sequence in emergency conditions, social, technological and environmental risks, and methods of reducing them;
3) *analytical* - ability of an analytical assessment of all probable conditions and risk causes in a manufacturing process;
4) *inductive* - ability to predict the consequences and probabilities of uncertainties;
5) *dynamic* - ability to make quick and reasoned decisions;
6) *motivational* - emotional and value understanding of risk activities.

Table 2. Preparedness and readiness for risk management, control versus experimental student group results (in % of total students)

Field of study	Chemical Technology						Mechanical Engineering						Technosphere Safety					
Preparedness and	CG			EG			CG			EG			CG			EG		
readiness components	l.	m.	h.	l.	m.	h.	l.	m.	h.	l.	m.	h.	l.	m.	h.	l.	m.	h.
cognitive	3	85	12	0	83	17	7	82	11	0	84	16	0	88	12	0	72	28
operational	5	77	18	0	74	26	4	75	21	0	77	23	0	88	12	0	76	24
analytical	16	78	6	0	89	11	11	78	11	0	84	16	8	80	12	0	68	32
inductive	22	74	4	2	79	19	18	73	9	0	82	18	4	78	18	0	68	32
dynamic	10	84	6	28	51	21	9	78	13	17	61	22	8	66	26	0	62	38
motivational	14	78	8	0	57	43	9	82	9	0	62	38	8	50	42	0	44	56

Notes: CG - control group, EG - experimental group, l. - low, m. - medium, h. - high.

Each of these component is proposed to be evaluated and *expressed* on a grading *scale* as '*high*', '*medium*' and '*low*' level (0,1,2).

It is obvious that the diagnostics system adoption in the framework of professional education is more aimed at development of cognitive and operational components of risk-based thinking.

Considering a professional task system of risk-based management as a pedagogical experiment and its introduction into university training of students studying Chemical Technology (Kazan national research technological University), Mechanical Engineering, Technosphere Safety (Kazan national research technical University) revealed significant differences, in their preparedness and readiness for risk-based management between the experimental and control student groups at the level of all components (**Table 2**).

It should be noted that this table presents the results of the control measurements carried out at the end of the pedagogical experiment based on the analysis of the students' course projects (according to the results of students' course project presentations). The data obtained showed that the levels of cognitive, operational and motivational components are identical in the experimental and control groups, which proves a high level of engineering training at the university as a whole. Significant differences in other components prove that the developed system of professional tasks significantly increases students' preparedness for risk management. Future specialists in the field of Technosphere Safety achieved high level and this fact confirms the importance of their knowledge and competence in the field of life safety to develop risk-based thinking. It should be noted that a high level in all 6-risk based thinking preparedness components has been achieved only by 7 students from the experimental groups. This fact indicates the importance of personal factors and personal abilities in developing risk based thinking; experts of this level can manage a strategic risk system at the enterprise and participate its management. The study of the intermediate and control outcomes after special training shows a stable increase in the level of readiness for risk-based management of students in the experimental groups. Group results have been compared using nonparametric Mann-Whitney U test: the obtained value was less than the critical, U at $p = 0.05$ (U= 470) which rejected *the null* hypothesis about differences between the experimental and control groups on the level of readiness for risk management after providing them special training. Comparison of the data presented allows us to draw the following conclusion: positive dynamics of changes in the components of preparedness and readiness for risk-based management is coherent. The data obtained prove risk-based training applicability in the system of higher education.

DISCUSSIONS

There are many employers and stakeholders, representatives of large industrial enterprises, who have assessed the university graduates as insufficiently prepared for their future responsibilities and unable to make immediate solutions beyond their professional boundaries or under the extreme, *force majeure*, conditions. The modern realities of production activities where emergency situations are not rare events, as well as manmade and natural hazards and disasters, have shown how valuable is the engineer' competence in the field of prevention of technogenic accidents, social and natural hazards, how significant is a professional and moral attitude to career (Michalopoulos & Paparrizos, 2008).

The issue of relationship between knowledge-based components of human activity and technical facilities in real production has been studied previously by many researchers of this country. This issue, at the general level or aspect, was touched upon in the papers on psychology and applied psychology (Aral, 2010; Levina et al., 2016; Modarres, Kaminsky & Kristov, 2007; Murzin, 2009; Klimov, 1996; Halperin, 1998; Zeer, 2001).

The study of scientific literature (Baetova, 2016; Steinberg, 2007; Michalopoulos, & Paparrizos, 2008; Synzynys, 2015; Vaganov, 2008; Vishnyakov, 2008) showed that the preparedness and readiness for professional activity is understood as a set of special knowledge, abilities and skills to perform work in a specific field of professional activity, and ability to understand regulatory requirements to work in a certain profession. We have included a set

of special components into this structure: students' positive attitude towards their *chosen career*, their ability and motivation relevant to requirements of their future job; knowledge and skills, professionally important cognitive, emotional and volitional processes (Roland & Moriarty, 1990; Tymula et al., 2012).

Professional thinking development is regarded as one of the constituent parts of higher education based on the principle of multi-factor interaction in hazards/risks –competency and safety of life system (Ayyub, 2013).

We have found that risk-based thinking development is contributed by the system of professional tasks that requires integration of knowledge in different subject areas and mobilization of personal abilities. These challenges may be solved using diversionary analysis method that allows us to prove by contradiction the existing risks and probabilities in production activities in terms of environmental and economic constraints. The diagnostic tools proposed by the authors contributes to determining the strengths of professional preparedness and readiness of engineering students at the university in general; determines their opportunities for professional development in the field of risk-based management and can be used in the framework of engineers' professional development. The outcomes obtained in the course of the experiment demonstrate positive attitude of teaching staff and students towards risk-based ecological-and-economics training of future engineers.

CONCLUSION

The study carried out to develop and implement a risk-based training at the university allowed us to make the following conclusions:

1. Objective probability of various risks in the operation of industrial enterprises determines the necessity to design special training content or courses on risk-based management at the university.
2. The effectiveness of engineers' study of risk-based ecologic economics is determined by their readiness to be involved in risk-based management and is one of their purposes in university study.
3. Diversionary analysis has been identified to be the mechanism of engineering students' training in ecologic economics in the context of their risk-based thinking development as the method to assess the effectiveness of the company's security system from the standpoint of possible risks ("sabotage"), promoting search and analysis of the real risks in engineering activities.
4. To develop holistically readiness for risk management it is recommended to provide proper study of ecological economics issues and have learning objectives corresponding to professional risks and related to *e*nterprise risk management.
5. Diagnostic tools to determine the preparedness of an engineer to risk management in their career allows to improve the process of the risk-based engineer training, and promotes pedagogical management at the university.

ACKNOWLEDGEMENT

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http://www.ejmste.com

A Bibliometric Retrospective of the Journal Eurasia Journal of Mathematics, Science and Technology Education between 2012 and 2017

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ABSTRACT

This study carries out a bibliometric retrospective of the journal *Eurasia Journal of Mathematics, Science and Technology Education* (*EJMSTE*) between 2012 and 2017 by using the bibliometric analysis and visualizing approaches. A series of bibliometric indicators, such as *H-Classics* publications, major prolific authors, institutions and countries and research themes etc., were included. With the help of 655 structured data retrieved from the *Web of Science*, we found a rapid growth trend of published productions. The most prolific authors, institutions and countries (territories) are mainly from Turkey and Taiwan, and this indicates this journal was dominated by these two countries (territories). Analysis of research themes showed science education, teacher education, mathematics education, attitude/attitudes research, problem solving and professional development were the main research themes for this journal. The citation impact analysis of research theme showed that three themes (i.e., student teacher, Technology Acceptance Model and animals) attracted more citations than others. Six clusters were identified which formed the main knowledge base of this journal. Analysis of cited and citing journals presented the knowledge commutation status of *EJMSTE* between other journals. These findings will help the readers to get a quick and intuitive overview and may be useful for helping the possible authors in deciding if their papers should be submitted to *EJMSTE*.

Keywords: EJMSTE, bibliometric analysis, knowledge commutation, research theme, scientific visualizing

INTRODUCTION AND BACKGROUND

EJMSTE, established in 2005, is an international open access peer-reviewed journal and every month published by Modestum. The journal addresses the important issues concerning Mathematics Education, Science Education, Environmental Education, Engineering Education, Technology Education and Educational/Instructional Technologies. It publishes research articles, reviews, editorials and selected meeting papers. Today, *EJMSTE* is a leading *Education & Educational Research* journal with an impact factor (IF) of 0.903, according to the 2017 Release of *Journal Citation Reports* (*Clarivate Analytics*).

The aim of this article is to provide a retrospective review of *EJMSTE* based on publications published between 2012 and 2017. Bibliometric analysis methods and scientific mapping procedures were employed to achieve this aim. Previously, a number of published studies reported the application of these methods to retrospectively analyze the performance of some other journals (Bharvi et al., 2003; Garg et al., 2015; Prathap, 2014). For example, Heck and Jensen (2007) studied the evolution of research contributions of the *Accounting Review*. By employing data from Web of Knowledge (*WoS*) and Elsevier's open-access Scopus, Bickers and Modlin (2012) provided an overview of metrics to measure and compare the performance of *Journal of Investigative Dermatology*. Merigó et al. (2015) analyzed the *Journal of Business Research* between 1973 and 2014. Blažun Vošner et al. (2016) retrospected the *Journal*

Contribution of this paper to the literature

- A single journal bibliometric research of the journal *EJMSTE* was performed on its publications over the past six years.
- The characteristics and history of *EJMSTE* have been analysed based on the following bibliometric indicators: the publication years, the document types, *H-Classics* publications, major prolific authors, institutions and countries, main research themes, 'intellectual structure' or 'knowledge base' and knowledge commutation status.
- This study expanded the application range of single journal analysis. And, the findings will help the readers to get a quick and intuitive overview and help future authors decide if their papers should be submitted to *EJMSTE*

Computers in Human Behavior during the period 1991–2015. Iefremova et al. (2016) studied the internationality of *Current Science* based on the internationality of its authors. Restrepo and Willett (2017) described the bibliometric characteristics of 2398 articles published in the *Journal of Mathematical Chemistry*. Córdoba et al. (2012) compared *European Journal of Information Systems* and *Management Information Systems Quarterly* between 1995 and 2008. Coupé (2003) studied the performance of economists and economics departments based on several economics journals. In general, these works usually present an overview of the publication years, the document types, *H-Classics* publications, prolific authors, institutions and countries, main research themes, 'intellectual structure' or 'knowledge base' etc. In some further studies, visualization tools were employed to give a visual map of the bibliometric results (Li and Hale, 2016). Interestingly, almost all the works above were published in the journals, which were the ones they analyzed.

The significances of our research can be summarized as follows: First, this study would fill in the gap, that no such analysis has been performed for the Journal *EJMSTE.* Second, this research can help the readers to get a quick, intuitive and deep overview of *EJMSTE.* Meanwhile, potential authors may also learn more about this journal, and decide if their papers should be submitted to it. Last, we hope to explore the research status of *EJMSTE* by bibliometric analysis, through which some meaningful information may be provided to improve the visibility of *EJMSTE.*

Therefore, in this study, we draw a bibliometric retrospective review of the journal *EJMSTE* between 2012 and 2017. In order to retrospect the journal clearly, we posed the following five research questions:

1. What is the distribute status of *H-Classics* publications?
2. What are the major prolific authors, institutions and countries (territories)?
3. What are the main research themes?
4. What is the 'intellectual structure' or 'knowledge base' of EJMSTE?
5. What is the status of knowledge commutation between EJMSTE and other journals?

The rest of our study is structured as follows. The next section deals with the Methodology. Section 3 analyses and visualizes the results of the bibliometric analysis. Finally, the last section summarizes the main conclusions and discussions of this study.

METHODOLOGY

We used the search terms: "*Eurasia Journal of Mathematics, Science and Technology Education*" in the Publication Name in *WoS* online database (developed by *Clarivate Analytics)* to search our research data on 1 August 2017. A total of 655 publications were retrieved from *WoS.* The dynamics of the publications in *EJMSTE* was shown in **Figure 1** in one-year block. As we can observe, it is from 2012 that *WoS* started to include *EJMSTE* data. Meanwhile, there is a rapid growth trend from the year 2012 to 2017. Both of these mean, just from 2012, *EJMSTE* has become a worldwide recognized high-quality academic journal. And the 655 publications (from 2012 to 2017) could represent the evolution of this journal and can be used as the data to answer our research questions efficiently.
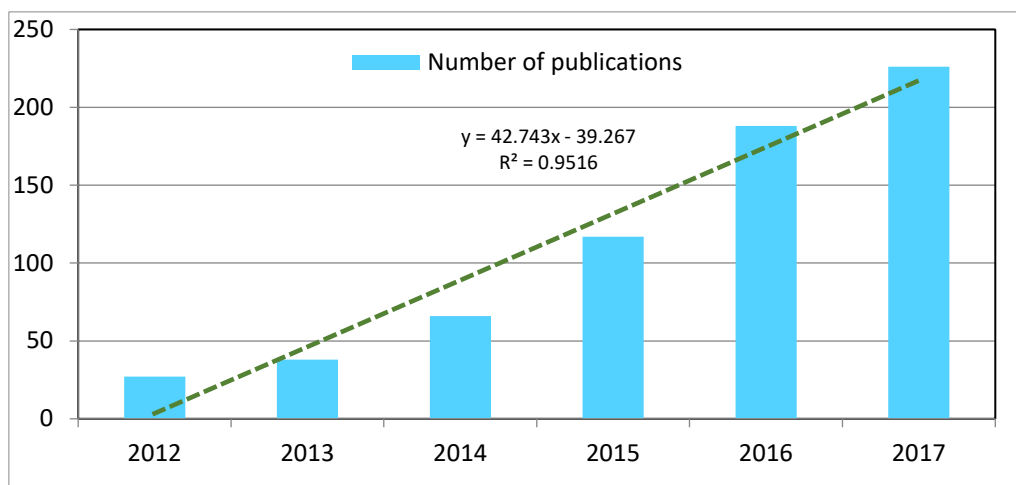
Figure 1. Trend of number of publications
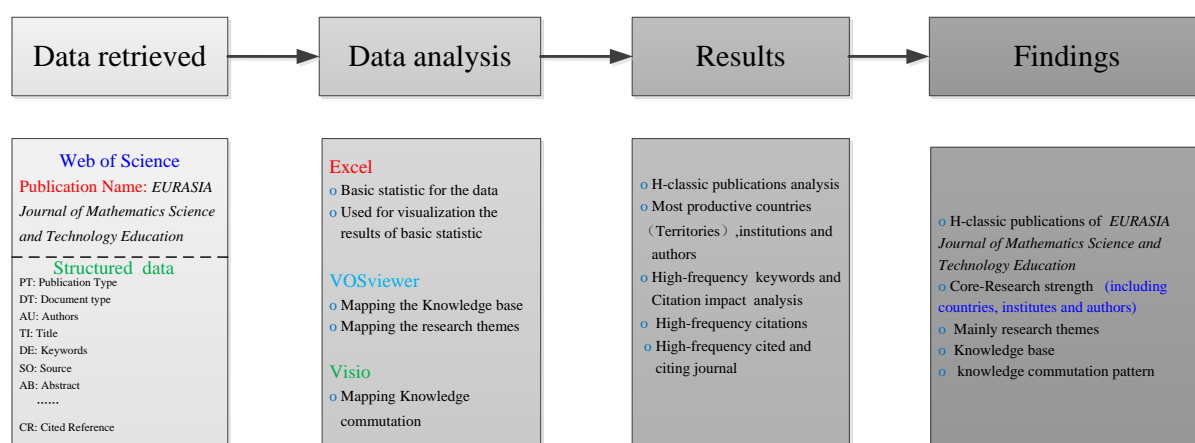
Figure 2. Overview of the research methodology

Among the 655 publications, each data including the Publication Type, Document type, Authors, Institutes, Title, Keywords, Abstract and Cited Reference was downloaded. *WoS* categorizes these data into 4 different publication types, namely articles (643), editorial materials (8), reviews (4), proceedings paper (1).

We employed bibliometric analysis and visualizing methods to detect the features of *EJMSTE*. Bibliometric analysis can be defined as the statistical method to explore the quantitative characteristics of bibliographic information, literature, articles and journals (Narin and Hamilton, 1996). In this study, a series of bibliometric analysis indicators were used as follows: *H-Classics* publications, most productive authors, countries (territories) and institutions, keywords for research theme analysis, citations for knowledge base and knowledge commutation analysis. Bibliometric visualizing method is usually used to present a structural overview of an academic field or a journal by using the visualize technique (Garfield, 2009). Some widespread visualizing techniques have been designed and developed as computer programs like *CitNetExplorer, Sci² Tool*, *VOSviewer* and *Citespace* (Eck and Waltman, 2014; Börner 2014; Eck et al., 2017; Chen, 2009). In this research, *VOSviewer* was used for creating, visualizing and exploring bibliometric features. Meanwhile, we also used *Excel* (developed by Microsoft, USA) to display the tables and draw the bar chart based on the number of publications. *Microsoft Visio* was also used to draw the overview of the research methodology and show the results of knowledge communication between *EJMSTE* and other journals (Li et al., 2015). The methodology is displayed in **Figure 2**.

ANALYSIS RESULT

H-Classics Publications **Analysis**

H-Classics publications, which are composed of *H* highly cited papers with more than *H* citations, were introduced by Martínez et al. (2015). By now, *H-Classics* indicator has become one of the most popular indicators to

Table 1. *H-classic* publications published by *EJMSTE*

Rank	Title	Authors	Year	Citations	Country / Territory
1	Effect of Technology-Embedded Scientific Inquiry on Senior Science Student Teachers' Self-Efficacy	Calik, M	2013	25	Turkey
2	The Relationship between Teachers' Knowledge and Beliefs about Science and Inquiry and Their Classroom Practices	Saad, R; BouJaoude, S	2012	21	Lebanon
3	Design and Assessment of Joyful Mobile Navigation Systems based on TAM and Integrating Learning Models Applied on Ecological Teaching Activity	Wang, TS	2013	16	Taiwan
4	Moodle as a Learning Environment in Promoting Conceptual Understanding for Secondary School Students	Psycharis, S; Chalatzoglidis, G; Kalogiannakis, M	2013	15	England
5	Using Problem-Based Learning to Stimulate Entrepreneurial Awareness Among Senior African Undergraduate Students	Swart, AJ	2014	11	South Africa
6	Perceived vulnerability to disease predicts environmental attitudes	Prokop, P; Kubiatko, M	2014	11	Slovakia
7	Perceived Disgust and Personal Experiences are Associated with Acceptance of Dissections in Schools	Fancovicova, J; Prokop, P; Leskova, A	2013	11	Slovakia
8	In-service Teachers' Implementation and Understanding of STEM Project Based Learning	Han, S; Yalvac, B; Capraro, MM; Capraro, RM	2015	9	South Korea
9	A Study on Identifying the Misconceptions of Pre-service and In-service Teachers about Basic Astronomy Concepts	Kanli, U	2014	9	Turkey

Table 2. Most prolific authors

Rank	Authors	Number of articles	Percentage
1	Chang CY	7	1.07%
2	Eilks I	7	1.07%
3	Yang DC	6	0.92%
4	Shieh CJ	6	0.92%
5	Prokop P	6	0.92%
6	Wu YW	5	0.76%
7	Su CH	5	0.76%
8	Sorgo A	5	0.76%
9	Mansour N	5	0.76%
10	Kubiatko M	5	0.76%
11	Kim MK	5	0.76%

highlight the high-quality publications of scientific knowledge domains, researchers and journals (Cobo et al., 2014). Thus, the *H-Classics* indicator is employed to explore the high-quality publications of *EJMSTE*. In the consideration of the time period 2012 –2017, *EJMSTE* published 9 *H-Classics* publications, as shown in **Table 1**.

According to the *H-Classics* indicator, *EJMSTE* has a good performance compared with the general rule of citation behavior in the year 2013. Regarding the author distribution of the *H-Classics* publications, only one author, Prokop from Slovakia, published two *H-Classics* publications and 17 authors have only one *H-Classic* publications. Considering the geographic distribution of *H-Classics* publications, we must highlight the important countries, Turkey and Slovakia, which published 2 *H-Classics* publications, respectively.

Prolific Authors, Institutions and Countries (Territories)

655 publications published in *EJMSTE* were coming from 1302 authors distributed in 61 different countries (territories) and 589 institutions. Concerning the core-strength of publications, the most prolific authors are listed in **Table 2**. The most prolific authors were Chang and Eilks (7 publications), followed by Yang, Shieh and Prokop (6 publications). And Wu, Su, Sorgo, Mansour, Kubiatko and Kim (5 publications) win the third place.

The main prolific productive institutions were listed in **Table 3**. Among them, National Taiwan Normal University is the most productive institution with 21 publications, followed by Gazi University (16 publications) and Middle East Technical University (14 publications).

Table 3. Most prolific institutions

Rank	Institutions	Number of articles	Percentage
1	National Taiwan Normal University	21	3.21%
2	Gazi University	16	2.44%
3	Middle East Technical University	14	2.14%
4	National Chiayi University	12	1.83%
5	Kazan Federal University	12	1.83%
6	Hacettepe University	12	1.83%
7	University of Bremen	11	1.68%
8	Universiti Malaya	11	1.68%
9	Near East University	11	1.68%
10	Southern Taiwan University of Science and Technology	10	1.53%
11	Karadeniz Teknik University	10	1.53%

Table 4. Most prolific countries (territories)

Rank	Country / Territory	Number of articles	Percentage
1	Turkey	157	23.97%
2	Taiwan	136	20.76%
3	Peoples R China	91	13.89%
4	USA	55	8.40%
5	South Korea	46	7.02%
6	Germany	25	3.82%
7	South Africa	25	3.82%
8	Malaysia	20	3.05%
9	Spain	19	2.90%
10	Cyprus	13	1.98%
11	Russia	13	1.98%

Table 4 shows the most prolific Countries (Territories) by the number of publications. The most productive countries (territories) are turkey (157 publications), followed by Taiwan (136 publications) and Peoples R China (91 publications). It is interesting to highlight that, the total numbers of top 3 counties (territories) publications were more than 58.6% in *EJMSTE*. This suggests that *EJMSTE* is dominated by Eurasia countries (territories) and need further internationalization.

Mainly Research Themes

Scholars usually consider author keywords analysis as one of the main means for identifying research themes within a given area or journal. Based on the density visualization drawn by *VOSviewer*, the scientific landscape of main research themes in journal *EJMSTE* was drawn. And keywords were colored depending on the occurrence frequency (shown in **Figure 3**). In this research, the larger the occurrence frequency of keywords associated with *EJMSTE,* the closer the color of keywords is to red. Conversely, the smaller the occurrence frequency of keywords associated with *EJMSTE*, the closer the color of keywords is to blue.

Table 5 displays the main research themes ranked by the frequency of occurrence. As can be seen, science education (30 occurrences), teacher education (20 occurrences), mathematics education (17 occurrences), attitude/attitudes(17 occurrences), problem solving (16 occurrences), professional development (13 occurrences), higher education (12 occurrences), science (11 occurrences), mathematics (11 occurrences), self-efficacy (11 occurrences), technology (11 occurrences), practical work (11 occurrences), gender (10 occurrences), nature of science (10 occurrences), physics education (10 occurrences), motivation (9 occurrences), mathematics achievement (8 occurrences), pedagogical content knowledge (8 occurrences), virtual reality (8 occurrences), creativity (8 occurrences), learning effectiveness (8 occurrences), and engineering education (8 occurrences) were the main research themes of the journal.
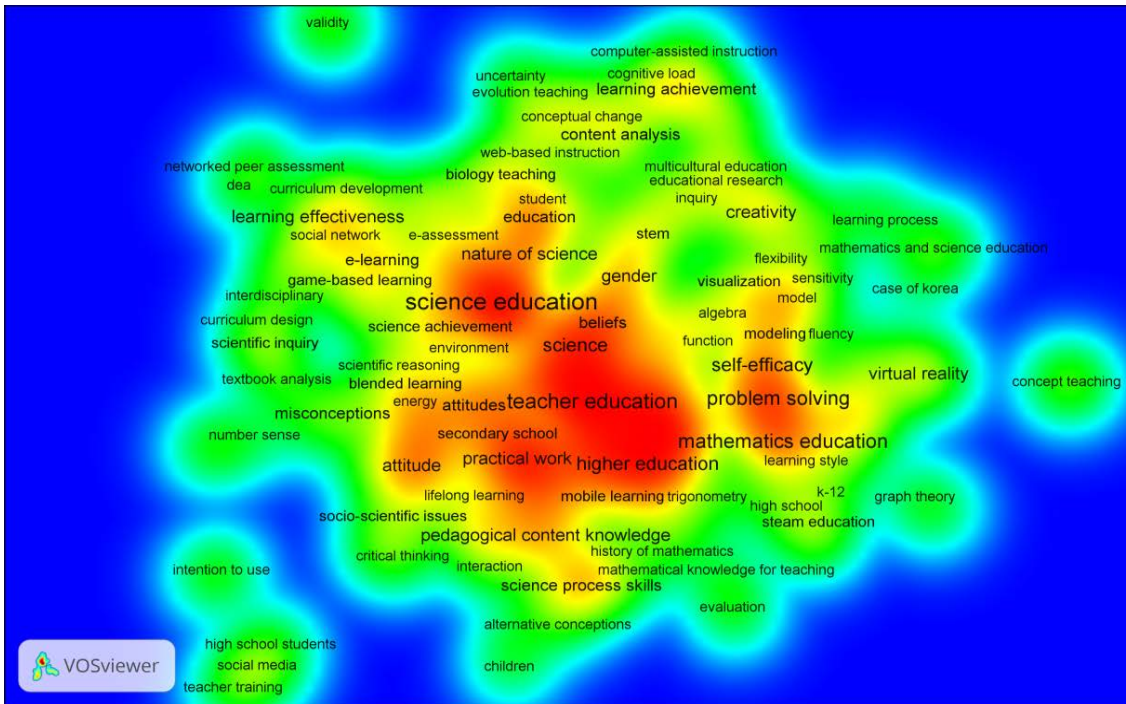
Figure 3. Visualizing the main research themes based on author keywords co-occurrences network

Table 5. Mainly research themes

Rank	Research theme	Frequency	Rank	Research theme	Frequency
1	science education	30	8	practical work	11
2	teacher education	20	13	gender	10
3	mathematics education	17	13	nature of science	10
3	attitude/attitudes	17	13	physics education	10
5	Problem solving occurrences)	16	16	motivation	9
6	professional development	13	17	mathematics achievement	8
7	higher education	12	17	pedagogical content knowledge	8
8	science	11	17	virtual reality	8
8	mathematics	11	17	creativity	8
8	self-efficacy	11	17	learning effectiveness	8
8	technology	11	17	engineering education	8

An in-depth study on the research themes citation impact was shown in **Figure 4**. The research themes are represented with colored frames to mirror the average citation impact. And, this was getting by taking the average of the normalized citation scores of all research themes appeared in. Similarly to **Figure 3**, research themes in **Figure 4** also has a color range from blue to red corresponding to normalized citation scores from 0 to 5. In this research, the larger the citation impacts of research themes, the color of keywords is to red. Conversely, the smaller the citation impact of research themes, the closer the color of keywords is to blue.

As can be observed in **Figure 4**, student teacher (15.5 Average citations scores), Technology Acceptance Model (TAM, 15.5 Average citations scores), animals (8.67 Average citations scores), Moodle (7.5 Average citations scores), inquiry (7 Average citations scores), socio-scientific issues-based science education (7 Average citations scores), beliefs (6.67Average citations scores), three-tier test (5.67 Average citations scores), attitudes toward science (5 Average citations scores), educational reform (5 Average citations scores), hands-on science (5 Average citations scores), problem-based learning (5 Average citations scores) ,blended learning (4.6 Average citations scores) and scientific inquiry (4 Average citations scores) were the most impact research themes. These reflected the above themes attracted more citations than other themes and made a significant contribution to expand *EJMSTE* journal's influence.

Figure 4. Visualizing the citation impact of the mainly research themes

Table 6. Most important themes

Rank	Research theme	Average citations scores
1	science education	15.5
2	Technology Acceptance Model (TAM)	15.5
3	animals	8.7
4	Moodle	7.5
5	inquiry occurrences	7.0
6	socio-scientific issues-based science education development	7.0
7	beliefs	6.7
8	three-tier test	5.7
9	attitudes toward science	5.0
10	educational reform	5.0
11	hands-on science	5.0
12	problem-based learning	5.0
13	blended learning	4.6
14	scientific inquiry	4.0

Intellectual Structure Analysis

The intellectual structure of a journal can be represented with a network of cited-references. Our paper focuses on co-cited references networks with *VOSviewer*. **Figure 5** displays the Panorama intellectual structure of *EJMSTE*. The size of a node is proportional to the number of cited references. A node with high citation counts would be more valuable than others (Chen et al. 2009). It is easy to observe that a guideline, named *Principles and Standards for School Mathematics,* is the best influence publication in *EJMSTE*. Followed two articles, "*Those Who Understand: Knowledge Growth in Teaching*" and "*Knowledge and Teaching: Foundations of the New Reform*" both published by Shulman (1986, 1987) get a second position of the landmark articles. *National Science Education Standards (NSES)*, a guideline for *K-12* science education in United States schools, win the third place. This indicates that reports published by education organization play an important role in the knowledge base of *EJMSTE*.

Additionally, 6 groups have also been identified and integrated in **Figure 5** through a color-coding. This was realized through using the cluster method for grouping documents together based on their similarities. It is also easy to observe, cluster 1 with red color consists of 182 publications with strong ties to the educational psychology.
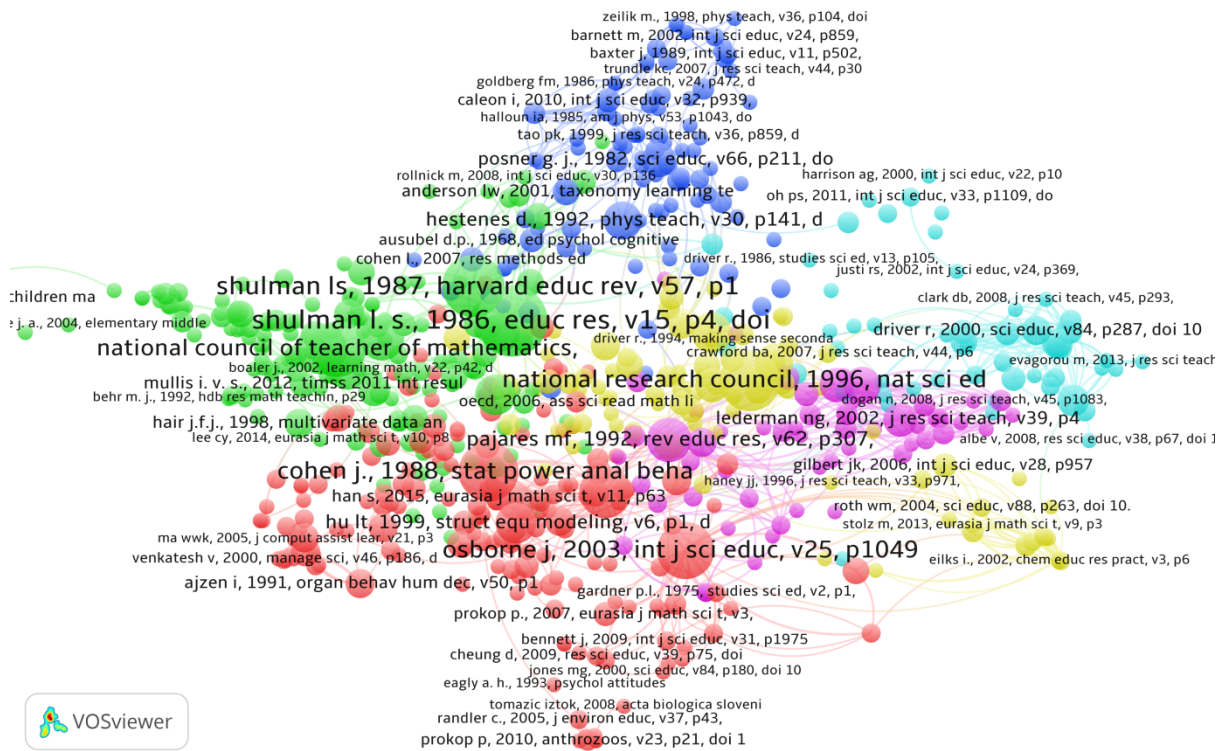
Figure 5. Panorama of intellectual structure

With green color, a second cluster consists of 177 publications and finds its roots in teacher education. A third cluster (blue color) groups a number of articles related to teaching and learning. Cluster 4 with yellow color consists of 92 publications with strong ties to the science education. Cluster 5 with purple color consists of 57 publications and finds its roots in nature of science. Cluster 6 seems to be the most heterogeneous. These six clusters formed the main knowledge base of *EJMSTE*.

Knowledge Commutation Analysis

How does knowledge flow between *EJMSTE* and other journals? **Figure 6** shows the knowledge flow between *EJMSTE* and its related journals. The left side of the figures shows the top 15 journals which cited by *EJMSTE,* reflecting the knowledge from these journals flowing to *EJMSTE*. The right side of the **Figure 6** shows the journals, from those indexed by *WoS*, were citing *EJMSTE* in their articles. This reflects the knowledge flow from *EJMSTE* to other journals.

The dominant cited journals by *EJMSTE* are *International Journal of Science Education* (739 times), *Journal of Research in Science Teaching* (690 times), and *EJMSTE* (529 times). This indicates that *EJMSTE* do drove by the journals in its own research field. We must highlight that *Computers & Education* and *Computers in Human Behavior* are also present in the top 15 cited journals. This reflects that computer related researches are becoming increasingly important in the mathematics and science education.

Figure 6 also shows the top 15 most citing journals from a total of 493 journals by the number of citing times. Among them, *EJMSTE* is the most dominant journal (184 times), followed by *Journal of Baltic Science Education* (31 times), and *Anthropologist* (31 times). This indicates that *EJMSTE* exhibits a slight problematic self-citation behavior. Whilst, the appearance of *Anthropologist* strengthens the conclusion that *EJMSTE* and *Anthropologist* are very closely allied, and *EJMSTE* will set up an important bridge between its own academic knowledge domain and anthropology.
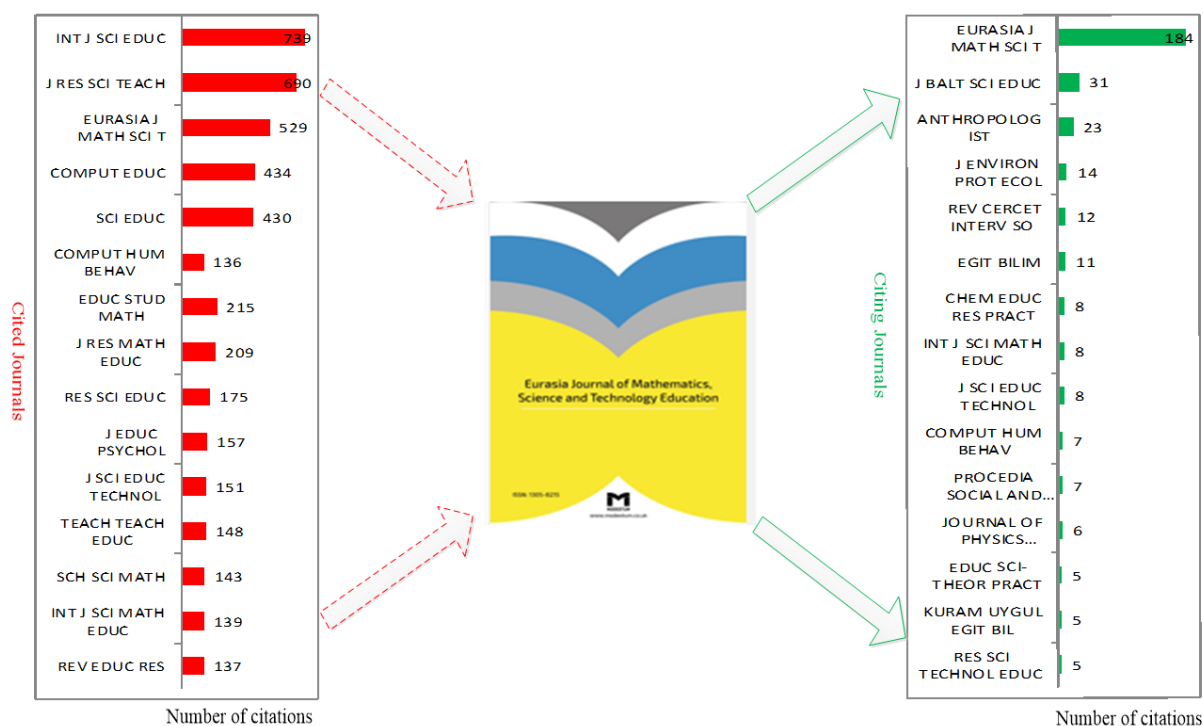
Figure 6. Knowledge communication between *EJMSTE* and other sources

DISCUSSIONS AND CONCLUSIONS

The aim of this study was to create a bibliometric profile of *EJMSTE* between 2012 and 2017 by using bibliometric analysis and visualizing methods. Considering this aim, we investigated the *H-Classics* publications, major prolific authors, institutions and countries (territories), main research themes, intellectual structure and knowledge commutation status. And then a spectrum of *EJMSTE* was posed, and this revealed the journal's bibliometric characteristics.

We found that, based on *WoS* database, 655 publications published in *EJMSTE (*from 2012 to 2017*)* can be divided into 4 different document types. This is much fewer than other journals, i.e. the findings performed by Blažun Vošner et al. (2016) (nine document types) and Fu and Ho (2015) (also nine document types). According to this, the attraction of *EJMSTE* to other document types is relatively limited. Therefore, *EJMSTE* could extend the document types. For example, the journal can publish more selected conference papers to improve journal's popularity.

By analyzing the dynamics and trends of published productions, we found an exponential growth trend in one-year block. The cause of this might be the rapid development of science and technology education research. Another cause might be due to the number of issues increased from 6 to 12. This change may do a favor for journal's prestige and visibility. Then, more submissions would be attracted by this journal. And, editor and reviewer also have more opportunity to select better papers. Similarly, *EJMSTE* also can increase the number of published papers in each issue. At the same time, a strict paper review process is also needed to promote paper quality.

By analyzing the *H-Classics* publications, we highlight the importance of Turkey and Slovakia, who published 2 *H-Classics* publications, respectively. Our findings showed that, the most prolific authors were Chang and Eilks (both published 7 articles). A more extensive investigation of the prolific authors revealed 11 authors who published more than five articles. Interestingly, two chief editors, Chang and Kubiatko, were both appeared in the top 10 prolific authors. The prolific institutions and countries (territories) presented that, publications in *EJMSTE* were dominated by Turkey, Taiwan, China and their institutions. This also suggests *EJMSTE* needs to go further internationalization.

To do this, *EJMSTE* may invite outstanding researchers from different countries to join the editorial board. Second, *EJMSTE*, currently, remits publication fees for editorial board member, reviewers, guest editorials, book reviews, and invited articles. Moreover, when doctoral students submit a manuscript stemming from their doctoral dissertations, they will be eligible for fully paid. In the same manner, we suggest that *EJMSTE* could make appropriate deductions of publication fees according to the quality of papers. Third, the reasonable use of new

media technology can also enlarge the influence of journals and published papers. Such as *Academy of Management Perspectives*, this journal starts to make a video for some papers to help readers understand the research deeply. This also will increase the influence of papers and journal.

Contrast with the geography distribution of *H-Classics* publications, there is no representation author from China emerges in *H-Classics* publications. The reason for this may due to the relatively late published time. It needs to take time for the papers from China to raise in the "citation" rankings. In addition, in the future, *EJMSTE* also need to pay attention to the review processes for these papers to ensure the papers' quality.

Analysis of research themes showed science education, teacher education, mathematics education, attitude/attitudes research, problem solving, professional development were the main research themes for the journal. The further analysis of research theme citation impact highlighted the positive contribution of student teacher, TAM and animals. These themes expand the influence of the journal. Therefore, *EJMSTE* could appropriately increase the publication of papers about these three topics. This will help to obtain more citations and improve impact factors of *EJMSTE*.

A network of cited-references enabled us to identify the knowledge base of *EJMSTE*. By using the clustering method based on the network of cited-references, six clusters consists of different publications were identified which formed the main knowledge base of *EJMSTE*. Analysis of cited and citing journals presented the knowledge commutation status of the journals. Cited journal analysis indicated that *EJMSTE* is drove its own academic knowledge domain. Citing journal analysis shows *EJMSTE* is the most dominant journal. This accords with the general law of journal citation, but it's also important to notice that a strictly control is necessary to avoid high self-cited.

Citing journal analysis also reflected *EJMSTE* is very closely allied with some other journals within in other academic knowledge domain, such as anthropology. Through the comprehensive analysis of the knowledge commutation status, we can easily draw the conclusion that *EJMSTE* will set up an important bridge between its own academic knowledge domain and some other academic knowledge domain, especially for anthropology. According to the theory of social network, the journals, acting as the bridges between different domains, will get an easier access to resources and high citations (Chen, 2011). Thus, *EJMSTE* need to maintain and consolidate this role. Not only closely connect with its own academic knowledge, but also actively promote the knowledge communication with other journals in different domains.

ACKNOWLEDGEMENTS

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Effects of Innovative Education on Innovation Capability and Organizational Performance in High-Tech Industry

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ABSTRACT

Looking at the development of domestic industries, the industrial structure has turned from agriculture in the past to the focus on manufacturing and service industries. With constant investment in R&D and the promotion of technology, manufacturing even turns to technology-intensive high-tech industry. Excellent talents and R&D innovation capability have been the critical but difficult problems for high-tech industry. For this reason, the quality of work force and the product innovative R&D capability in high-tech industry could merely be enhanced by reinforcing innovative education. Semiconductor manufacturers with the revenue ranked top three in 2016 in Taiwan are selected as the research subjects. Total 600 copies of questionnaire are distributed to the supervisors and employees, and 469 valid copies are retrieved, with the retrieval rate 78%. The research results show significantly positive effects of 1.innovative education on innovation capability, 2.innovation capability on organizational performance and 3.innovative education on organizational performance. According to the results, suggestions are proposed in this study, expecting to assist high-tech businesses in promoting human capital and innovation capability.

Keywords: high-tech industry, innovative education, innovation capability, organizational performance

INTRODUCTION

The rapid development of domestic economy has the industrial structure face the transformation, promoting from past labor-intensive industries to the focus on technology-intensive structure. The effort made for the development of high-tech industry is significant to increase the demand for senior technology talents. In order to thoroughly supply distinct science and technology talents required for industrial development, the cultivation of science and technology talents has become the prior point. The rich science and technology talents and established famous technology industries or products are the niche to develop high-tech industry domestically. However, the demand for innovation talents in future high-tech industry appears serious gap, and talents excessively concentrate on certain popular industries to cause talent exclusion that it is adverse to the long-term balance development of high-tech industry.

The urgent demand for professional technology talents and the accelerating change in personnel in high-tech industry has changed the management conditions from business competition to the competition of the quality of work force. Education of high-tech employees is therefore emphasized domestically and becomes the focus to compete with businesses in the same industry. Furthermore, the fast change in technology, particular in high-tech industry, has shorten the update cycle of products and technology that even experts perceive the risk of not being able to catch up. Simply speaking, an enterprise has to constantly and frequently educate the employees for innovative R&D in order to have high-tech industry catch up the advance of technology in the world. Apparently, excellent talents and R&D innovation capability are the primary but difficult problems for high-tech industry. The quality of work force and the product innovative R&D capability of high-tech businesses could merely be enhanced by reinforcing the innovative education. Nonetheless, how is employees' innovation capability after the innovative education? This study therefore intends to discuss the effect of innovative education on innovation capability and organizational performance in high-tech industry.

Contribution of this paper to the literature

- Seniors present rich social networks, social experiences, and innovation experiences that the experiences and opinions could be the reference for developing innovation in high-tech businesses.
- The construction of cultural climate with innovative education is initiated by the organizational structure; especially, the encouragement from a leader presents the demonstration of leadership.
- To have employees consciously reflect and maintain the systems and innovation culture of the enterprise, employees' realization is necessary.

LITERATURE REVIEW

Innovative Education

Innovation of itself is vitality and energy, which could help a target become more exquisite and excellent after making changes (Hyung, 2016). Bakker et al. (2016) regarded "innovation" as successfully introducing and applying new tactics or purposes to a situation. Schmitt et al. (2016) pointed out "innovation" as the process transforming creative ideas into useful products, services, or working methods to enhance the improvement and promotion of the quality of an organization. It aimed to have an organization sustainably maintain the competitive advantages and generate new value through new procedures and directions (DeCenzo et al., 2013). Tims et al. (2016) regarded innovative education as the strategy of an organization having the employees pursue breakthrough, change current conditions, and develop characteristics on products, processes, or services through education so as to enhance organizational performance. Alessandri et al. (2015) explained innovative education as a leader presenting creative ideas and actively establishing various educational trainings useful for innovation, e.g. members commonly participating in decision-making, shaping communication and dialogue situations without slaughter, inducing opportunities for members' innovation, and further creating innovative and excellent organizational culture to enhance the overall competitive advantages and maintain the sustainable status of the organization. Noe (2013) indicated that the promotion of innovative education aimed to establish the mechanism for organizational employees participating in knowledge sharing and the ability of innovation and group creation, intending to integrate dispersed knowledge to create larger added value and benefits. Innovative education is the knowledge and skills used for changing behaviors and action to help an organization cope with changes in external conditions and enhance the efficiency of organizational innovation. Innovative education is developed through vision, innovative knowledge, mental model, and the sharing of past innovation experiences. It is considered as the major process to generate management innovation and stresses on organization innovation as an autonomous output through the past knowledge of the organization and the process of innovation experience (Xie et al., 2016). Referring to Fang and Zhang (2014), innovative education is measured with learning commitment, vision sharing, and open mind in this study.

Innovation Capability

Zumrah et al. (2013) pointed out "innovation" as the adoption of a new idea and behavior. From resource-based theory, innovation is defined as changing the output of resources that innovation capability is a new idea for internal facilities, systems, policies, procedures, products, and services of an enterprise (Guta, 2013). Barba Aragón et al. (2014) proposed the innovation capability required for modern enterprise organizations. First, it required constant development or improvement of current workflow to improve products or services which could continuously be competitive in the market within 2-3 years. Second, an organization could either utilize internal learning or absorb new knowledge externally to research and develop new products, based on current products or technologies, for next generation. Finally, an organization should present innovative process systems with the process of constant innovation, digestion, and re-innovation and not stick to the operation of basic knowledge, which would have new knowledge soon become out of date to lose the meaning to utilize new knowledge for innovation (Karatepe and Aga, 2016). Aksoy et al. (2014) defined innovation capability as the abilities 1. to develop new products to satisfy market requirements, 2. to apply proper processes and technologies to produce new products, 3. to develop and adopt new products, processes, and technologies to satisfy future requirements, and 4. to respond to unexpected technological actions taken by competitors and to create sudden opportunities.

Referring to Li (2014), technology innovation capability and management innovation capability in the organizational innovation capability scale are used for measuring innovation capability. Technology innovation capability refers to a company using new technologies and equipment for production and manufacturing so as to conform to the rapid market change. Management innovation capability refers to a company applying innovative

management measures (pay systems for encouraging innovation, novel performance measurement, use of leadership) to the entire business management system.

Organizational Performance

Organizational performance could be the output-input ratio in the entire business of an enterprise, the degree of target achievement, and the satisfaction of participants in the business process (Henseler et al., 2015). By organizing the points of view from various studies, Aküzüm (2014) proposed that (1) organizational performance was the core of organization theory, (2) there was not a single performance indicator presenting distribution, (3) it was difficult to show consensus for performance indicators, (4) there were different performance indicators corresponding to various situations, and (5) theory orientation was replaced with problem-solving orientation (Koffel et al., 2016). Organizational performance presents complexity that the interpretation should contain multiple dimensions so that there are different definitions, measurement methods, and indicators of organizational performance for current applications and requirements (Breevaart et al., 2016). Peng et al. (2014) suggested "job satisfaction", "organizational objective", and "job performance" as the measuring indicators of "organizational performance". According to researchers' suggestions, above three indicators are included in this study for evaluating "organizational performance". The definitions are explained as follows.

Job satisfaction

Degago (2014) was the first scholar proposing job satisfaction and regarded it as employees' subjective satisfaction with working environment and work itself psychologically and physiologically. Job satisfaction was considered as the degree of employees preferring the job that job satisfaction would appear when the job characteristics were suitable for the workers' expectation.

Organizational objective

An objective refers to the achieved standard in a job or a plan as well as a correct, specific, and logical post, which is pushed by intrinsic drive.

Job performance

Olçer and Florescu (2015) pointed out job performance as the "quality and quantity" performed by individuals or teams to achieve the tasks at work. Andrews et al. (2016) regarded job performance as the behavior of an individual, as an organizational member, completing what the organization expected, regulated, or required for a formal role.

Research on innovative education and innovation capability

Innovative education, as a part in the changing process of an organization, could induce the knowledge, belief, and behavior changes of an organization and eventually enhance organization growth and innovation (DeCenzo et al., 2013). Demerouti et al. (2015) argued that an enterprise could respond to the environment by proceeding product innovation as well as actively change the employees' attitudes, value, and behavior model toward innovation by proceeding innovative education. It could deliver the sustained innovation vision to the employees to have them integrate such a thought in daily life and enterprise business and enhance employees' innovation capability so that the enterprise could sustainably develop and maintain the competitive advantages. Bakker et al. (2016) indicated that an enterprise absorbing and assimilating external conditions through innovative education could assist in the promotion of internal innovation. In the research on the effects of innovative education on innovation management system in organizations, Milkovich et al. (2017) indirectly proved the possibility of direct effects of innovative education on innovation capability. Alessandri et al. (2015) mentioned that an enterprise simply changing the manufacturing process and product design was not the real innovation; an enterprise could merely sustainably develop to promote the employees' innovation capability and maintain the competitive advantages by applying innovative education to introduce innovation culture to the company culture and practice in employees' daily life and enterprise business. The following hypothesis is then proposed in this study.

H1: Innovative education shows significantly positive effects on innovation capability.

Research on innovation capability and organizational performance

With actual tests, Hoon and Parent (2013) indicated that high-performance organizations, compared to low-performance ones, showed high correlations between management innovation and technology innovation, i.e. highly positive effects of innovation capability on organizational performance. Zumrah et al. (2013) pointed out the

positive effect of organization innovation on performance, and even the directly positive effects of technology innovation and management innovation on organizational performance. Seppälä et al. (2015) considered that the effect of management innovation on organizational performance was larger than the effect of technology innovation on organizational performance. Barba Aragón et al. (2014) particularly pointed out the factors in the contribution of innovation capability to organizational performance, including that 1. technology innovation could reinforce current value to the major customers of an organization to enhance the organizational performance and 2. innovation capability could acquire new customers by establishing new markets (Karatepe and Aga, 2016). In this case, the following hypothesis is proposed in this study.

H2: Innovation capability reveals notably organizational positive effects on performance

Research on innovative education and organizational performance

Aküzüm (2014)) pointed out the positive effect of innovative education on organizational performance. Olçer and Florescu (2015) indicated that innovative education could indirectly affect organizational performance by improving the quality of market-oriented behavior, and the product, procedure, and system innovation, through creative learning, could directly affect organizational performance. Lin (2014) also stated that innovative education and organization knowledge could enhance competitive advantages and organizational performance. Degago (2014) mentioned that innovative education could enhance performance, productivity, and profits. Tsai et al. (2013) indicated that most small and medium enterprises did not practice innovative education; when traditional restrictions were eliminated to enhance innovative education, the innovation capability, flexible and rapid response capability, and information and communication capability could be promoted to further promote organizational performance. Breevaart et al. (2016) argued the importance of innovative education that the application of innovative education could enhance efficiency and promote innovation capability and performance. The following hypothesis is therefore proposed in this study.

H3: Innovative education presents remarkably positive effects on organizational performance.

DESIGN OF RESEARCH METHOD

Operational Definition and Measurement of Variable

Innovative education

Innovative education is divided into learning commitment, vision sharing, and open mind, which is referred to Fang and Zhang (2014). The overall reliability coefficients show 0.86, 0.82, and 0.87 for learning commitment, vision sharing, and open mind, respectively.

Innovation capability

Referring to Li (2014), innovation capability is divided into technology innovation capability and management innovation capability. The overall reliability coefficients appear 0.88 and 0.90 for technology innovation capability and management innovation capability, respectively.

Organizational performance

Referring to Peng et al. (2014), organizational performance contains three dimensions of job satisfaction, organizational objective, and job performance. The overall reliability coefficients reveal 0.83, 0.81, and 0.84 for job satisfaction, organizational objective, and job performance, respectively.

Research Object

Aiming at high-tech industry in Taiwan, semiconductor manufacturers with the revenue ranked top three in 2016 are studied. Total 600 copies of questionnaire are distributed to the supervisors and employees, and 469 valid copies are retrieved, with the retrieval rate 78%. According to the consolidated revenues in January-December, 2016, the three semiconductor manufacturers are Taiwan Semiconductor Manufacturing Company Limited, MediaTek Inc., and Advanced Semiconductor Engineering, Inc.

Table 1. Confirmatory Factor Analysis

Research dimension	Overall fit	Analysis result
innovative education	X2=0(P<0.001); DF=0; GFI=1.00; CFI=1.00	Good overall model fit
innovation capability	X2=0(P<0.001); DF=0; GFI=1.00; CFI=1.00	Good overall model fit
organizational performance	X2=0(P<0.001); DF=0; GFI=1.00; CFI=1.00	Good overall model fit

Table 2. Correlation analysis

Research dimension	α	innovative education	innovation capability	organizational performance
innovative education	0.85			
innovation capability	0.89	0.33**		
organizational performance	0.83	0.31**	0.37**	

Table 3. Analysis of overall linear structural model

	X2/Df	1.946
overall fit	GFI	0.969
	AGFI	0.921
	RMR	0.007

Note: * stands for p<0.05, ** for p<0.01, and *** for p<0.001

Test of Reliability and Validity Analysis

The reliability of the dimensions in this study achieves above 0.7, revealing the high reliability. The construct validity of the research scales is analyzed with Confirmatory Factor Analysis. From **Table 1**, the scales present favorable convergent validity and construct validity.

ANALYSIS RESULT

Correlation Analysis

Table 2 reveals the remarkable correlation among innovative education, innovation capability, and organizational performance. Such results show the possibility of multicollinearity among dimensions. Nested model analysis could be used for solving such a problem. The significant correlations among dimensions also reveal the correspondence with the hypotheses.

Discussion of Overall Model

In regard to overall model fit, **Table 3**, the overall model fit standards $\chi2/Df$ 1.946, smaller than the standard 3, and RMR 0.007 present the appropriate results. Furthermore, chi-square value is sensitive to sample size that it is not suitable for directly judging the fit. However, the overall model fit standards GFI 0.969 and AGFI 0.921 are higher than 0.9 (the closer GFI and AGFI to 1, the better model fit) that this model shows good fit index.

Discussion of Research Hypothesis

With nested model, chi-square difference test is used for the research hypotheses as each nested model appears a degree of freedom. When the difference between the chi-square value of nested model and the chi-square of theoretical model achieves the significance, the path coefficient set 0 is remarkable. The research results reveal the significance of the model; the analysis of nested model is shown in **Table 4**, and the hypothesis test is shown in **Table 5**.

Table 4. Nested model analysis

Model	χ²	Δχ²	GFI	CFI	RMSEA
Theoretical model	251.84		0.969	0.977	0.08
Model 1: Testing hypothesis	257.97	6.13*	0.969	0.977	0.08
Model 2: Testing hypothesis	263.81	5.84*	0.969	0.977	0.08
Model 3: Testing hypothesis	270.25	6.44*	0.969	0.977	0.08

Table 5. Test of hypothesis

Research hypothesis	Correlation	Empirical result	P	Result
H1	+	0.423	0.00	supported
H2	+	0.512	0.00	supported
H3	+	0.388	0.00	supported

CONCLUSION

The research findings show the direct effect of innovative education on innovation capability and organizational performance that high-tech businesses could improve the innovation capability through internal innovative education to directly and obviously enhance the organizational performance. High-tech businesses could promote the organizational members' innovation capability through the reinforcement of innovative education and to have them present knowledge with low replaceability and high added value. In this case, the completion of innovative education to help high-tech businesses enhance talent training could simultaneously cultivate employees' uniqueness and professional capability and further accumulate organizational human capital. A high-tech business could have the employees continuously learn, share experiences and knowledge, and create organizational value through innovative education. Employees with strong intention to maintain the relationship with the organization would agree with the innovation objective and value of the organization and be willing to make more effort to innovation. In this case, new innovation capability could be brought in the organization and organizational performance could be promoted.

SUGGESTION

The results and findings are organized in this study, and practical suggestions are proposed as follows.

I. Seniors present rich social networks, social experiences, and innovation experiences that the experiences and opinions could be the reference for developing innovation in high-tech businesses. Besides, assisting new staff in the socialization with seniors' influence and experiences could have new staff soon realize the innovation culture in the organization and develop the role function to enhance the innovation capability.

II. In the tide of multi-intelligence, most employees in high-tech industry follow the rule of better keeping still than move and would not easily step out the original frame. The construction of cultural climate with innovative education is initiated by the organizational structure; especially, the encouragement from a leader presents the demonstration of leadership. In the era with multiple challenges, the rapid development and circulation of information technology have changed the current pattern of high-tech industry. Employees in high-tech industry have to keep up with the trend, self-reflection, self-fulfillment, accumulating new energy, and stressing on organizational learning and knowledge sharing to present endless innovation and appear creative behaviors.

III. The innovative education courses in high-tech industry could be vivid. Corporate culture is not learned, but acquired through "realization". To have employees consciously reflect and maintain the systems and innovation culture of the enterprise, employees' realization is necessary. Various innovative education approaches, including lecturing, case study, team participation, and games, could be applied and arranged according to the contents and subjects. For instance, lecturing might be suitable for the inheritance from high-level supervisors to employees; games could be used for the contact with new staff or the re-training of employees in order to induce the passion and agreement; and, cast study is suitable for employees proceeding in-depth exploration of innovation so as to cohere consensus.

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Differences in Parental Involvement and Perception of Video Games: A Pilot Study on American-Born and Immigrant Parents

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ABSTRACT

As more and more students from diverse families populate 21st century classrooms, the need for more culturally sensitive pedagogical approaches intensifies. Although literature suggests that differences of parenting styles between immigrant and native-born American parents will influence children's learning, classroom teaching, and policy making, little is known about whether there is any difference in parental involvement in the video game process and parental perceptions of integrating video games into the regular classroom. In this aspect, an online survey was conducted. Consistent with our hypotheses, although the sampled native parents were more likely to hold an overall negative attitude toward violence in games, they were less worried about the integration of video games in the classroom than immigrant parents were. Results also suggested that the sampled immigrant parents were less involved in the game playing process than their counterpart native-born parents were. Additional correlation analyses revealed that if parents held more negative attitudes toward social effects brought on by the violence in video games, they would most likely use stricter mediation techniques toward their children's video game playing. On the other hand, the more negative the attitude was, the more involved parents were in their children's gameplay. Implications, limitations and future research opportunities were discussed.

Keywords: parental attitude, cultural diversity, video game violence, technology integration

INTRODUCTION

In the last decade, scholars have advocated the adoption of video games for learning and instruction (Wouters et al., 2013). A significant body of research has studied the effects of video game play on children's academic development (Burguillo, 2010; Kebritchi et al., 2010; Shaffer, 2006), cognitive development (Eow et al., 2009), and social development (Skoien & Berthelsen, 1996). According to the meta-analysis conducted by Wouters et al. (2013), serious games are found to be more effective in terms of learning and retention. On the other side, increasing evidence has concluded that there was no relation between violent games and societal aggression or violence (Markey et al., 2014; Przybylski et al., 2014; Ferguson, 2015; Ferguson et al., 2015). For instance, Ferguson et al. (2015) conducted three experiments and none of them provided evidence for concerns linking violent video games to aggression or reduced empathy in youth aged 12–18. Their studies also show that personal experience with games was associated with more positive attitudes toward video games.

However, literature on digital game-based learning suggests that negative parental perceptions are often influencing decisions that teachers and policy makers make in terms of video game integration into the regular classrooms (Bourgonjon et al., 2011). Research also demonstrates that the overall perception that games have a potentially damaging effect on children has contributed to the public debates about excessive violence in video games (Oosting et al., 2008). According to Kutner & Olson (2008), parents are oftentimes left behind when it comes to video games and their impact on children, and parental ignorance about video games is often overlooked. As Jenkins (2006) stated, there is a huge disconnect between parental perception of video games and what the research shows.

Contribution of this paper to the literature

- Although the sampled native parents were more likely to hold an overall negative attitude toward violence in games, they were less worried about the integration of video games in classroom than immigrant parents were.
- The sampled immigrant parents were less involved in the game playing process than their counterpart native-born parents were.
- If parents held more negative attitudes toward social effects brought on by the violence in video games, they would most likely use stricter mediation techniques toward their children's video game playing.

Besides violence concern, families' own history, socioeconomic status, and socio-cultural knowledge are also identified as important factors that influence parental attitude toward video games (Skoien & Berthelsen, 1996; Bourgonjon et al., 2011). As more and more students from diverse families populate 21st century classrooms, the need for more culturally sensitive pedagogical approaches intensifies. Although differences in parenting styles between immigrant and native-born American parents (e.g. "Tiger Mom" vs. "Panda Dad") have instigated public debates, there is still little research on parental attitudes toward video games in the classrooms.

According to the US Census report (2011), 13% of the U.S. population (40.4 million) was foreign born in 2011, and the numbers were 12% and 37.2 million in 2007; this indicates that the volume of migration to the United States is increasing. In 2011, over half (53%) of all foreign-born individuals were born in Latin America and the Caribbean. The second largest group came from Asia, which represented 29% and the next largest was from Europe representing 12% (US Census, 2011). The increasing number of immigrant population is changing the structure of the classrooms. As Moreno & Chuang (2011) suggested, immigrant parents either willingly or unwillingly bring their preexisting cultural values and beliefs into their parenting behaviors. Today's classrooms not only require teachers to educate students of different national origins, cultural upbringing, native language and learning differences (Gollnick & Chinn, 2002), but also cater to the needs of culturally diverse parents (Joshi et al., 2005). Therefore, this study was designed as a first step in investigating the differences in perceptions of video games integration into the classroom between American born and immigrant parents. In the following sections we will present the synopsis of the literature, state the hypotheses, describe methodology, report findings and discuss implications for future research.

CONCEPTUAL FRAMEWORK

Parental Perceptions of and Involvement in Video Game Play

A great majority of research tends to concentrate on how digital games affect children's development and wellbeing (Kim & Hong, 2007), as well as the impact of video game integration into the regular classroom (Gee, 2007). Many scholars have found that the introduction of video games into the classroom is a necessary and invaluable step that will help schools to better cater to the needs of today's generation (Gee, 2007; Jukes et al., 2010a). There are also educators who see great potential in integrating digital gameplay across academic subjects (Jukes et al., 2010a and 2010b; Prensky, 2006; Gee, 2007, Gee, 2009). For example, a positive relationship has been found between time spent on videogames and a child's intelligence (van Schie & Wiegman, 1997; Whitebread et al., 2012). Research also found that the full potential of game play could only be activated when both teachers and parents are actively involved as participants (Whitebread et al., 2012). However, literature on digital game-based learning suggests that the integration of video games into the classroom is often influenced by negative parental attitudes (Bourgonjon et al., 2011).

Parental attitudes play an important role in students' and eventually educators' approaches toward gaming (Skoien & Berthelsen, 1996; Whitebread et al., 2012). Green et al. (2009) find that if parents accept a certain non-traditional digital learning tool, then their children would most likely have a similar attitude toward it. Prior studies have identified that parental involvement in scholastic activities in and outside of school has a positive correlation with high-achieving youth (Kao & Tienda, 1995). Several researchers agreed that parental involvement and mediation were significant factors in contributing to the overall educational effect of multimedia in general and video games in particular (Neuman, 1995; Rideout, 2014; Singer & Singer, 1983; Skoien & Berthelsen, 1996; Turkay et al., 2014; Whitebread et al., 2012).

Skoien & Berthelsen (1996) suggested that the socio-cultural environment in which people exist affects their attitudes therefore people always strive to do what is considered to be socially acceptable. Therefore the examination of parental perceptions, attitudes, and other contextual backgrounds of families in relation to video games might provide a good basis for understanding of how educators, administrators and researchers can

influence the level of acceptance of video game integration into the regular classroom among culturally diverse families (Skoien & Berthelsen, 1996).

Concerns about Violence and Cultural Diversity

Research shows that there are several factors that influence parental attitudes toward video games. One of them is media coverage on video game violence, which paints a rather negative image of the impact that the violence in digital games has on children's well-being (van Schie & Wiegman, 1997). Research demonstrates that public debates about the excessive violence in video games also contribute to the overall perception that games have a potentially damaging effect on children (Oosting et al., 2008). Researchers find that parents are prone to having a few pre-conceived notions that are based primarily on what they see on the screen when their children play video games, although many of those notions proved incorrect or are applicable only to a very small group of children (Oosting et al., 2008; van Schie & Wiegman, 1997; Whitebread et al., 2012). Furthermore, Ferguson et al. (2015) finds that there is no consensus in beliefs about games among parents. It is worth noting that parental attitudes toward violent games are diverse. Following this thread, we define violent video games in terms of having aggressive (Bartholow et al., 2005; Fischer et al., 2010) or violent content (Funk et al., 2003; Gentile et al., 2004; Harvard Health Publications, 2010) in video games. However, we want to mention that there are controversies regarding those broad definitions of violent games. A notable example is one scholar had to admit on the stand of a murder trial that Pac-Man could be considered a "violent video game" as the way people define it. The U.S. Supreme Court in a 2011 decision overturning a California statute that restricted the sale or rental of violent video games to minors dismissed the expert's conclusions about potentially harmful effects of violent video games, finding that any effects are "both small and indistinguishable from effects produced by other media" (Rushton, 2013).

Another factor that may influence parental attitude is families' own history, socioeconomic status, and socio-cultural knowledge. According to Skoien and Berthelsen (1996), parental involvement is a complex process, which is influenced not only by socioeconomic status of the parents but also by their cultural values. Difference of parenting styles between immigrant and native-born American parents is not only discussed as anecdotes (e.g. "Tiger Mom" vs. "Panda Dad"), but also as an increasingly significant research topic. Previous research suggests that divergent cultural backgrounds impact (1) parental involvement in children's lives and choices children make, (2) discipline methods used, (3) the independence/interdependence of a child within a family, (4) academic expectations, (5) parental attitude toward "play," and (6) content censorships when it comes to TV, books, games, etc. (Green et al., 2009; Kim & Hong, 2007; Sharif, 2009). Behavioral differences between native and immigrant parents are identified as essential factors in explaining the different performance levels between native and immigrant youth (Kao & Tienda, 1995). Immigrant parents cannot avoid bringing their preexisting cultural values and beliefs to their parenting behaviors, although sometimes their own values and practices may conflict with those of the new country (Moreno & Chuang, 2011). However, when it comes to demographics and parental perception, the majority of research is concentrated on (1) statistical figures on the average number of hours children play (Green et al., 2009); (2) socioeconomic status of families (Green et al., 2009); and (3) parental mediation techniques (Kim & Hong, 2007; van der Voot et al., 1992). Unfortunately, the parental perception of video games' importance continues to be one of the areas that need to be explored further and in detail (Green et al., 2009). Since parents play an important role in students' and eventually educators' attitudes toward gaming, we hope that exploration of differences in parental thinking and attitudes will provide beneficial insight into how parents can help educators and researchers to better accommodate video games for learning in diverse classrooms.

Hypotheses

As Moreno & Chuang (2011) stated, "parents want a better life for their children" (p. 239), so for many immigrant families an opportunity to provide better educational opportunities is a main factor that motivates the migration. For example, Dreby (2009) find that one main reason for Mexican migrants to move to the United States is that they expect to enhance their children's opportunities through continued labor force participation. High expectations might result in immigrant parents being more involved in their children's education. But as video games are generally perceived as a negative factor that affects children's academic performance, and as Whitebread et al. (2012) found, gameplay is often seen as contrasted with "work" and characterized as a type of activity that is essentially unimportant, trivial, and lacking in any serious purpose, we hypothesize:

H1a: Integration of video games into the classroom is perceived more negatively by immigrant parents than American born parents.

H1b: Immigrant parents are more concerned about the educational potential of video games than American-born parents are.

H2: Immigrant parents are more likely to have lower tolerance levels toward video game violence than American-born parents do.

However, research on parental involvements shows obscure results. Immigrant parents were found in some research to be more involved in their children's education relevant activities. According to Lopez et al. (2000), unlike U.S.-born parents, parents born in Mexico are more likely to indicate that they are engaged in helping their children with schoolwork and are more involved in parent-school communication. However, some researchers find opposite results. Immigrant status has been found to be a barrier rather than impetus to parental involvement. Turney & Kao (2009) find that in comparison to native-born parents, minority immigrant parents suffer more barriers to participation, such as a lack of time and limited English language proficiency, and as a result, are less likely to be involved in school activities. Based on the limited findings on this topic, in the present pilot study, we propose a two-directional hypothesis:

H3: There is a difference in the level of involvement in video game play between immigrant and American-born parents.

Furthermore, immigrant parents are found to set stricter rules when it comes to household discipline and academic performance due to their higher expectations (Lopez et al., 2000). Therefore, we hypothesize that

H4: Immigrant parents will utilize stricter mediation techniques when it comes to their children video game play than American-born parents.

METHODOLOGY

Participants and Procedure

An online survey was conducted on Qualtrics.com. The online data collection lasted 30 days, from November 1, 2012 to November 30, 2012. Respondents were recruited through (1) the two researchers' personal email invitations, (2) one researcher's personal Facebook distribution, and (3) Email requests sent to Arts and Technology Institutes' parental database of 420 people.

Given the goal of the present study, a parent in the survey was defined as an individual who has at least one school-aged child. A school-aged child was defined as a boy or a girl, ages 5-18. The survey consisted of three major parts. Part I contained screening questions that helped us determine if the respondent was qualified to participate in the survey. Part II—the main body of the questionnaire—allowed us to collect data and explore the research question itself. Part III consisted of questions that captured the demographic information, such as age and sex, of the respondents.

A total of 94 people agreed to participate in the survey. Forty-nine of them were qualified to continue the survey. The final sample included 45 parents, two thirds ($n = 29$) of whom were native-born American parents and one third ($n = 16$) of whom were immigrant parents. Half of these 45 respondents ($n = 24$) were 25 to 34 years old; 15.6% of them ($n = 7$) were 35 to 45 years old; and 13.3% of them ($n = 6$) were 24 years of age or younger. Of the 45 qualified participants, 60% ($n = 27$) were female and 22.2% ($n = 10$) were male. 17.8% ($n=8$) did not answer this question as they abandoned the survey before completion.

Immigration Status

We measured each respondent's immigrant status by two criteria (1) whether one was born in the United States and (2) whether one came to the United States before the age of 14. The respondents who met both criteria were qualified as American parents. The cut off age of 14 was selected based on several factors. According to Papalia and Feldman (2003), adolescence starts roughly at 11-12 and peaks at 14. Additionally, based on Piaget's *Cognitive Development* theory, adolescents at the age of 14 can develop hypothetical and deductive reasoning, and establish firm beliefs. A parent who came to the United States at or after 14 will be categorized as immigrant parent since even though adolescent immigrants are mostly well integrated into mainstream culture they are still aware of their native heritage and what is expected of them in their private community (Güngör, 2011).

Based on our review of the literature, we conceptualized *parental perception* across two dimensions: (1) Parental attitudes toward video games in education, which are measured across two sub-dimensions: a. The potential of the integration of video games in the classroom; b. Parental concerns about games in the educational settings; (2) Parental attitudes toward violent video games.

Parental Involvement has been measured across two dimensions: (1) Parental involvement in their children's game play and (2) Parental mediation of their children video game play.

Perception of Education Potential of Video Games

The attitude toward games in education was measured across two subscales: (1) parental perceptions of the potential of the integration of video games in the classroom and (2) the concerns about games in the educational

settings. The measurements were adapted from Wlodarczyk (2012) who used modified version of the "Games in Education Teacher Survey" scale originally developed at the University of Connecticut in 2003.

Parental Attitudes toward Violent Video Games

We measured this variable as parental perceptions of the affordances of video games, utilizing the scales adapted from Attitude Scales toward Violence on Televisions, created by Çitak (2009). This set of scales included three dimensions: (1) items related to attitudes toward individual effects of violent video games; (2) items related to attitudes toward social effects of violent video games; (3) and items related to attitudes toward social control of violent video games. We modified the original 17 items to fit with our research questions. We added seven items to "individual effects," according to previous related findings (i.e., Ferguson, 2007; Guerra et al., 1995, as cited in Funk, 2000). Our instrument measured this part with Likert-type scales, asking the respondents to choose from 1=*strongly disagree* to 5=*strongly agree* with each statement.

Parental Mediation and Involvement

For this study, parental involvement was measured across two sub-dimensions: (1) parental mediation (e.g., mediation techniques, rule setting) and (2) parental involvement (e.g., playing video games with the child; buying games for the child). Both of these measures have been adapted from a scale developed by van der Voot and Nikken's (1992). The same scale was adapted once before by Skoien and Berthelsen (1996) to study parental beliefs about video games.

Parental mediation has been defined as methods by which parents guide their youngest child's video game playing behavior (van der Voot & Nikken, 1992). Five items from the television scale (van der Voot & Nikken, 1992) have been directly transferred to the new scale by substituting words where necessary. Followed the original scale, we employed the four-point rating instrument with response options from 1=*Never, 2=Occasionally, 3=Often,* to 4=*Always.*

Parental involvement scale was adapted from van der Voot and Nikken (1992) and Skoien & Berthelsen (1996). As adapted, these questions were (1) How often do you discuss your child's interest in the video game; (2) How often do you watch while your child plays a video game; (3) How often do you encourage the child to play a video game you enjoy; (4) How often do you talk about the differences between video games and real life; (5) How often do you discuss the video game played or about to be played; (6) How often do you play video games with your child; (7) How often do you play video games with your child for the benefit of the child; and (8)How often you do you play video games with your child at the request of the child. Followed the original scale, we employed the four-point rating instrument with response options from 1=Never, 2=Occasionally, 3=Often, to 4=Always.

RESULTS

Preliminary Analyses

Table 1 presents the means and standard deviations of all the dependent variables used in the analyses by status (native-born parents or immigrant parents). For all the dependent variables, the standard deviations of immigrant parents were relatively larger than those of native-born parents. On the average, the former group also showed higher diversity than the latter group did.

A two-way contingency table analysis was conducted to evaluate whether children of native-born parents played games more often. The two variables were: (1) status (native-born and immigrant parents) and (2) video game play at home (play and not play). Status and video game play were found to be significantly correlated, Pearson χ^2 (1, N = 45) = 6.90, p = .01. The results suggested that the children of sampled native families play video games more often than the children of sampled immigrant families. No significant correlations between status and other independent variables, such as age, education, gender, and race/ethnicity were found.

Table 1. Means and Standard Deviations for Variables of Native and Immigrant Parents

	Native		Immigrant	
	M	*SD*	*M*	*SD*
Parental mediation [ns] (1→5: less → more mediation and monitoring)	2.60	.79	2.68	.90
Parental involvement ** (1→4: less → more involved)	2.17	.42	1.82	.55
Concern about video games in classroom* (1→5: less → more negative concerns)	2.87	.51	3.36	.76
Individual effect of violence in video games (original scale)* (1→5: less → more perceived negative effects)	3.83	.96	3.11	1.02
Individual effect of violence in video games (new scale)[ns] (1→5: less → more perceived negative effects)	3.88	.89	3.35	1.05
Social effect of violence in video games ** (1→5: less → more perceived negative effects)	4.25	.55	3.64	.68
Social control of violence in video games [ns] (1→5: less → more perceived social controls)	3.48	.91	2.95	1.12
Attitude toward violence in video games (original scale)* (1→5: less → more negative attitude)	3.93	.67	3.30	.70
Attitude toward violence in video games (new scale)* (1→5: less → more perceived negative effects)	3.93	.70	3.38	.78

Note: Native = parent born in the United States or immigrated to the United States before the age of 14; Immigrant = parent born outside the United States or immigrated to the United States at or after the age of 14. *M* = mean; *SD* = standard deviation. * significant at the 0.05 level. ** significant at the 0.01 level.
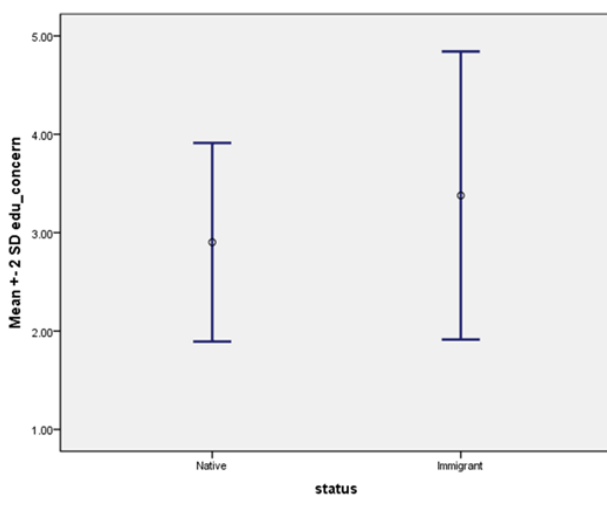
Figure 1. Differences in the level of concern for video game integration into the classroom.
Native = parent born in the United States or immigrated to the United States before the age of 14; Immigrant = parent born outside the United States or immigrated to the United States at or after the age of 14. SD = standard deviation; edu_concern = parental concern about the use of video games in the classroom.

Status and Perception of Educational Potential of Video Games

We tested the first hypothesis across two dimensions by using two separate subscales to measure: (1) whether immigrant parents are more negative about the integration of video games into the classroom; and (2) whether native-born parents are more positive toward the educational potential of video games.

Two independent-sample *t* tests were conducted. The correlation between status and concern was significant (t (43) = -2.92, p = .02.). The results show that immigrant parents were more negative (M = 3.38, SD = .73) about the integration of video games in classroom than native parents were (M = 2.90, SD =. 50). The 95% confidence interval for the difference in means ranged from -.88 to -.07. The η^2 index indicated that 13.4% of the variance of the level of concern was accounted for by whether a parent held immigrant or native-born status. **Figure 1** shows the distribution for the two groups. Therefore H1a was accepted. However, the difference in the perceptions regarding the education potential of video games was not significant between the two groups.
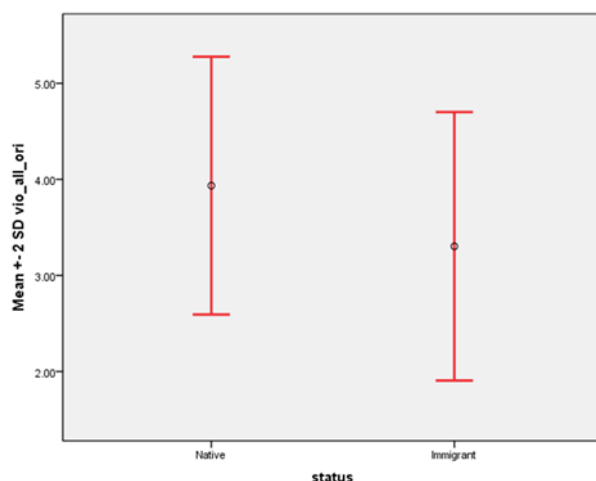
Figure 2. Differences in attitudes toward violence in video games.
Native = parent born in the United States or immigrated to the United States before the age of 14; Immigrant = parent born outside the United States or immigrated to the United States at or after the age of 14. SD = standard deviation; vio_all_ori = parental tolerance of violent video gameplay.

Status and Attitudes toward Violence in Video Games

As explained above, to address the question of tolerance toward video games, we implemented three sets of subscales: (1) attitudes toward individual effect; (2) attitudes toward social effect; and (3) attitudes toward social control of violence in video games.

With the first set of scales, we added five new items to the original five items of Çitak's scale of "Attitude toward violence in television" (2009). To ensure internal reliability, we calculated a split-half coefficient, expressed as a Spearman-Brown corrected correlation. Spearman-Brown corrected correlation was calculated to be .97 whereas alpha coefficient was .97 as well. The overall nineteen-item scale of violence coefficients were .87, .74, and .95 respectively, each indicating satisfactory reliability.

Given two scales of individual effect, two independent-sample t tests were conducted. Interestingly, when the original five-item scale was used, parental attitudes toward individual effect were found significantly correlated with status (t (43) = 2.11, p = .04). Native parents (M = 3.83, SD = .96) were more worried about the negative individual effect of violence in video games than immigrant parents were (M = 3.11, SD =1.02, p = .02). However, when the new ten-item scale was adopted, no significant correlation was found.

Parental attitudes toward the social effect of violence in video games were found to be significantly different between the two groups (t (43) = 2.94, p = .01). Native parents were more likely to hold negative attitudes toward the social effect of violence in games (M = 4.25, SD = .55) than immigrant parents were (M = 3.64, SD = .68). However, there was no significant correlation between the status (native or immigrant) and the attitude toward social control of violence in video games.

Figure 2 shows the distribution for the two groups. Based on our nineteen-item scale, native-born parents (M = 3.93, SD = .70) were more negative toward violence in video games than immigrant parents were (M = 3.38, SD = .78), t (43) = 2.20, p = .04.) Therefore, H2 was accepted.

Status and Parental Participation in Video Game Play

The third hypothesis addresses whether immigrant parents and native-born parents had different degrees of involvements in video game play. Parental involvement scale including eight items was used and the internal consistency estimate of reliability was computed. Alpha coefficient value was .83 indicating satisfactory reliability. Independent-sample t test was conducted. Hypothesis 3, native-born parents and immigrant parents differ in the amount of their involvement in gameplay with their children, was supported (t (43) = 2.57, p = .01). On average, **immigrant parents were less involved (M = 1.83, SD = .49) in the playing process than their counterpart native-born parents were (M = 2.19,** SD = .43). **Figure 3** shows the distribution for the two groups.
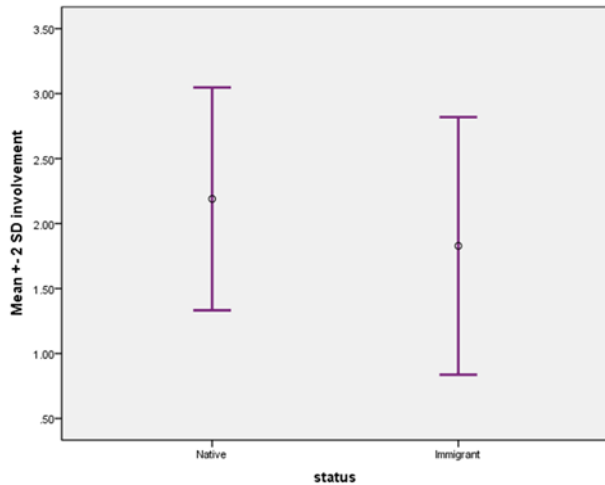
Figure 3. Differences for the native-born vs. immigrant parent groups.
Native = parent born in the United States or immigrated to the United States before the age of 14; Immigrant = parent born outside the United States or immigrated to the United States at or after the age of 14. SD = standard deviation; Involvement = parental participation in gameplay.

Table 2. Correlations Among Dependent Variables

	1	2	3	4	5	6	7	8	9	10
1. mediation	_	.223	-.165	.170	.192	.206	.355*	.205	.292	.278
2. involvement		_	.096	-.172	.215	.299	.494**	.291	.383*	.394*
3. edu_potential			_	-.564**	-.282	-.299	.002	-.255	-.214	-.252
4. edu_concern				_	.209	.212	-.070	.250	.149	.175
5. vio_indi_ori					_	.960**	.487**	.763**	.908**	.929**
6. vio_indi_new						_	.471**	.775**	.885**	.954**
7. vio_soci							_	.494**	.771**	.689**
8. vio_contr								_	.862**	.856**
9. vio_all_ori									_	.977**
10. vio_all_new										_

Note. * Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Status and Parental Mediation of Video Game Play

Parental mediation scale with five items was used (Alpha coefficient = .83). Independent-sample *t* tests were conducted to evaluate the hypothesis that immigrant parents will set more stricter rules for digital gameplay. However, the result shows no significant difference between the two groups. H4 was not supported.

Correlations of Dependent Variables

Correlation coefficients were computed among the ten variables. The results of correlational analyses presented in **Table 2** show that 20 out of the 45 correlations were statistically significant and were greater than or equal to .355. The significant correlation between mediation and attitude toward social effect suggested that if parents held more negative attitudes toward social effects brought on by the violence in video games, they would most likely use stricter mediation techniques toward their children's video game playing. On the other hand, the more negative the attitude was, the more involved parents were in their children's gameplay.

DISCUSSION

Current research findings suggest that there are differences in the perception of video games between American born and Immigrant parents. Those differences seem significant in some areas and, surprisingly, are non-existent in others. For example, in contrast to our original hypothesis, we found no significant differences between parental mediation techniques. However, the correlation between the negative attitude toward social impact of violent video games and stricter mediation techniques suggest that no matter what the parental status is, stricter rules for video

game play might stem from the belief that violence in games is harmful for society. Although, according to the research program funded by the U.S. Department of Justice, there is no connection between video game violence and real world violence (Kutner & Olson, 2008).

Another interesting finding is that no matter what the status is (immigrant or American-born), the more involved they are in the game play itself, the more negative parents feel toward video games. This result may imply at least two possible interpretations: (1) some parents consider being involved as part of their mediation techniques, or (2) when parents are involved they are more exposed to the potential violence or questionable situations within the game narrative. This result seems contradictory to the assumption that the deeper parental knowledge of the game-play is the easier it would be to justify their decisions when it comes to monitoring and restrictions. However, a possible explanation for the negative relations found between involvement and attitude might be the established negative perception of video games due to personal beliefs and/or social norm. As Whitebread et al. (2012) found, gameplay is often regarded as "fun activity" and frequently contrasted with "work". Oftentimes, games are characterized as something that only children do and will outgrow once they become adults. Therefore gameplay must be essentially unimportant, trivial and lacking any serious purpose. Therefore, questions for further research might include the following: How does the amount of time parents spend playing games with their children affect parental perceptions toward integration of video games into their child's education, and why?

As we expected, immigrant parents are more concerned about the integration of video games into the classroom. It would be useful to understand what aids in shaping the parental beliefs and negative attitudes toward the social impact of video games and video game integration into the classroom. Our hypothesis that unlike American-born parents, immigrant parents were not much involved in their children's video game play was also supported by the data collected. We can only speculate as to why this disproportion exists since no data have been collected on parental language ability or current living situation. However, as presented in the literature review section, there are several barriers that may stand in the way of immigrant parents' involvement in their child's game play. Language deficiency might be one of them. We noticed that 19% of immigrant respondents abandoned the survey when the language used in questionnaire became progressively more complicated. Another barrier might be the number of other burdens carried by immigrant parents. Examples are lower socioeconomic status, inequality, discrimination, and parental legal status in the country. According to Santrock (2004), Socioeconomic status (SES) refers to "the categorization of people according to their economic, educational, and occupational characteristics" (p.134). Previous research suggests that the differences in SES between immigrant and native-born parents always play a significant role in parental involvement in their children's daily activities. For example, Menjívar and Abrego (2009) suggested that legal instability brings tremendous pain to immigrant families not only because of limited opportunities but also because of physical and emotional insecurities as well. Future study can include SES questions to explore the question in-depth. Future study could also collect more background data of the parents and their families beyond SES, such as number of children and parental involvement in the child's schooling. Research can further explore the differences in attitudes toward video games among diverse cultural groups within immigrant population since this pilot study has shown that immigrant groups are not homogeneous. In addition, idiosyncrasies of each group might be an interesting topic to explore further. Researching different ethnic groups (i.e. Chinese, Indian, eastern-Europeans) might aid in creating a stronger profile for each immigrant subculture. One more area for future research might include the exploration of different methods used to educate diverse ethnic and cultural groups within American society about the impact of video games and other digital media on children and society. For example, whether and how techniques educators, administrations, and policy makers can implement to engage and educate parents from different ethnic and cultural backgrounds about the potential benefits of video games in the classroom. This type of research might also be useful for educators and administrators to better understand where their students are coming from and how they can cater to their needs. In addition, this further research might provide valuable information for video game design companies in developing and marketing their products to different populations.

Furthermore, the results of the present study should be treated with some caution due to a few limitations. First, a cross-sectional approach was adopted, based on a limited number of samples through convenience sampling method. The authors conducted a strict screening procedure and defined "immigrant parents" based on literature. The immigrant age and the cultural localization of immigrant parents are fully considered. Besides, we limited the children age at 5-18. However, these strict conditions lowered the number of effective data. However, caution is advised when trying to generalize these findings to a broader population. Second, the survey builds on self-report instruments to study attitudes and behaviors. Third, the correlational analysis chosen for the pilot study could not provide insight into the reasons behind certain attitudes and behaviors. Liaw (2008) suggests a multidisciplinary approach to collect quantitative data, as well as trustworthy qualitative research methodology. Therefore, to further investigate the topic in question, mixed methods research involving either structured or unstructured interviews might be needed. Furthermore, the study focused both on general video game perception and digital game-based learning, according to Bourgonjon et al. (2010), which might have introduced response bias because respondents might feel not that easy to think of video games "in general". Especially, we defined violent video games in a broad

way that may include all the games with violent elements or contents. Therefore, future research could focus on specific beliefs concerning specific types of video games.

ACKNOWLEDGEMENTS

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MODESTUM

Social Media and its Potential Impacts on Multicultural Education in Turkey

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ABSTRACT

The purpose of this study is to learn the perceptions of social media users regarding multicultural education in Turkey. With this goal in mind, a short film was created that summarized the issue of multicultural education, which was shared via social media. After viewing the film, the views of the participants who had expressed comments concerning multicultural education were taken for evaluation, and 95.65% of participants harbored positive perceptions about multicultural education. Furthermore, the collected data were analyzed employing a thematic analytical method. The themes found were: alienation, social justice and equality, empathy and tolerance and cultural diversity and difference. On examining the results, it emerged that participants thought that, because multicultural education, discrimination, injustice and alienation would disappear and increased empathy, tolerance and justice would emerge.

Keywords: multiculturalism, multicultural education, diversity, tolerance, social media, Turkey

INTRODUCTION

As technology progresses, the information and knowledge that are needed likewise increase daily. The gap in knowledge that was previously closed with the help of books and encyclopedias has been reduced over the last thirty years with the aid of the Internet (Karaman & Kurtoglu, 2009; Hoffmann, 2017). The Internet constitutes a virtual world in which the concept of distance is removed leading to an increase in the need for knowledge as technology itself advances undeterred. The Internet, that was launched for public service using Web 1.0 technology and allowed people to access information in quickly, has been superseded by Web 2.0 and 3.0 systems that have made the Internet even more user-friendly (Hossain & Aydin, 2011). Because these developments, people have stopped being merely passive recipients of information and have instead become active participants in the sharing of knowledge. Through the emergence of social media platforms such as Facebook, YouTube, Twitter, Instagram and Hi5, people have been able to exchange ideas, share multimedia items such as photographs and videos, express ideas about texts and objects (products) and socialize on a wide scale. One service that social media offers to its users is the opportunity to communicate with one another in a way divorced from traditional prejudices (Hossain & Aydin, 2011).

Over the course of the last fifty years, one of the most popular areas of research has been that of multicultural education that has as its aim the objective to increase social relationships between people of different territories and locations to ensure that they can live together in peace and tranquility (Gunay, 2015; Hossain & Aydin 2011). The way that social media has allowed people of various cultures to embark on a process of sharing seems to represent the essence of the target of multicultural education. The results of research conducted in Turkey, demonstrate that knowledge regarding multicultural education currently is insufficient (Aydin, 2013a; Faltis, 2014; Gunay et al., 2015) For this reason, the aim of this research study is to inform its readers regarding what multicultural education constitutes and how it might be applied, and, as an extension, to discover the perceptions of social media users regarding multicultural education. With this aim in mind, a short film was uploaded to social media addresses and shared via Facebook, Twitter, and the film was about 2.45 minutes long and was in the Turkish language with including pictures, artifacts, and words related multicultural education, such as equity, social justice, tolerance,

Contribution of this paper to the literature

- This paper explores the perceptions of social media users regarding multicultural education in Turkey.
- This study points out that multicultural education helps to raise students as individuals able to adapt to the requirements of the new information society
- This study stresses that participants obtain access to greater amounts of knowledge regarding their own culture and other cultures, allowing them to gain a better understanding of diverse aspects of other cultures from all over the world.
- This study indicates that multicultural education deems itself respectful towards differences and supports cultural diversity through social media.

empathy, and pluralism etc.. Within the context of this research, an attempt was made to answer the following question: "What are the perceptions of social media users towards multicultural education?"

The Internet and Web Technologies

Since the beginning of human existence, a deep-rooted curiosity towards knowledge has persisted, a factor that has propelled humanity from primitive times to today's information age. The term "the information age" that was frequently employed at the start of the 21st century, evolved along with the astonishing pace of development of communication technologies and has been transformed into coined phrases of "the information-communication age" or "the informatics age". The influence of the transformations in Internet technologies and mobile devices has had a profound influence on the development of these terms.

By the 2000s with the easy operability of social media, the Internet had begun to affect the lives of individuals from every field of life (Vural & Bat, 2010). The social media adventure began because of the development of Web 1.0 technology, which grew from ARPANET, and advanced via Web 2.0 technology. Quick and easy access to the Internet through personal computers and portable mobile devices, combined with the interactive properties that have come about because of recently developed Web 2.0 technologies have rendered the Internet simpler to access than ever before and has also ensured cooperation and interaction between people within this newly-created "virtual world" (Hossain & Aydin 2011).

The term Web 2.0 was first employed by Tim O' Reilly (O'Reilly, 2005). In O' Reilly's view (2005), Web 2.0 is a web platform that renders benefits for both software writers and users. This technology comprises content created by users both on an individual and shared basis. Facebook, Twitter, YouTube, Instagram, Hi5 and Wiki are just some of these shared platforms. According to Karaman et al. (2008), Web 2.0 is a virtual space in which users can produce and change Web content. In this space, users can create their own contact addresses and share photographs pictures, documents and videos using a web-based interface.

Web 3.0, moreover, comprises applications that have increased the number of personal web experiences of those users, most of whom previously used Web 1.0 technologies (Sabbagh et al., 2011). The basic aim of Web 3.0, which has been described as "the semantic web," is to allow users to access information in a very short period by requiring less data entry. For instance, current sharing sites offer suggestions or opportunities to label photographs of people who attach these to content through the use of face recognition systems. Research and development incorporating 3.0 is progressing at a great speed. In tandem with these developments, a large increase in people using the Internet and Internet-related social media has been observed.

Figure 1 features the number of Internet and computer users in Turkey in percentage terms (TUIK, 2017).
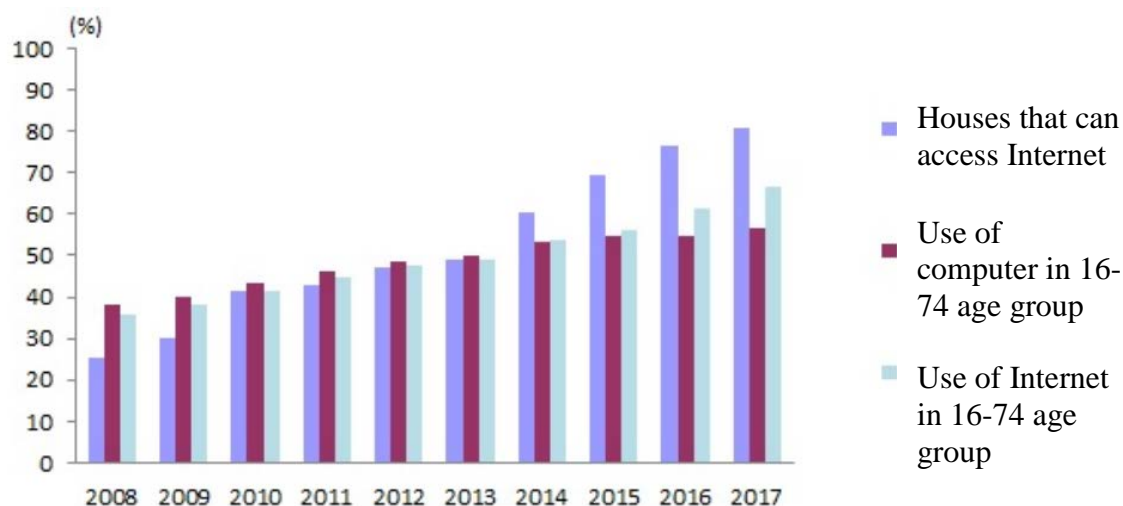
Figure 1. Internet and Computer Use in Percentage Terms (In Turkey)

As can be seen from **Figure 1**, Turkey has witnessed a constant increase in Internet use since 2008. In a parallel development to Internet use, young people in Turkey use the Internet most frequently as a tool to establish communication (Oguz, 2012). According to another study, Turkey currently occupies second place in the world rankings regarding the use of social media platforms (Dijital Ajanslar, 2017).

Social media is a human means of communication that allows people to meet in a shared environment and discuss a range of matters irrespective of limitations of time and space. Through the medium of social media, individuals can give comments regarding their present location and share photographs, objects and thoughts. Furthermore, they can establish communication with friends, relatives, teachers and other people with whom they have not made contact for an extended period and with whom relationships may have broken off due to assorted reasons.

According to Kirshenbaum (2004), social media is also a platform that influences societal behaviour. For example, social media as a source of free news transmission had an effect in mobilizing thousands of people during the notorious *Taksim Gezi Park* demonstrations. People who were unable to receive information via established television stations were able to obtain immediate information by way of social media via Twitter (Bozkurt, 2013). Board Member of the Information Technology, Levent Karadag, referred to the fact that, during the demonstrations, people had established contact with one another via mobile devices and, in such a way, were able to organize and mobilize themselves within an abbreviated period (Bozkurt, 2013).

As the use of mobile telephones has spread, people have been able to access the Internet using mobile devices and can easily keep themselves informed about world events. Furthermore, through social media, they can catch up with the events happening on the world stage, and, in the same way, they can follow events in real time and are able simultaneously to elicit the views of experts and obtain public opinion on a variety of pressing issues.

Multicultural Education

Multicultural education is a type of education that emerged in the United States and has enabled education systems in several countries to have successful outcomes (Banks, 2008; Bennett, 2011). The success of this educational philosophy lies in the way it encourages the cognitive and moral development of all peoples, strives to increase creativity, emphasizes how the same problems can be solved by employing different points of view, aims to reduce prejudices by ensuring communication between individuals, promotes the renewal of society through an emphasis on the richness of its different cultures and helps develop a view of the world that is sophisticated in its outlook (Ameny-Dixon, 2004; Aydin, 2012; Damgaci, 2013). The multicultural education that emerged in the 1960's is actually a type of education that reflects cultural plurality and social equality as part of a societal structure (Gunay, 2014; Sleeter & Grant, 1987). However, multicultural education does not merely comprise subjects such as democracy and human rights or citizenship education, but is an overriding principle that encompasses concepts such as justice, equality, democracy, empathy and tolerance (Damgaci, 2016; Gay, 2004; Houdyshellm, 2017; Lafer &Aydin, 2012; Lafer, 2014; Toraman et al., 2015; Tarman & Acun, 2010).

Bullivant (1979), at the time when multicultural education first emerged, argued that this was a field that ought to be supported in future. In Bullivant's view, three basic principles or assumptions are present in a multicultural society (Verma et al., 1994). The first assumption is that learning is realized and educational success is increased

when children learn definitions of their own ethnicity and about their ethnic identity. The second assumption is related to the first, in that as a child learns about his own culture and traditions, this learning leads to the possibility of achieving equality in opportunities in education. The third assumption is focused only on minority and immigrant groups; namely, that because of recognizing the existence of different cultures, a decrease is produced in prejudice towards and distinctions regarding others (Bullivant, 1979; Huang et al., 2017).

If an evaluation were made of the level that present-day multicultural education has reached in the context of these assumptions, the observation would be that many countries have realized these principles and others have even surpassed expectations (Aydin, 2013b). In addition to the assumptions listed above, when the principles of multicultural education are specified in a clear and scientific way, qualitative success can be achieved.

Bennet sets out these principles as follows:

1. A theory of cultural plurality;
2. The adoption of ideals of social justice and the ending of divisive constructs such as racism and sexism;
3. The acceptance of culture as an element of the teaching and learning process; and
4. The raising of academic levels and provision of equality in education.

As a response to the proven success of multicultural education on the world stage, Turkey has moved slowly towards acceptance of this philosophy. With respect to research studies conducted internationally, the number of studies in Turkey remains insufficient; however, in recent years an increase has occurred in studies in this field in this country (Demir, 2012; Gunay & Aydin, 2015).

Despite these studies, most people including teachers, students, and academicians have insufficient knowledge with regard this type of education. Damgaci and Aydin's (2013) study focusing on teaching staff and academics employed at education faculties in Turkey established that several staff members, even among this very elite group of the population, had never heard of the concept *multiculturalism*. As a result of their research study, it emerged that academics held a range of opinions. These ranged from those who did not support this type of education as they were not fully aware of the precise meaning of the concept to others who did not support it because of the possibility that it could wreak havoc in society in the event of mistaken implementation of the philosophy. A third group also existed that supported the concept unreservedly.

For this reason, the first aim of this research study is to explain to those from every section of society exactly what multicultural education is and how it is implemented. Another aim of this research is to learn participants' perceptions regarding multicultural education. It is widely accepted that social media is a platform that academicians, students, and parents share and one that incorporates people of all ages (or as is said in Turkish from 7 to 70 years old) (Gulbahar et al., 2013; Kolcak, 2015). For this reason, the view is widely held is that social media offer a realm of easily-accessible opportunities when used to achieve educational objectives (Gulbahar et al., 2013).

Multicultural Education and Technology

As McLuhan and Fiore (2001) has stated, the world is transforming into a "global village" (Kopish, 2016). In Bucher's view (2000), people's lives are changing because of these technological developments in such a way that their lifestyles are becoming increasingly similar (Aydin & Damgaci, 2017; Kilinç et al. 2016). People living in different regions of the world can speak to one another via the Internet and are able to share the details and events of their daily lives (in the same virtual meeting place). This has brought about a situation in which people's daily experiences of life resemble those of others situated in a distant location. Even if it might be said that differences persist in terms of ethnic origin, race, gender or social class, people have been "allowed to be exposed to" the same life experiences (Bucher, 2000; Corona et al, 2017).

Multicultural education helps in the acquisition of reading, writing and mathematical skills through interaction with the world of technology that has pervaded our lives (Banks, 2008; Kaya, 2015). One may speak of a mutual interaction process that is occurring between education and technology. Multicultural education, in the way that it allows people to adapt to the world of technology, may be seen advantageous in the sense it offers an opportunity both for the spread of information technology and for the diversity of that education (Bucher, 2000). In contrast, an absence of the principles of multicultural education may lead to an encouragement of prejudicial attitudes regarding students with foreign characteristics or of different backgrounds and, by extension, a centralized conveyance of knowledge in which the necessary social and technological skills needed by society are not acquired (Tomlinson, 2012). Furthermore, in Damgaci's view (2013), multicultural education helps to raise students as individuals able to adapt to the requirements of the new information society.

Multicultural Education and Social Media

Electronic communication means the flow of knowledge and information or the spread of information technology (Bucher, 2000). In recent years, the Internet has become ever more multicultural in nature. This is because software has been designed that is appropriate for use in the medium for a multitude of world languages (Alanay & Aydin, 2016; Ozfidan & Burblaw, 2016). In this respect, electronic communication is used in an effective manner within the field of education. Teachers can facilitate communication with students using web pages and social media accounts, and, in such a way, students can establish contact and interact with their classmates and teachers in reduced periods of time. Moreover, through sharing sites and platforms that constitute an essential element of social media communication, students and teachers can share learning materials and "content" that they have created (essays, assignments, and projects) that are extremely conducive to study and therefore participate in an exchange of knowledge and information (Tarman, 2016). In addition, students may discuss lesson content via social media.

Because social media accounts may be visited and accessed from all other the world, students may undertake lessons from distinct locations, following and observing students and teachers from other areas and regions of their country and the wider world as they do so. This situation is directly related to multicultural education. This is because multicultural education encourages students to discover other cultures, to recognize and understand them and to destroy prejudices (Parekh, 2000). Through using social media, students can recognize other cultures and may notice the existence of different viewpoints about the same subject (Hossain & Aydin, 2011; Mauch & Tarman, 2016). In this context, the central focus of this research study has been defined as "the perceptions of social media users with regard to multicultural education."

METHODOLOGY

Research Design

A qualitative research model was employed in this study in which research was conducted using comments expressed via social media regarding a short film prepared on the theme of multicultural education. According to Glesne (2012), the characteristics that distinguish a qualitative research study may be placed in two main categories. The first of these categories is the study's philosophical aim and encompasses the data collection of the study and the technical methods used for it including the sampling and analysis stages as well as the main aims and assumptions of the study (Cresswell, 2012; Kaya & Aydin, 2016). The researcher, with a view to understanding the logic and meaning of events, is forced to relate and connect events with his own experiences. The second category of a qualitative research study comprises the methodology, analysis and presentation of results (Chapman & MacLean, 1990).

Participants

The population of the research study was 304 people who watched a short film entitled *Multicultural Education* who were contacted via Facebook and Twitter addresses. A short film of 2.45 minutes in Turkish was about the understanding of diversity, multiculturalism, multicultural education, peace, social justice, heritages, races, ethnic groups, cultures, religions, stereotypes about other cultures, human rights, and democracy which teaching student's cultural competency is critical for competing and succeeding in our diverse democracy. The sample group of the research study was the 23 individuals (10 females and 13 males) who watched the film and submitted comments, the participants included teachers, academics, and students. The comments of all those who submitted them were evaluated as variation and diversity was necessary for the study. For this reason, the sampling method employed in the study was a maximum diversity sampling type, a type of purposeful sampling. The aim of this decision was to create a compact, small sample group size while maximizing the number of individuals who could be used within the sample group (Yildirim & Simsek, 2013).

Data Sources and Processing

Within the context of the study, a short film entitled *Multicultural Education* was created and uploaded to www.izlesene.com and shared via a variety of Facebook and Twitter accounts. An explanatory text was prepared concerning the film, and, after viewers watched the film, they were asked to submit short written comments regarding multicultural education. Within the film, several photographs were included with the following captions:

1. Multicultural education is an education of tolerance
2. Multicultural education supports diversity
3. Multicultural education embraces differences

4. Multicultural education guarantees the right to education in one's mother tongue

5. Multicultural education increases dialogue between different cultures.

6. Multicultural education is an education of values.

7. Multicultural education ensures equality of opportunity in education.

8. Multicultural education ensures equality, democracy and justice

9. Multicultural education necessitates the creation of empathy

10. Multicultural education rejects prejudice and segregation

11. Multicultural education raises academic successes.

12. Multicultural society sets the individual free

After the researchers specified these captions, feedback was elicited from experts in a related field of research. The captions were defined with respect to the descriptions, goals and targets of multicultural education.

After a one-week period, the comments submitted by viewers were collected and analyzed using NVivo 10 software. By focusing on the themes and topic headings that emerged because of the analysis, the researchers attempted to define the perceptions of the participants regarding multicultural education.

The researchers took care to conduct a literature review and, in so doing, obtained correct and detailed information and insights regarding the topic. These findings were borne in mind throughout the application stage of the research study. The researchers also attempted to comprehend the facts and concepts of the study in an objective manner, removed from the prejudice and independent of personal inclinations on the topic (Cresswell, 2012).

For this reason, before posting, the film was shown first to two teaching staff members of the Educational Program and Teaching Programs at Yıldız Technical University and, at a later stage, to eight doctoral students who were following the Multicultural Education course, as well as two specialists from the Computer Studies Teaching Department. At this stage, the viewers were asked to submit their criticisms regarding each frame of the film and regarding the captions used. As a result of this process, the background music and certain background images and captions were changed. Furthermore, the short film was shown to three different volunteer groups at weekly intervals, and certain alterations were made to the film as a result.

The views of experts in the field were elicited regarding the visuals about their validity/suitability for the purposes of the topic of the study, and the researchers conducting the study checked the movie regarding its comprehensibility and operability. Once these stages were concluded, the final version of the short film was uploaded to social media sites. The short film was watched, and detailed reports were composed concerning the content of the film and the reliability of the results of the study. The comments of the film regarding the reliability of the data collected were checked by two other people apart from the researchers themselves.

One criteria that must be kept in mind to ensure the validity of a study is that of description. Detailed description, or to use another more precise term "rich thick description" is defined as the collection and the reporting of detailed descriptive data (Creswell & Miller, 2000) to conduct a detailed description, within the context of this study:

1. The research process was described in detail;

2. The information was processed with care;

3. The stages of the data collection and analysis were described in detail; and

4. There was an attempt to remain impartial within the description process.

Another criterion that must be kept in mind is that of the reliability of the study. In accordance with this criterion, the various research data must remain constant, and the checking of the data must be undertaken by individuals other than the researchers themselves. For this reason, and with a view to maximizing the validity of the study, throughout the course of the research, the opinions of experts in the field were elicited and data were checked and confirmed by individuals other than the principal researchers of the study.

For the purposes of collecting the data for this study, permission was requested from the Institute of Social Sciences Institute at Yıldız Technical University. As the first part of the data collection process of the research study, a 2.45-minute film was produced and was uploaded to the www.izlesene.com address on spring 2014 and, on the same date, shared researchers' via Facebook and Twitter accounts. Comments on the film were accepted and collected for evaluation up to 2 March 2014, and comments submitted after that date were not accepted. Throughout the course of the study the three researchers' did not establish any kind of communication with those individuals who had submitted comments and did not provide any additional information about the film. The researchers conducted the study in a wholly detached and impartial fashion.

Data Analysis

Within the context of this research, the collected data were entered using the NVivo 10.0 software version and the themes and topic headings that emerged because of the analysis conducted were taken for evaluation. Furthermore, a content data-analysis method, known as the categorical analysis method, was used for the purposes of processing the data, and the most prominent topic headings/themes were defined. The main aim of content analysis is to arrive at concepts and pieces of knowledge or information that may explain data (Yildirim & Simsek, 2013). To conduct content analysis, all data must be grouped into concepts for ease of understanding and then arranged according to these concepts. In the final stage, these concepts are grouped under themes or topic headings. These themes must be homogenous, objective, holistic, and appropriate to the aims of the study and comprehensible to the participants (Yildirim & Simsek, 2013).

In content analysis studies, thematic or categorical analysis expresses the division of data into units of understandable knowledge and then those pieces or units of knowledge are grouped according to specified criteria. In this research,

1. After entering the data on an individual basis into the NVivo 10.00 software, themes were derived.

2. In addition to the outcomes engineered by the NVivo 10.00 software, researchers read the collected data, and explanatory, distinctive and meaningful theme headings were defined. These themes were defined considering the description, components, goals, aims and the content of multiculturalism within the context of the study.

3. The specified themes and topic headings were presented to experts in the field, whose feedback was elicited regarding the appearance and scope of the validity of the data collection and the creation of theme/topic headings.

4. In the light of the feedback submitted by experts in the field, the themes were reviewed, and the final versions of the theme headings were created.

The themes defined were then expressed in table form. The comments of every participant were then considered and grouped under the thematic headings and the findings derived were highlighted.

LIMITATIONS

The number of participants featured in the study was limited by the number of people who were reached via the accounts opened by the researchers. In addition, although the film was watched by a total of 304 people, only 23 viewers (10 female and 13 male) actually submitted comments. This situation may be interpreted as an indication that some of the users were reluctant to take part in the study.

FINDINGS

The aim of this study was to discover the perceptions of the users of social media, a means of communication that has become increasing popular in recent years, with regard to multicultural education. By the end of the time allowed by the research study of the 304 people who had watched the film, 23 recipients (10 females, 13 males) had shared their thoughts on the topic.

In this section, space is allocated for a discussion of the general findings of the study. Following from this, a discussion of the themes that emerged is included and the quotations are given from the answers provided by participants. At the end of the comments offered by each recipient, the number of the participant and a letter indicating the gender of the recipient is given. In such a codification system, "M" stands for a male participant, while "F" indicates a female. The data collected were analyzed using content and thematic analysis methods, and the themes that emerged were defined.

Theme One: Alienation

Alienation, can be defined either as a process of personalization in which we do not feel as though we are not spiritually or physically present or as the exclusion or ostracization of an individual from a different culture or background (Kaya & Aydin, 2014). While two of the participants of this study used this term directly, several other participants expressed this concept in the following ways: regarding someone with hatred, exclusion because of one's mother tongue, belittling someone because he/she comes from a different village or expressing it in terms of a singular way of looking at things.

These comments included the following: One participant (11, F) stressed that multicultural education would bring an end to alienation, stating "I dream of a school environment in which no-one feels alienation because the clothes she wears, the books he chooses to read or the (political) ideology that he adopts." She (11, F) went on to

add that "people do not experience alienation merely because their culture, but are even shunned due to the ideas they adopt. For this reason, a school atmosphere is necessary in which egoism and prejudice are pushed to the sidelines and the school becomes a real social environment."

Participants (10 females and 13 males) defended the view that, when confronted with the social structure of Turkey both on an individual and collective level, a general feeling of alienation can be observed, and, to tackle this unfortunate situation, multicultural education must be included within the wider educational context of the country.

Theme Two: Social Justice and Equality

In the data that was subjected to analysis, the word justice was used 8 times, and the word equality 6 times. One of the aims of multicultural education is to ensure equal opportunities within education (Banks, 2008). For numerous reasons, ostracized, disparaged belittled or alienated citizens may obtain a share of justice through education-based projects, and equality may be realized among people. A male participant expressed this opinion using the following words:

> *In this country, there is always a contradiction between what should be and what things are in reality. For the development of democracy and justice, we have to answer the question as to "what should happen?" Because we know that the road(s) to hell is paved with good intentions. In this film, the ideas that were expressed were wonderful statements of intent. While we express our good intentions as regards our country as one that must be free and equal, and it might be better, in my opinion, if we also gave ideas as to what type of societal support should be given (to teachers and students) and concretely, what types of multicultural projects should be created.*

Another male participant, with reference to this issue, articulated the view that teachers could establish justice in schools. He said:

> *Let us consider a class in which there are three Muslim students and the other students belong to other faiths. The teacher, by saying that today is Friday and we have postponed our class for one hour to allow them to attend Friday prayers, will experience an increase in loyalty and love towards the teacher, the school and even the whole country on the part of the Muslim students. If this special dispensation is also allowed towards other groups on their special days, there will be an increase in respect and tolerance. However, if there is special dispensation only towards a single group, then an atmosphere of tension will be created among the other groups. A system which ensures justice and balance, will by extension necessitate respect towards the individual person, and in this way more effective and fruitful results will be achieved.*

Among the thoughts of participants on this issue were that multicultural education is an area that needs to be given attention and focus because it endeavors to reform education to bring about justice through considering students equally without giving preferential treatment because of differences in their religion, language, race, gender age or social class thus allowing them to take advantage of educational opportunities in an egalitarian manner.

Theme Three. Empathy and Tolerance

In the research study, the word empathy was used 4 times and the word tolerance 6 times. Empathy is the ability to put oneself into the mind of another and to be able to understand the other person's feelings, desires and thoughts without directly experiencing them (TDK, 2017). In Turkish, the word *hosgoru* as well as the borrowed word *tolerance* are used to convey the meaning, the latter generally signifying to face all experiences with understanding. The participants generally used these two Turkish words for the concept of tolerance, interchangeably. One participant explained what multicultural education was in detail, listing its main aims:

> *Multicultural education is an understanding of education that endeavors to remove the inequality and justice between individuals, aims to prevent many problems, most significantly ethnic problems, and assists students in acquiring important attitudes and behaviors such as empathy, tolerance, respect and personal differences (6, M).*

Furthermore, one participant put forward the view that the concepts empathy and tolerance were directly related stating that "multicultural education, develops not a feeling of myself but one of ourselves" (3, M). Another participant, stressing that multicultural education had many positive sides, emphasized that the creation of

empathy was an extremely important development in any society. In his words "if multicultural education simply increases empathy, that will be enough for me" (5, M).

The attempts to help students understand one another, also influence academic success in a positive manner. One participant expressed this situation as follows:

> *Multicultural education offers a holistic approach that considers not merely the child's mental development, but also his physical and psychological development. Through the incorporation of concepts such as tolerance that have come to the forefront of education in the West in recent years, children are provided with a vision of the world that is simultaneously local and universal. Children feel an affinity both to their own cultures, while also being provided with the opportunity of acquiring ideas about (all) other nations (4, F).*

One participant saw empathy as a factor that combined respect and tolerance and that the increase of respect towards differences brought about through multicultural society was the result of people's development of an understanding of tolerance towards one another (8, M). Another participant, a member of the teaching faculty, likened people to a piece of traditional Turkish art, the *Ebru* or *marbling* painting, which is a collection of apparently indecipherable splashes and spots. She felt that, only through multicultural education, can a perception of the differences be arrived at in that "painting" and, by so doing, will our respect and tolerance of another increase (9, F).

Theme Four: Cultural Diversity and Difference

Throughout the course of the study the words different, difference and awareness were used a total of 30 times. The terms diversity and cultural diversity were employed a total of 9 times. For this reason, the most prominent theme in the research study was that of "Cultural Diversity and Difference". A reflection of this theme may be observed among the student profiles at schools. The fact that students from various cultures come together to receive an education in Turkish schools may lead to a variety of cultural problems. The people who can help to bring about solutions to cultural problems in the classroom environment are undoubtedly the teachers. For this reason, a teacher must possess multicultural educational skills. One participant interpreted the situation as follows:

> *The fact that there is cultural diversity in Turkish schools is an inescapable fact…. However, it is difficult to say that much attention is paid to multiculturalism either with regard to the design of teacher training programs or the recruitment and assignment processes of teachers. The education and upbringing of well-informed and well-rounded generations is only possible through teachers of great quality. In this regard, the teachers must be equipped with the skills to face the difficulties inherent in multicultural and multilingual classes, and the teacher's acquisition of these qualities is an educational problem of vital importance. The teacher training programs currently in existence in Turkey and the structure of education faculties, are far from being able to equip teachers with these skills. For his reason, we are in great need of far-reaching reform in education (10, M).*

Regarding the issue of the multicultural skills of teachers, one participant felt that, in his view, many teachers in Turkey lacked such skills, and many teachers who described themselves as multicultural teachers did not possess such skills overall. He posted the question, "can you show me a teacher who truly accepts (his) students of different faiths, colors, denominations, ethnic backgrounds, races, genders or sexual preferences?" (9, M).

Those participants who submitted comments within the context of the headings of cultural diversity, expressed their belief that the aim of multicultural education was not to remove or destroy cultural diversity, but rather to let that diversity exist freely and prosper. This is because multiculturalism attaches importance to the creation of a political and social atmosphere in which cultural diversity will be recognized and in which these cultures will be able to live freely and grow (Aydin, 2013b).

With respect to the attitudes of the participants regarding multicultural education, including the acceptance of one's own reality or being and the right to an education in one's mother tongue is possible within the theme of diversity. To gain respect for the differences of others, arriving at an understanding of the differences present within oneself is necessary. One participant, moreover in his descriptions about multiculturalism found below, regarded diversity as a value that forms the essence of multiculturalism.

> *In my opinion, multiculturalism is a prism, which aims by reiterating the diversity found in human nature through various channels, to reflect the diversity of life in all its stages. In such a way when you look at yourself from different viewpoints you see various reflections of yourself. In a similar fashion, multicultural society tries get people to take out a mirror to look at one another so as to extract the essence of life. It teaches us to look at one another through other people's prisms. It reminds us that the*

special and delicious aspect of a bowl of fruit is always found in it diversity. And by doing so, it invokes the sensitivity of a mother who is careful to share the meatballs that she has cooked, by placing them equally on the plates of all her children.). In such a way, it serves to create an ideal society, one in which one sees different things when looking in the same place and who discovers new tastes and flavors when eating the same dish (23, M).

DISCUSSION AND CONCLUSION

In recent years, studies have been conducted regarding how and in what way the Internet and social media are used as an educational tool and in what subject areas these tools are being employed. For example, in compilation studies carried out by Karaman et al. (2008), an attempt was made to highlight the transformational potential brought about by Web 2.0 applications with respect to their use in education. A year-over-year increase in the number of empirical studies regarding Web 2.0 applications can be found in the ERIC database, with most of these studies appearing at an undergraduate degree level.

As regards the subject areas of this research, the three most general areas of focus have been first, Education using Social Media; second, Language Education; and third, Social Media's Role in Rendering Learning Effective. Many studies have also been published in which the findings concluded that social media helps in the acquisition of group work skills.

In a study regarding the use of social media in education conducted by Kilis et al. (2014) that focused on educators in higher education in Turkey and Germany, an attempt was made to highlight the cultural differences between the two countries. The study, which was conducted with the participation of 22 educators (10 German, 12 Turkish), found that an awareness of the need to use social media as an educational tool exists, but a low level of consciousness as to how this could be realized was present. Educators stressed how they had experienced difficulties in using technological tools to bring about a harmonized integration of education and social media. The Turkish participants argued that this problem emanated from an inadequate infrastructure and a lack of resources to help teachers. The educators in both countries in general complained about the lack of a plan or strategies to combine social media and education.

One study that aimed to measure the effectiveness of the influential and widespread social network Facebook regarding education was that conducted by Isman and Albayrak (2014) together with students at Sakarya University. Isman and Albayrak created a Facebook group for the non-elective Management of Information Technology course attended by all students in the faculty in which documents related with the lesson were shared with students through the file sharing properties of this social media application. They found that the Facebook group was beneficial in terms of its usability, contributions to group work, follow-up on announcements, and accessing more and more people (Koseoglu et al., 2017).

Smart phones, because of applications that allow instant messaging, are becoming an important social media platform. According to Bulun et al. (2004) mobile phone based-education incorporates many advantages from the point of view of effective learning including: ensuring lifelong learning, learning without effort, learning only when required, and learning that is independent of time and location. For instance, a person with a mobile device in his or her hand may instantly obtain information about recent events elsewhere in the world. Furthermore, due to applications such as Instagram, people can share photographs instantly, talk to friends at long distances, and even do business with others. Moreover, thanks to platforms such as Facebook, Instagram and Twitter, users may create and share short films, and opinions and comments of viewers may be elicited. The result of this study was to demonstrate that people did not show much demand for educationally themed short films. Even if they were curious about such films and watched them, they did not tend to write comments.

A substantial number of studies have been published regarding social media and the use of the Internet as an educational tool. A clear distinction between the studies mentioned and this study was present in that this current research lacked a clear authoritative figure. For example, if this film had been presented to students by an academic authority within the context of a prescribed lesson, the likelihood is that the film would have reached a larger number of participants and commentators.

Multicultural education is a constructive suggestion for a solution to countries that house numerous cultures within their territories and suffer from problems emanating from the nature of communication between these cultures at a domestic level (Kaya & Aydin, 2014). Numerous countries with a multicultural make-up, have managed to arrive at solutions to internal problems because multicultural education.

Studies conducted concerning multicultural education in Turkey have demonstrated that the perceptions of Turkish citizens towards multicultural education are largely positive (Damgaci & Aydin, 2013). This current study, with a sample group in which 95.65% of the participants held positive perceptions of multicultural education, may be included among those studies in which the recipients had positive attitudes towards multicultural education. For this reason, the space allocated to multicultural education within the context of existing educational programs

of the Turkish Ministry of Education should be expanded considering the results of these studies, and education programs need to be reformed from top to bottom to bring them into line with the philosophy of multicultural education.

Moreover, Hossain and Aydin (2011) in their research, in which they argued that Web 2.0 offers a cooperative model for multicultural education, put forward the view that social media because these properties that allow for openness, cooperation and interaction, create a virtual environment in which students from different backgrounds can come together. As a result, students obtain access to greater amounts of knowledge regarding their own culture and other cultures, allowing them to gain a better understanding of diverse aspects of other cultures from all over the world. Social media is growing in importance daily because of its positive qualities that encourage integration and active, not passive, learning. For that reason, to realize the successful application of social media in a multicultural educational setting, studies must be conducted by the National Ministry of Education and academicians in Turkey regarding the development of a plan, program, strategy and teaching/learning materials.

Education, is a phenomenon that may develop and change according to transformations in the cultural environment. (Karatas, 2015). Presently, cultures largely influence one another because of expanding social media and Internet use. In this regard, if educational systems take into consideration cultural transformations, they can adapt themselves to the requirements of the communication age.

Within the context of this study that had as its principle aim to discover the perceptions of social media users regarding multicultural education, the comments of 23 people (10 females and 13 males) were elicited about a short film prepared specifically for the aims of the research study. Twenty-two of the participants held positive perceptions regarding multicultural education while one participant expressed the view that the claims of the film that "multicultural education ensured equality and justice" were contentious. This participant was asked to submit examples regarding this viewpoint. On examination, the male participant mentioned above did not hold sufficient knowledge regarding what multicultural education constituted.

As a result of the analysis that was conducted on the data collected, four principle themes emerged. These were as follows: 1) alienation, 2) social justice and equality, 3) empathy and tolerance and 4) cultural diversity and difference. Alienation can be defined as the positive perception towards the characteristics of individuals belonging to one's own particular social group, while simultaneously harboring negative perceptions about the language, religion, skin color, culture or habits of another group (Karaduman, 2010). The concept of alienation can be considered as encompassing feelings such as hate, belittlement, ostracization and monism (a shared way of looking at experiences). Within the context of this study the participants employed the above terms with regard to the theme of alienation and stressed the fact that multicultural education could serve as a structure with which one could confront alienation.

Another theme that emerged was that of social justice that was considered together with the topic of equality of opportunity in education under the wider theme of equality. In education the concepts of social justice and multicultural education are demonstrated to have a similar effect in ensuring equality of opportunity for students from different cultures (Banks, 2008; Damgaci & Aydin, 2014). According to the findings of the current study, the participants argued that it was essential that students benefit from education on an equal basis so as to prevent feelings of alienation.

Tolerance means respect towards people who are different from us, as well as respect for the opinions that they hold and the feelings that they experience (Kepenekci, 2004). Empathy and tolerance are intertwined concepts, with empathy involving a heightened understanding of others. With regard to the theme of empathy and tolerance, participants stressed the importance of teachers behaving in a tolerant fashion towards their students and the need for teachers to create an environment in which students could behave in a tolerant manner towards one another. In addition, participants emphasized the fact that multicultural education would help all those involved in education to become tolerant, developing the ability to establish empathy for others.

Cultural diversity and difference were the most prominent themes that emerged from the research study. Multicultural education deems itself respectful towards differences and supports cultural diversity (Banks, 2008; Kaya & Aydin, 2014). While most participants in the study agreed with this opinion, they were incapable of distinguishing between multiculturalism and multicultural education; however, most articulated that multicultural education was not opposed to diversity but rather supported the existence of diversity. This research study, which attempted to find an answer to the question of what the perceptions of social media users were about multicultural education, determined that, when an evaluation was conducted taking into consideration the number of participants who issued comments, 95.65% of those participants held opinions that were positive regarding multicultural education.

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A Comparative Analysis of Division in Elementary Mathematics Textbooks in Korea and Japan

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ABSTRACT

The purpose of the study is to examine how Korean and Japanese elementary mathematics textbooks series present division in terms of the perspective of making connections. For this purpose, units dealing with division of whole numbers, fractions, and decimal numbers were analyzed with foci on the meanings of division and procedures of division. Findings showed that, in the textbooks of both countries, the various meanings of division were consistently applied not only to whole numbers but also to fractions and decimal numbers. Moreover, the procedures of division were connected as numbers were expanded from whole numbers to fractions. Noticeable differences included: as for the organization of the contents of division, Korean textbooks presented division of fractions first, whereas Japanese textbooks dealt with division of decimal numbers first. Regarding the meanings of division, the Korean textbooks dealt mainly with partition and measurement division situations, while the Japanese counterparts were more inclusive with multiple situations, such as determination of a unit rate. This study is expected to provide information on how Korean and Japanese textbooks present division and to give implications for textbook developers and teachers to connect division meaningfully as students deal with whole numbers, fractions, and decimal numbers.

Keywords: comparative analysis, division, elementary mathematics textbooks, making connections

INTRODUCTION

The understanding of mathematical ideas involves making connections among such ideas (NCTM, 2000). As students are able to connect mathematical ideas to one another, they develop a deeper and more lasting understanding. The four basic operations, which are of great importance in elementary mathematics curricula, are interrelated to each other (Barnett-Clarke et al., 2010; Blanton et al., 2011; Carpenter et al., 1999). Addition and subtraction have an inverse relationship, as do multiplication and division. Moreover, as subtraction and division are defined in relation to addition and multiplication respectively, it is necessary for students to consider relations in order to fully understand the four operations.

The meanings of each operation remain constant and connected, even as numbers become more complicated (Barnett-Clarke et al., 2010). For example, division of whole numbers, 8÷2, can be interpreted as the idea of finding how many groups of 2 are in 8. As students move to division of fractions, this whole number understanding can be connected to similar examples, such as $8/15 \div 2/15$, by asking how many groups of 2/15 are in 8/15. Likewise, most meanings are essentially the same although some need adaptation.

Many studies report that students have difficulty solving division problems, especially when fractions or decimal numbers are involved (Barnett-Clarke et al., 2010; Sinicrope et al., 2002). One possible reason for this difficulty is that students simply depend on memorized procedures without necessarily understanding the meanings behind such procedures (Gojak, 2013). They may be unable to connect division interpretations from whole numbers to rational numbers and rather deal with them separately.

However, few studies have focused on division in a comprehensive way. Given that textbooks are one of the main instructional materials (Stein et al., 2007), it is necessary to scrutinize how division is presented in textbooks from the perspective of connections. In addition, given that Korean and Japanese students have shown high achievement on recent TIMSS and PISA tests (Ku et al., 2016; Sang et al., 2016), these positive results may be attributed to the influence of the textbooks of each country on such performance. With this background, the study targeted the textbooks from Korea and Japan and investigated how division was represented. As such, this study is expected to suggest implications for how to connect division from whole numbers to fractions and decimal numbers in mathematics instructional materials.

RATIONALE AND RESEARCH QUESTIONS

Analysis of Textbooks

With the importance of textbooks and their strong influence on instruction and students' achievement (Alajmi, 2009; Remillard, 2005; Weiss et al., 2003), there have been numerous studies which investigated textbooks from various perspectives. Regardless of the topics and analytic foci of such studies, overall structures of textbooks tend to be examined in common (e. g., Alajmi, 2012; Charalambous et al., 2010; Son & Senk, 2010).

For example, Alajmi (2012) reviewed how fractions were addressed in mathematics textbooks in the USA, Japan, and Kuwait in terms of three aspects: the physical characteristics, the structure of the lessons, and the nature of the problems. Charalambous et al. (2010) compared the addition and subtraction of fractions in the textbooks from Cyprus, Ireland, and Taiwan. In their analytic framework, horizontal and vertical approaches were used: a horizontal approach means to examine background information and overall structures of textbooks, whereas a vertical approach indicates textbook analysis by topic-specific perspectives such as definitions, mathematical practices, and connections.

To reiterate, understanding the flow and structure of textbooks is necessary before delving into the detailed analysis tailored to the specific topic under study. This is especially true for this study because the topic of division is covered across multiple grade levels. Given this, first an exploration was conducted of how the contents of division are organized and connected in the Korean and Japanese textbooks. Then the meanings and the procedures of division were evaluated from a topic-specific perspective. Specifically, an examination was made of how the meanings and the procedures of division are presented and connected in the textbooks.

Meanings and Procedures of Division

Division is one of the main areas of school mathematics and is essential for students to succeed in elementary grades and their subsequent grades (Otto et al., 2011). In the Common Core State Standards for Mathematics (CCSSM), division is addressed in diverse domains such as 'Operations and Algebraic Thinking' and 'Number and Operations in Base Ten' (CCSSM, 2010). In this respect, understanding division is crucial in learning elementary mathematics.

While learning division, understanding what division means is of great importance. For whole-number division, division is usually interpreted as two different meanings: partition and measurement (Reys et al., 2014). In the partition context, also known as fair-sharing, a collection of objects is separated into a given number of equivalent groups and the quotient means the size of each group. In the measurement context, a collection of objects is separated into parts of a given size and the quotient means the number of equal-sized groups. **Table 1** summarizes partition and measurement division.

Table 1. Meanings of division: Partition and measurement

	Partition	Measurement
Whole	○ (dividend)	○ (dividend)
The size of each group	× *(quotient)*	○ (divisor)
The number of groups	○ (divisor)	× *(quotient)*
Ex. 8÷2=4		

Note '○' refers to what is known in the problem, whereas '×' refers to what is unknown.

These two basic meanings of division are well applied in whole-number contexts, but adjustment of such meanings is necessary in fraction or decimal number contexts. In partition division, if a divisor is a fraction or a decimal number, the situation will not make sense. Rather, it must be modified as division of determination of a unit rate, which focuses on the size of a whole (Barnett-Clarke et al., 2010; Siebert, 2002). For example, $3 \div \frac{2}{5}$, a problem of division of fractions, can be considered as determination of a unit rate by asking a question, "If $\frac{2}{5}$ of a group gets 3, then how much does the whole group get?"

Other meanings such as 'inverse of multiplication' and 'inverse of a Cartesian product' may be considered (Sinicrope et al., 2002). The meaning of division as inverse of multiplication is usually approached by reversing the procedures of the original multiplication. Regarding the meaning of inverse of a Cartesian product, a prevalent example is that the total area and one dimension of a rectangular region are known, and thus quotient is the other dimension. **Figure 1** shows an example of the division of 8 ÷ 2, which is interpreted as determining the width of a rectangular array that has an area of 8 and a length of 2.
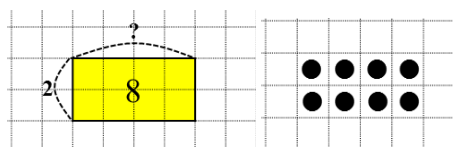
Figure 1. Models of the inverse of a Cartesian product

Up to now, the meanings of division are categorized as follows: (1) partition, (2) measurement, (3) unit rate, (4) inverse of multiplication, and (5) inverse of a Cartesian product. As each meaning needs different procedural reasoning process, it is important for students to understand what division means from various aspects.

The procedures of division are also connected as numbers are extended from whole numbers to fractions and decimal numbers. However, there are few studies which focused on connecting procedures of division of whole numbers, division of fractions, and division of decimal numbers. Rather, most of them tended to focus mainly on one aspect of division procedures. For instance, Van de Walle et al. (2008) recommended the instructional guidelines for improving computational competence for fractions. Among them, "connecting the meanings of fraction computation with whole number computation" (Van de Walle et al., 2008, p. 310) implies the need for connecting procedures of division. Li (2008) examined how the Chinese textbooks presented division of fractions compared to their counterparts in the United States. To be sure, connections of division of fractions with division of whole numbers were documented in part, but the main focus of Li's study was given to the conceptual procedures and the applications of division of fractions.

Many studies report that students experience difficulties in learning division (Barnett-Clarke et al., 2010; Sinicrope et al., 2002). For instance, Li and Kulm (2008) reported that students had difficulties in learning division of fractions and solved problems just by applying an "invert and multiply" algorithm without understanding its meaning. Regarding the division of decimal numbers, students usually focused on dividing vertically by moving a decimal point without knowing why it works (Sherman et al., 2015). Given that division procedures are connected even when the range of numbers is extended, these results indicate that students were not able to connect the procedures of division while learning division.

To summarize, the meanings of division are multiple and need to be connected and adjusted as the ranges of numbers are extended from whole numbers to fractions and decimals. In a similar vein, the procedures of division must also be connected as the ranges of numbers are changed, because students do not realize such connections by themselves. In this respect, it is significant to investigate how the meanings and procedures of division are presented and connected in textbooks and to explore implications for the organization of textbooks in order to help students gain a deeper understanding of division as a coherent whole.

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Research Questions

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Given the rationale and literature review, the aims of this study are to compare how divisions of whole numbers, fractions, and decimal numbers are presented in the Korean and Japanese textbooks series and to explore instructional implications to connect division. Specifically, this study addresses the following research questions:

(1) How are the contents of division organized and connected in the Korean and Japanese textbooks?

(2) How are the meanings of division presented and connected in the Korean and Japanese textbooks?

(3) How are the procedures of divisions presented and connected in the Korean and Japanese textbooks?

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METHODOLOGY

Mathematics Textbooks Selection

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In order to investigate how division is presented in elementary mathematics textbooks series, textbooks in Korea and Japan from grades 3 to 6 were selected based on their similarities and differences. Both countries have a national curriculum respectively, and textbooks are aligned with the curriculum. In Korea, there is only one kind of mathematics textbooks series developed by the Ministry of Education. In Japan, however, private authors or publishers develop textbooks based on the curriculum guidelines. The series developed by Hitotsumatsu et al. (2011a~f) was chosen for analysis in this study. The Japanese series was originally translated into English, so only the Korean ones were translated into English by the authors as needed for this paper. In total, the following 11 mathematics textbooks in Korea and Japan were examined as shown in **Table 2**.

Table 2. Subjects of analysis

Country	Korea	Japan
Textbook	Mathematics textbook 3-1, 3-2, 4-1, 5-2, 6-1	Study with Your Friends MATHEMATICS for elementary school 3-1, 4-1, 4-2, 5-1, 5-2, 6-1
Publication	Ministry of Education (2016a~c, 2015a~b)	Gakkohtosho co., LTD. (2011a~f)

<div align="center">

Data Collection and Analysis

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All units dealing with division of whole numbers, division of fractions, and division of decimal numbers were analyzed. In every unit, main activities were included for analysis but the problems for individual practice or assessment were excluded from the study. These were excluded for the following reasons. First, most problems for individual practice are presented without situation. Also, problems for assessment tend to be aligned with the problems in the main activities. So there are few opportunities to find other meanings of division by including the problems for individual practice or assessment. **Table 3** shows the analytical framework used for the study.

Table 3. Framework used to analyze the contents, meanings, and procedures

Analytic foci	Focus questions	Aspects investigated
Contents of division	• When and how is division introduced and developed? • In which contents are the units composed?	• Overall structure • Development of the units
Meanings of division	• How are the meanings of division presented? • How are the meanings of division connected in fractions and decimal numbers?	• Types of meanings of division • Frequencies of meanings of division • Connections of the meanings of division to fractions and decimal numbers
Procedures of division	• What kinds of strategies are used? • Are the procedures of division interconnected with each other?	• Types of strategies • Connections of the procedures

As shown in **Table 3**, the collected data was analyzed in three aspects. Firstly, we examined how the contents of division were organized and sequenced in the Korean and Japanese textbooks. Specifically, we examined what contents were addressed and in which grade and semester they were presented. For example, in the Korean textbook series, whole-number division was introduced during the 1st semester of 3rd grade and addressed until the 1st semester of 4th grade. Next, we analyzed how the meanings of division were distributed in the textbooks, focusing on whether such meanings were presented in a way to facilitate the connection of the contexts to division of fractions and decimal numbers. To this end, we categorized problem contexts into six types of division meanings: Note that, in addition to five meanings described in the previous section, 'no situation' was added because it was

frequently presented in every learning theme. **Table 4** illustrates examples of the meanings of division from the Korean and Japanese textbooks.

Table 4. Examples of meanings of division

Meanings of division	Korea	Japan
Partition	Let's share 8.2L of milk equally with 4 students. (2015a, p.124)	Let's share 12 candies equally amongst 4 children. (2011a, p.58)
Measurement	You cut a fabric of 1m by 1/4m to make a magic tie. How many magic ties can you make? (2015b. p.42)	There are 12 sweets. If one child receives 3 sweets, how many children can receive sweets? (2011a, p.64)
Determination of a unit rate	–	We used 5.76dL of paint to paint a $3.2m^2$ wall. How many dL of paint will we use to paint a $1m^2$ wall? (2011d, p.70)
Inverse of multiplication	You transform a magic stick of 0.46m into a tree of 3.68m. How many times taller is the tree than the stick? (2015b, p.72)	–
Inverse of a Cartesian product	–	There is a rectangular flower bed that is 2.3m long and has an area of $12m^2$. How long is the width in meters? (2011d, p.69)
No situation	Write an expression into a vertical form and figure out a quotient: 48÷8. (2016a, p. 103)	Let's think about how to divide 96÷33 in vertical form. (2011b, p.83)

All the problems were coded by the authors and intra-class correlation coefficient between measurements taken by the authors was 0.974 indicating very high inter-rater reliability. After that, frequencies and percentages of meanings were calculated. Problems which were classified into different meanings by the authors were discussed until the authors agreed on a single classification.

Finally, we investigated what and how the procedures of division were addressed in the textbooks. For this, we examined what kinds of strategies were presented and in what sequences such strategies were arranged. In doing so, connections among division strategies of whole numbers, fractions, and decimal numbers were examined.

RESULTS

Contents of Division

Table 5 shows the organization of content regarding division in the textbooks. In both countries, division was introduced in 3rd grade with whole-numbers and it was dealt until the 6th grade.

Table 5. Organization of contents about division in the textbooks

Grade	Semester			Korea	Japan	
3	1	W		3. Division	6. Division	W
	2			2. Division		
4	1			2. Multiplication and Division	2. Division 5. Division by One-digit Numbers 7. Division by Two-digit Numbers	W
	2				16. Multiplication and Division of Decimal Numbers	D
5	1				5. Division of Decimal Numbers	
	2	F		3. Division of Fractions	10. Multiplication and Division of Fractions	F
		D		4. Division of Decimal Numbers		
6	1	F		2. Division of Fractions	4. Division of Fractions	
		D		3. Division of Decimal Numbers		

Note W: Whole numbers, F: Fractions, D: Decimal numbers

The division of whole numbers was addressed in partition situations, i. e., a total number of objects were fairly shared into 2 plates or 4 children respectively (see **Figure 2**). Here, discrete quantities such as Baduk stones or candies were used.

Korea (MOE, 2016a, p. 95)	Japan (Hitotsumatsu et al., 2011a, p.64)
 8 divided by 2 is 4. It is written as 8÷2=4 and read as "8 divided by 2 equals 4". Sentences like 8÷2=4 are called division and 4 is the quotient of when 8 is divided by 2.	
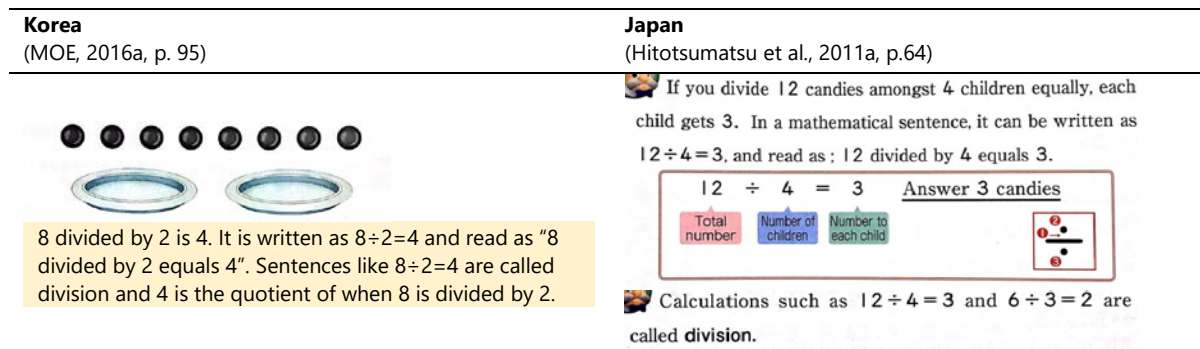
Figure 2. Introduction of the definition of division

Most of the content regarding whole-number division was similar in both countries. The units dealing with the division of whole numbers were usually sequenced in terms of how many place-values the divisor had or whether or not the dividend was divisible in the set of whole numbers. Only the Japanese textbooks included division with 1 and 0 as divisor or dividend. **Figure 3** shows the situations in which the given dividend is 0 and when the divisor is 1 in the Japanese textbook. By dealing with these specific types of division within meaningful situations, students may understand why dividing 0 by any number yields 0 and dividing any number by 1 yields the same number.

When the dividend is 0	When the divisor is 1
 (2011a, p.67)	 (2011a, p.67)
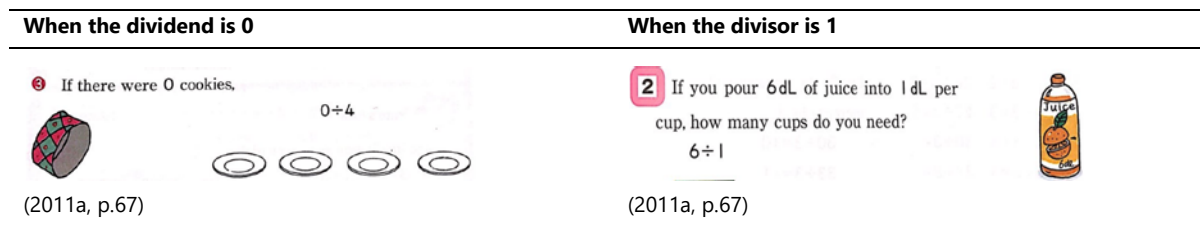
Figure 3. Problem situations of division with 0 and 1 in the Japanese textbook

Another remarkable difference was the sequence of content regarding division. The Korean textbooks introduced the division of fractions earlier than the division of decimal numbers, but this order was reversed in the Japanese textbooks. Specifically, in the Korean textbooks for the 5th and the 6th graders, the unit dealing with division of decimal numbers is always followed by the unit dealing with division of fractions as shown in **Table 5**. This sequence of the units is to connect division of fractions with division of decimal numbers. In fact, in the unit dealing with the division of decimal numbers in the Korean textbooks, the main strategy is to change the given decimal number into the fraction, which leads to the division of fractions (see **Table 6**).

Table 6. Connections among division strategies in the Korean textbooks

Strategy	Example
• Change the given division into the division of fractions with the common denominator, and then deal with it as division of whole numbers	$14 \div 3.5 = \dfrac{140}{10} \div \dfrac{35}{10} = \boxed{} \div \boxed{} = \boxed{}$ (2015b, p.77)
• Change the given division into the division of fractions, and then follow the algorithm for the division of fractions	$91.44 \div 4 = \dfrac{\boxed{}}{100} \div 4 = \dfrac{\boxed{}}{100} \times \dfrac{1}{\boxed{}} = \dfrac{\boxed{}}{100}$ (2015a, p.119)

Note that both Korean and Japanese textbooks had two units on division of fractions and division of decimals respectively. The two units are differentiated according to the kinds of divisors. For instance, the unit 'Division of Fractions' appeared in both grade 5 and grade 6 in the Korean textbooks, the only difference being is the kinds of divisors. The textbook for grade 5 deals only with natural numbers as divisors in division of fractions, whereas the textbook for grade 6 deals with fractions as divisors. From the perspective of connections, the differentiation of the units across grades is intended to connect the division of fractions with the division of whole numbers.

Meanings of Division

Division problems from each textbook were analyzed in terms of the meanings of division. As shown in **Figure 4**, the situations were classified into partition (P), measurement (M), determination of a unit rate (UR), inverse of multiplication (IM), inverse of a Cartesian product (ICP), and no situation (No). In the Korean textbook series, the most frequent meaning of division was Measurement (29%) followed by Partition (26%), Inverse of Multiplication (3%). Note also that No situation was as much as 42%. In contrast, the Japanese textbooks included more varied situations such as UR and ICP. Here, the percentage of partition situation was the highest (34%), whereas No situation was 26%.
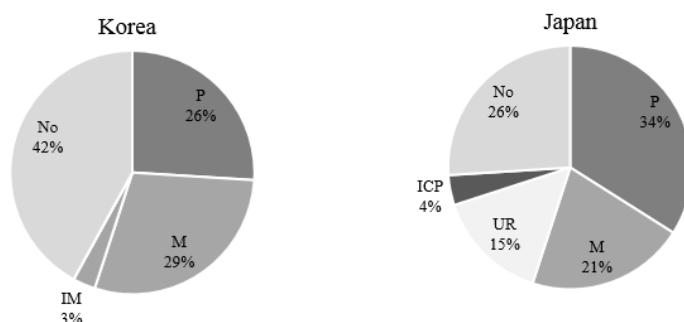
Note P: Partition, M: Measurement, IM: Inverse of Multiplication, UR: Unit Rate,
ICP: Inverse of a Cartesian Product, No: No situation.

Figure 4. Distribution of division meanings in the Korean and Japanese textbooks

Table 7 displays detailed results by presenting the frequencies of division meanings according to the types of numbers. In total, the Japanese series included 95 problems and the Korean series only 76, indicating that more problems were in the Japanese textbooks. In fact, one learning theme in the Japanese textbooks included 3 to 5 word problems, whereas the Korean textbooks began with a word problem, moved to 1 or 2 activities to solve the given problem, and then ended with 1 or 2 problems without situations mainly for practice. This textbook structure explains why the Korean textbooks included a smaller quantity of problems than their counterparts in Japan.
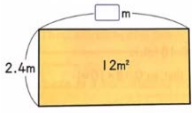
Table 7. Frequencies of meanings of division in the Korean and Japanese textbooks

	Korea							Japan						
	P	M	UR	IM	ICP	No	Total	P	M	UR	IM	ICP	No	Total
Whole Numbers	9	11	0	0	0	9	29	23	15	0	0	0	20	58
Fractions	2	6	0	0	0	20	28	4	3	8	0	3	3	21
Decimal Numbers	9	5	0	2	0	3	19	5	2	6	0	1	2	16
Total	20	22	0	2	0	32	76	32	20	14	0	4	25	95
(%)	(26)	(29)	(0)	(3)	(0)	(42)	(100)	(34)	(21)	(15)	(0)	(4)	(26)	(100)

As for the meanings of division, two countries revealed different results. In the Korean textbooks, the percentage of measurement division was higher than those of partition division both with whole numbers and with fractions. As for the division of decimal numbers, the percentage of partition division was higher than measurement division, because divisors were natural numbers so that partition situations could be more easily understood. In contrast, the percentages of partition division were higher in the Japanese textbooks than those of measurement division, regardless of the types of numbers.

For situations in which the divisor was a fraction or a decimal number, both countries revealed different results. Since interpreting the division of fractions such as $'\frac{3}{4} \div \frac{2}{5}'$ as partition situations does not make sense, alternative meanings needed to be included. In this case, the Japanese textbooks included situations of 'determination of a unit rate' and 'inverse of a Cartesian product'. However, in the Korean textbooks, measurement situations were used more frequently rather than adapting new situations. In fact, division as the inverse of multiplication was addressed only twice. These differences between two countries may have an influence on students in a distinct way. For instance, Japanese students are expected to have an opportunity to apply division to diverse situations, whereas Korean students are expected to have an opportunity to consistently connect the meanings of division from whole numbers to fractions. **Table 8** illustrates problem situations for all kinds of division meanings, as the numbers were expanded from whole numbers to fractions or decimal numbers.

Table 8. Examples of problem situations

		Whole Numbers	Fractions, Decimal Numbers
Korea	*Partition*	Equally sharing 20 oranges among 5 persons. (2016a, p.98)	Equally sharing sweet potatoes of 2.6kg between two persons. (2015a, p.114)
	Measurement	When dividing 12 bags of sweets into 2 for each child, how many children can receive the sweets? (2016a, p.96)	Making an invitation card of $\frac{1}{6}$ width with $\frac{5}{6}$-width paper. (2015b, p.44)
	Inverse of multiplication		When transforming a magic stick of 0.46m into a tree of 3.68m, how many times taller is the tree than the stick? (2015b, p.71)
Japan	*Partition*	Sharing 12 candies amongst 4 children. (2011a, p.58)	To make 6 ribbons from $\frac{8}{9}$m long tape, how many meters long will each ribbon be? (2011b, p.22)
	Measurement	Dividing 12 sweets by giving 3 per child, how many children can receive sweets? (2011a, p.59)	There is $1\frac{4}{5}$ L of milk. If you drink $\frac{3}{5}$dL each time, how many meals can you have? (2011f, p.47)
	Determination of a unit rate		We used $\frac{3}{4}$dL of blue paint for a $\frac{2}{5}m^2$ fence. How many m^2 did we cover with a 1dL of paint? (2011f, p.43)
	Inverse of a Cartesian product		(2011d, p.69)

As mentioned earlier, the situations such as 'determination of a unit rate' or 'inverse of a Cartesian product' were not included in the Korean textbooks. However, the Korean workbooks included situations of inverse of a Cartesian product. Considered that workbooks in Korea were made for students' self-directed study at home for practice, it seems that they were intended to give an opportunity for students to apply division in diverse situations on their own. In contrast, as Japan has only textbook series without workbooks, it seems that multiple situations were included in the textbooks.

As the situation of 'determination of a unit rate' is related to the concept of rate, students need to learn what rate is to understand such a situation. In the Korean textbooks, the concept of rate is addressed immediately following division of decimal numbers in 6th grade. Because of the order of units, the division of fractions is not explained in the situation of unit rate. In contrast, in the Japanese textbooks, the concept of rate was addressed in 5th grade and the situations of 'determination of a unit rate' were introduced in 6th grade. This implies that it is important to understand the curriculum thoroughly for suggesting suitable content for textbooks.
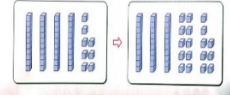
Procedures of Division

The procedures of division of whole numbers, fractions, and decimal numbers in the Korean and Japanese textbooks were analyzed by how they were structured and connected to one another. Before looking into the procedures of division, it is important to understand how a learning theme is composed in the textbooks. In the Korean textbooks, a problem situation was initially presented, along with 2 or 3 strategies, and followed by step-by-step questions. It ended with simple problems for students to practice their calculation skills. The Japanese textbooks are the same with Korean ones in that a problem situation was presented at first and 2 or 3 strategies followed. In the textbooks of both countries, the strategies presented earlier were more concrete and subsequent strategies more abstract. However, the difference was that the Japanese textbooks let students find the commonalities or principles of given strategies and led them to apply what they found to the subsequent problems.

The Korean Mathematics Textbook Series

Table 9 summarizes representative examples of division procedures presented in the Korean textbook series. Division of whole numbers, division of fractions, and division of decimal numbers were introduced in order. The kinds of numbers (i.e., whole numbers, fractions, and decimal numbers) are different, but the overall procedure of addressing division with such numbers is similar. Firstly, a problem situation is presented in a word problem. Two or three activities to solve the given problem follow. Here the first activity often includes using concrete materials or demonstrating visual representations for students to understand the problem situation. The second or third activity addresses various methods to solve the problem including the standard algorithm at the end.

Table 9. Procedures of division in the Korean mathematics textbooks

Whole Numbers	Fractions	Decimal Numbers	
$48 \div 3$ (2016b, p.54-55)	$\frac{4}{5} \div \frac{4}{15}$ / $\frac{2}{3} \div \frac{5}{7}$ (2015b, pp.48-49)	$8.6 \div 5$ (2015a, pp.122-123)	$3.68 \div 0.46$ (2015b, pp.72-73)
• Drawing (making 3 groups from 48)	• Representing the problem in fraction bars and grouping by $\frac{4}{15}$	• Estimation	• Repeated subtractions Q. *How many times can you subtract 0.46 from 3.68 to make 0?*
↓	↓	↓	↓
• Base-ten blocks	• Changing to division of whole numbers $\frac{4}{5} \div \frac{4}{15} = \frac{12}{15} \div \frac{4}{15} = \square \div \square = \square$ • Changing to multiplication of fractions $\frac{2}{3} \div \frac{5}{7} = \frac{\square}{\square} \times \frac{\square}{\square}$	• Changing to multiplication of fractions $8.6 \div 5 = \frac{\square}{10} \div 5 = \frac{\square}{10} \times \frac{1}{5}$ $= \frac{\square}{50} = \frac{\square}{100} = \square$ • Comparing to division of whole numbers $860 \div 5 = \square$ $8.6 \div 5 = \square$	• Transformation of unit (m→cm) $3.68\,m = \square\ cm,\ 0.46\,m = \square\ cm$ $\Rightarrow 3.68 \div 0.46 = 368 \div \square = \square$ • Changing to division of fractions $3.68 \div 0.46 = \frac{368}{100} \div \frac{46}{100}$ $= \square \div \square = \square$
↓		↓	↓
• Vertical form		• Vertical form	• Vertical form

From the perspective of connections, division of whole numbers was connected to division of fractions or division of decimal numbers. Knowing how to perform division of whole numbers serves as the foundation for understanding division of fractions and division of decimal numbers. For example, in the process of calculating division of fractions, division of whole numbers was used after reducing a common denominator and dividing between numerators.
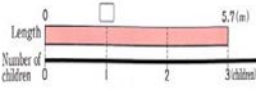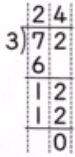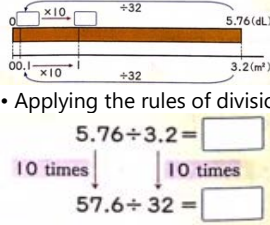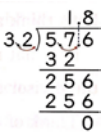
Division of fractions and division of decimal numbers interconnect with each other. Division of decimal numbers can be calculated by changing the given decimal numbers into fractions and simply applying the procedure for division of fractions. As each learning theme dealing with division of decimal numbers in the Korean textbooks includes at least one strategy of changing decimal numbers into factions, understanding how to perform the procedures and why the procedures work can lead to success in conducting division of decimal numbers.

The Japanese Mathematics Textbook Series

Table 10 shows representative cases of the procedures of division in the Japanese textbook series. Pictures, tables, or rectangles were frequently used to describe the given problem situations. After that, 2 or 3 approaches to solve the problems were displayed and their strategies were discussed. It ended by summarizing principles or methods of division, which were sometimes formalized algebraically.

Note that, unlike the Korean series, the Japanese series introduced division of whole numbers, division of decimal numbers, and then division of fractions in order. As division of decimal numbers preceded division of fractions, division of decimal numbers was not solved by changing the decimal numbers into fractions. Instead, 'the rules of division' were applied frequently from the beginning of introducing division of whole numbers: "*In division, the answers (quotients) are the same if the dividend and divisor are multiplied or divided by the same number.*" (Hitotsumatsu et al., 2011b, p. 23) This implies that division of whole numbers, fractions, and decimal numbers are

Table 10. Procedures of division in the Japanese mathematics textbooks

Whole Numbers	Decimal Numbers		Fractions
72÷3 (2011b, pp.44-45)	5.7÷3 (2011c, pp.63-64)	5.76÷3.2 (2011d, p.70)	$\frac{2}{5} \div \frac{3}{4}$ (2011f, pp.43-45)
• Representing problem situations	• Representing problem situations	• Representing problem situations	• Representing problem situations
↓	↓	↓	↓
• Applying the distributive property of division over addition 	• Figuring out the length each of the children get by using 0.1 and dividing 10 • Using the rules of division	• Figuring out how much dL will be needed by using $0.1 m^2$ and multiplying 10 • Applying the rules of division 	• Regarding $\frac{3}{4}$ as an operator • Figuring out how many unit fractions are used by looking at the figure • Using the rules of division and changing fractions to whole numbers
↓	↓	↓	↓
• Vertical form 	• Vertical form	• Vertical form 	• Algebraic formalization $$\frac{B}{A} \div \frac{D}{C} = \frac{B}{A} \times \frac{C}{D}$$

interconnected by making use of the rules of division. In this way, division of fractions or division of decimal numbers can be calculated in the same manner as division of whole numbers.

DISCUSSION

Given the importance of connections among mathematical ideas, a promising result in this study was that the meanings of division and the procedures of division were connected from whole numbers to fractions or decimal numbers in the elementary mathematics textbooks of both countries.

First of all, regarding the meanings of division, although some meanings need to be adjusted as division extends from whole numbers to fractions, both partition and measurement division were consistently addressed across the division of whole numbers, the division of fractions, and the division of decimal numbers. Considering that it is important for students to experience mathematics in a context (NCTM, 2000), this result implies that the textbooks are expected to give opportunities for students to recognize the diverse contexts of division and to come up with expressions of division regardless of what types of numbers are included.

Note that there is a difference between the Korean and Japanese textbooks in presenting problem situations related to division. In the Korean series, two typical meanings (i.e., partition and measurement division) were consistently employed across almost all of division situations. However, the Japanese series included other kinds of meanings such as determination of a unit rate or inverse of Cartesian products when division was expanded into factions. On one hand, from the perspective of connections, the Korean textbooks are expected to give students opportunities to connect the essential meanings of division in a coherent way as the ranges of numbers are extended. On the other hand, Korean students may experience difficulties in gaining a conceptual understanding of division of fractions, because some meanings of whole-number division such as partition are not sufficient for interpreting division of fractions (Sinicrope et al., 2002). In this case, it may be informative to consider other interpretations for the division of fractions, as found in the Japanese textbook series.

Another prominent result was that procedures of division from whole numbers to fractions or decimal numbers were connected in different ways in Korea and Japan. In the Korean series, procedures of whole-number division

were used in calculating division of fractions and division of decimal numbers. The processes of fraction division were applied when figuring out quotients of division of decimal numbers by changing the decimal numbers into fractions. In the Japanese series, however, the rules of division for whole numbers were used frequently. Unlike the Korean textbooks, the Japanese textbooks did not introduce a method of changing decimals into fractions when dealing with the division of decimal numbers. For instance, 320÷1.6, the Japanese textbooks solved it by multiplying 10 to both 320 and 1.6 and making 3200÷16. In contrast, the Korean textbooks changed the decimal into a fraction and treating the division such as dividing between numerators: $\frac{3200}{10} \div \frac{16}{10}$=3200÷16 for an instance.

These differences may result from the sequence of division. In the Korean textbook series, division was introduced in the order of whole numbers, fractions, and decimal numbers. In the Japanese textbooks, however, division of decimal numbers was presented earlier than division of fractions. Procedures of fraction division were not utilized in solving division of decimal numbers, and rather was emphasized changing decimal numbers into whole numbers by making use of rules of division. More fundamentally, these differences may come from different perspectives of how a decimal number is defined in each textbook series. The Korean textbooks defined decimal numbers as another name of fractions (MOE, 2016a) and they constantly emphasized connections between decimal numbers and fractions. Their counterparts in Japan, however, defined decimal numbers with units smaller than natural numbers without relating to fractions.

These results raise the issue of how to deal with division of decimal numbers: Focus on connections with division of whole numbers or division of fractions? On one hand, according to Stevin (1540-1620) who defined decimal numbers, operations of decimal numbers can be calculated using only decimal numbers, while fractions may be employed when justifying the results of such operations (Sanford, 1921). On the other hand, decimal numbers have usually been treated as another name for fractions, even calling them as 'decimal fractions'. Furthermore, fractions have been utilized whenever calculating decimal numbers (Resnick et al., 1989; Van de Walle et al., 2008). From the perspective of connections, the Korean textbooks are expected to focus on connections between decimal numbers with fractions, whereas the Japanese counterparts pay attention to the connections between decimal numbers with whole numbers. These imply that different conceptions or emphases of a mathematical topic may lead to different construction of textbooks.

In conclusion, this study is expected to provide information on how division from whole numbers to fractions and decimal numbers are addressed in the Korean and Japanese textbook series. The study also gives implications for how to connect division meaningfully in mathematics instructional materials.
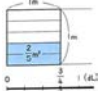
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MODESTUM

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The Influence of Higher Engineering Education Investment and Technical Progress on the Sustainable Development of Manufacturing Industry in China

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ABSTRACT

With SEM analysis, to explore the influence of higher engineering education investment and technical progress on the sustainable development of manufacturing industry, the results show that, to see from the path relationship between the variables, the higher engineering education investment and technical progress has a direct positive effect on China's manufacturing growth, in addition, the higher engineering education investment have an indirect effect on the sustainable development of the manufacturing industry through the intermediary variables of technical progress.

Keywords: higher engineering education, technical progress, manufacturing, sustainable development, influence coefficient

INTRODUCTION

In recent years, with the continuous development of manufacturing industry, China has already established its status as the world's factory (Sansom & Shore, 2013), but at the same time the country is facing unprecedented challenges such as excessive consumption of domestic resources and environmental pollution problems and other issues (Chen, 2010; Feng, 2011), and to see from the quality of industrial manufactured goods, most of them are not high (Wang, 2017), the input-output efficiency and international competitiveness is low (Tang, 2016).

Under the background of knowledge economy, the traditional "quantitative expansion" model of the manufacturing industry has been unsustainable (Mungaray-Lagarda, 2002), it is obliged to pay more attention to the sustainable development of manufacturing industry(Tang, 2014), based on this, this paper, to explores the influence of higher engineering education investment and technical progress on the sustainable development of manufacturing industry from the perspective of education and technical innovation, it has important guiding significance for promoting the orderly and efficient development of China's manufacturing industry, and also has important theoretical and practical significance for the realization of the strategic goal of "made in China 2025".

LITERATURE REVIEW

Recently, many scholars at home and abroad have explored the dynamic factors of sustainable development of manufacturing industry from different angles, and have obtained many important achievements in the related fields, but there still have some content that needs to be further improved and discussed.

Firstly, to see from the research tendency, according to the existing literatures of manufacturing industry sustainable development at home and abroad, presently, in order to change the traditional growth mode of purely pursuing the "factor-quantity expansion" (Riis, 2001), more and more research has been made to the "resource saving and environmental protection", and the technical progress factor has been paid more and more attention.

Secondly, to seen from the research content, the analysis and research on the sustainable development of manufacturing industry has gradually shifted from the traditional research on "factor supply" to "supply structure

optimization, input-output efficiency" (Wei & Guo, 2011), and more emphasis has been put on the importance of "efficiency improvement".

And from the view of research results, at the present time, the relevant literatures about the sustainable development of manufacturing industry at home and abroad are mainly based on qualitative analysis and relatively few in quantitative analysis, which are mainly confined to the "single direction" research on a specific factor but ignoring the possible "intermediary-effects" of the factors (Koho et al., 2015).

Based on this, considering the requirements of sustainable development of manufacturing industry, it is necessary to build a multivariable comprehensive evaluation model from the perspective of the input-output of capital and labor. To explore the direct influence and indirect conduction effect of higher engineering education investment and technical progress on the growth of manufacturing industry (Harik et al., 2015; Zhu, 2013), which has important practical significance to effectively identify the mutual influence of higher engineering education investment and technical progress on the sustainable development of manufacturing industry.

MODEL BUILDING AND RESEARCH HYPOTHESIS

Method Selection

At present, concerning the study of the influence of higher engineering education investment and technical progress on manufacturing industry, it is mainly based on the analysis of "industry association-coefficient method" with a relatively single decomposition factors, and the research results are mostly lack of systematicness and comparability, and in the selection of indicators, the actual effect of latent variables (hidden variables) cannot be effectively calculated, and it is impossible to avoid the multiple collinear problems that may occur among the factors, in view of the above-mentioned facts, this paper, to introduce the theory of "multivariate data relations processing" in order to avoid the occurrence of singular matrix, and choose structural equation model (SEM) to effectively test the multiple colinearity among the variables, it can more accurately detect the overall fitting degree between the measurement model and the data.

In addition, with the existing literatures, the studies focusing on higher engineering education are relatively small, considering the representativeness and availability of the industrial statistics, the data are obtained only 1992-2016 years, and the number of data samples is relatively small, thus to choose the structural equation model based on partial least squares (PLS) is more suitable for the needs of this paper.

Data Sources

Combined with the requirements of sustainable development of manufacturing industry, to make a research from the perspective of capital and labor input-output(as is shown in **Table 1**) (Pardi et al., 2015; Galang, 2010), and the statistical data are taken from "China Statistical Yearbook 1992-2016" and "China Industrial Statistics Yearbook 1992-2016" (in order to keep the continuity and comparability of data, the initial-value-method is adopted to deal with the non dimensional processing).

First of all, with SPSS20.0 software, according to the data provided from **Table 1**, the KMO value is calculated as 0.761 (> 0.7) , and the value of Bartlett sphericity is 0.000 (< 0.001), the results show that the internal consistency of the data is good, and it is suitable for factor analysis. This paper, to carry out the exploratory factor analysis and confirmatory factor analysis for data preprocessing to build the trust model, after calculation, the cumulative contribution rate is 90.619%, which meaning the explaining extent of the model is higher, meeting the research requirements of this paper.

Table 1. Indicators of Sustainable Development Capability of Manufacturing Industry

Influence factors	Measure indicators	
Higher engineering education investment	Financial appropriation for higher engineering education (hundred million)	x1
	The total number of professional teachers in higher engineering education (ten thousand)	x2
	Fixed investment of higher engineering education (ten thousand)	x3
	Number of enrollment size for higher engineering education（ten thousand）	x4
	R&D funds input in higher engineering education (ten thousand)	x5
Industrial technical progress	Number of industrial authorized patents (hundred)	x6
	Growth rate of total factor productivity（%）	x7
	Rate of capital output（%）	x8

Table 2. Evaluation Indicators For Sustainable Development Ability Of Manufacturing Industry

Variable	Measure indicators	
Industrial generating capacity	The proportion of Bachelor degree or above in manufacturing industry (persons with bachelor degree or above / total number of employees in manufacturing industry)	y1
	The proportion of independent intellectual property rights (the number of industrial independent intellectual property rights / the total number of intellectual property rights in China)	y2
	Market share of independent innovation products (the sales of independent products / total sales of industry)	y3
	Profitability of industry independent innovation product (independent product operating profit / operating income)	y4
	R & D investment ratio (R & D annual input / industry annual turnover)	y5
Industrial competitiveness	Industrial market share (Total sales of industrial products of Chinese enterprises / total sales in domestic market)	y6
	Industrial trade competitiveness index (trade gap between imports and exports of industrial products / total import and export trade)	y7
	Industrial dominant comparative advantage index (the proportion of exports to the total value of exports / the proportion of similar goods to the total value of exports in the world)	y8
	Concentration ration of industry (CR6=sales of the top six enterprises /total industrial sales)	y9
Industrial control capability	Market share of Chinese funded enterprises (total sales of Chinese holding manufacturing enterprises / total sales of industrial products)	y10
	Chinese brand share (brand number of Chinese enterprises / industrial total brand)	y11
	Control degree of Chinese enterprises operating decisions (output value of Chinese enterprises / industrial total output value)	y12
	Core technical control degree of Chinese enterprises (total number of industrial core technical in Chinese enterprises / total number of industrial core technical)	y13

MODEL BUILDING

Variable Selection

For the structural equation model (SEM), the variables can be divided into two categories: one is the significant variables (i.e., measurable variables, refers to the variables that can be observed and measured directly), the other is the latent variables (i.e. hidden variables, which cannot be observed and measured directly).

For the model design of manufacturing industrial sustainable development evaluation, this paper, to take "sustainable development ability of manufacturing industry" as dependent variable, and take "higher engineering education investment" and "technical progress" as independent variables in the structural equation model, considering the factors of "higher engineering education investment, technical progress and sustainable development ability of manufacturing industry" cannot be measured directly, to take them as "latent variables" that need to be comprehensively reflected by several measurable variables, thus a complete structural equation model is constructed (as following).

Latent variables 1: sustainable development ability of manufacturing industry (η)

Drawing on the existing literatures, considering the realistic requirements of sustainable development of manufacturing industry, 13 indicators (as measurable variables) are selected from the aspects of "Industrial generation capacity, industrial competitiveness and industrial control capability", the content of the measure indicators are shown in **Table 2**.
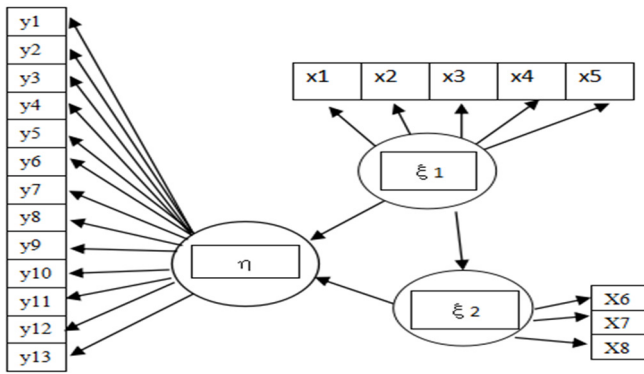
Figure 1. Research hypothesis diagram

Latent variables 2: higher engineering education investment (ξ1)

From the perspective of capital and labor input, five measurable variables are selected, which can be shown as follows: Financial appropriation for higher engineering education (x1) and the total number of professional teachers in higher engineering education (x2), fixed investment of higher engineering education (x3), Number of enrollment size for higher engineering education (x4), R&D funds input in higher engineering education (x5).

Latent variables 3: industry technical progress (ξ2)

And three measurable variables are selected, which can be shown as follows: Number of industrial authorized patents (x6), growth rate of total factor productivity (x7), Rate of capital output (x8).

Model Hypothesis

Using Smart PLS 2.0 analysis software, to take "higher engineering education investment, technical progress and manufacturing sustainable development ability" as latent variables, x1-x8 and y1-y13 as measurable variables to build structural model, and the relationship between the latent variables can be expressed in the form of path diagram (or equation), and the following research hypotheses are proposed (the research hypothesis diagram is shown in **Figure 1**).

H1: Higher engineering education investment (ξ1) has a positive influence on the sustainable development ability of manufacturing industry (η).

H2: Industrial technical progress (ξ2) has a positive influence on the sustainable development ability of manufacturing industry (η).

H3: Higher engineering education investment (ξ1) has a positive influence on industrial technical progress (ξ2).

SEM MODEL CHECKING

Validity Analysis of Model Interpretation

In order to make an evaluation on the explaining extent of the model, firstly, to adopt the structural equation and partial least squares method with Smart PLS 2 software, and the adjusted chi-square test (χ^2/df), the root mean square error (RMSEA) and the comparative fit index (CFI) are chosen as the evaluation indexes, which are less affected by the sample size (the acceptable range of each fitting index are shown in **Table 3**), thus the results of the fitting degree can be calculated (as shown in **Table 3**), and it can be seen that the values of all the fitting indexes are within the acceptable range, and all the hypotheses have passed the test, which shows that the fitting degree between the measurement model and the data is better, and the overall explanatory validity of the model is higher.

Table 3. Values of the Fitting Degree

	χ^2/df	RMSEA	CFI	Fitting results
Hypothesis 1	2.41	.069	.933	adopt
Hypothesis 2	2.34	.061	.960	adopt
Hypothesis 3	1.82	.053	.911	adopt
Acceptable range	[1-3]	<0.08	>0.9	--

Table 4. Standardized Path Coefficient Analysis

Paths	Standardized path coefficient	Significance test at 0.01 level	Hypothesis test results
H1 : η（ξ1)	.8273	remarkable	support H1
H2 : η（ξ2)	.5881	remarkable	support H2
H3 : ξ2（ξ1)	.4986	remarkable	support H3
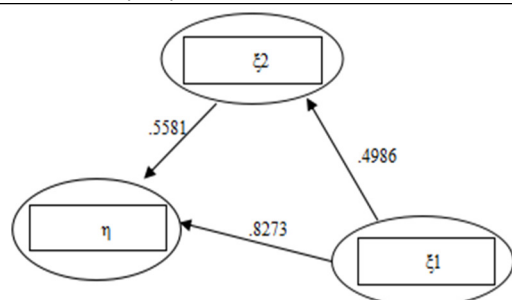
Figure 2. Paths diagram of structural equation model

Table 5. Paths Coefficient and Influence Effect of the Model

Paths	Influence path number	Direct influence coefficient	indirect influence coefficient	Total influence effect
ξ1- η	2	.8273	.2396	1.1205
ξ2- η	1	.5881	——	.5881
ξ1- ξ2	1	.4986	——	.4986

Model Path Validity Analysis

In order to ensure the suitability of the model, the test results of the overall fitting degree of the model need to be calculated, and then to make a validity test of the fitting index and the standardized path coefficient, the path validity is mainly reflected in the standardized path coefficient and the value of T, and the calculation results of T test show that at the significance level of 0.01, all the path coefficients in the model pass the T test, that is, the model path assumptions about H1-H3 are valid (results are shown in **Table 4** and **Figure 2**).

Analysis of Influence Effects of SEM Variables

Combined with the path relationship of the variables in the **Figure 2**, the direct influence coefficient, the indirect influence coefficient and the total influence effect of the latent variables can be calculated (results shown in **Table 4**).

The results show that "ξ1 and ξ2" have a positive and direct impact on η, to sort the variables according to the coefficient of path coefficient are as follows: higher engineering education investment (0.8273), technical progress (0.5881), and ξ1 has relatively higher direct effect on η.

In addition, ξ1 has a significant indirect influence on the η, which can be reflected that ξ1 has positive and direct influence on ξ2 (0.4986), and has an influence on the η through the transitivity path of ξ2, after calculation and analysis, the indirect influence degree of ξ1 on η is obtained (0.2932).

Add up the indirect and direct effect, the total influence effect of the latent variables can be obtained, as: the "ξ1- η" is 1.1205, "ξ2- η" is 0.5881 (as shown in **Table 5**).

RESULTS ANALYSIS

Higher engineering education investment and technical progress are the key factors to promote and guarantee the sustainable development of China's manufacturing industry.

First of all, according to **Table 4**, "higher engineering education investment" has the greatest influence effect and the most associated paths, the main reason is: in China, compared to the developed countries in Europe and America, the total amount of investment in higher engineering education is insufficient, the marginal utility of input-output is large, and the manufacturing industry is still in the extensive quantity expansion stage, which is in the rising period of scale economy, characterized by simultaneously expanding between the higher engineering education investment and manufacturing development, thus the result of the influence degree shows greater. Therefore, it is necessary to continue to increase the investment in higher engineering education, which is the most critical factor to effectively improve the sustainable development ability of manufacturing industry in contemporary China.

Secondly, technical progress has an obvious direct impact on the sustainable development of China's manufacturing industry, and it is the important material basis for the sustainable development of China's manufacturing industry, but according to the total effect calculation result, compared with the "higher engineering education investment" factor variables, the overall impact is relatively small, the main reason is that the overall technical level of China's manufacturing industry is not high, and the share of high-tech industry in the national economy is not large (about 15%), the high-tech industrial chain is relatively short, and it is relatively weak to influence and drive the development of other related industries, the result is the existence of a large number of traditional manufacturing industry blurs the contribution of technical progress to industrial development.

Thirdly, the direct impact coefficient of higher engineering education investment on technical progress is 0.4986, which indicates that the input-output level of higher engineering education in China is low, and the efficiency of engineering education needs to be improved. It is necessary to actively carry out strategic action plans such as "excellent engineer program" and "engineering education accreditation" in the future, so as to effectively promote the contribution of higher engineering education to technical progress.

CONCLUSION AND PROSPECT

In order to realize the sustainable development of China's manufacturing industry, it is necessary to pay more attention to the higher engineering education investment and technical progress, and to increase the investment in higher engineering education, besides, it is also important to effectively improve the input-output level of higher engineering education, and improve the contribution level of higher engineering education to technical progress.

Limited space, the specific strategies for the coordinated development of higher engineering education, technical progress and manufacturing industry in China will be further studied in another manuscript.

ACKNOWLEDGEMENT

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The Validity of a Design Technology for a Higher Education Quality Assurance System Based on the EFQM Model

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ABSTRACT

In current conditions, higher educational institutions have to develop innovative mechanisms of education quality assurance independently. One such mechanism is the implementation of the European Foundation for Quality Management (EFQM) model, although the 9001:2001 International Organization for Standardization (ISO) model is widely implemented in the higher education system of Kazakhstan. International Organization for Standardization (ISO) model is widely implemented in the higher education system of Kazakhstan. In-depth theoretical and methodological studies developed a design technology for a quality assurance system. The purpose of this study is to confirm the validity of this technology, which is why the study sets the following tasks: 1) to determine the validity criteria for the developed technology; 2) to show that the developed technology meets the validity criteria. An important result of this study is that it substantiated the criteria of the selected types of technology validity: construct, criterion, and content. The study proved that the developed technology met the criteria of validity, which was the main result. This allows recommending higher educational institution in Kazakhstan to implement this technology.

Keywords: higher education, validity criteria, educational management, ISO model, Kazakhstan

INTRODUCTION

Education quality assurance is regarded as one of the most urgent problems worldwide (Ewell, 2010; Ingvarson & Rowley, 2017). One can note that the Bologna process in Europe is probably the most visible multinational transformation in the world today and, of course, has a quality assurance dimension discharged through such multinational organizations as the European Association for Quality Assurance in Higher Education formally the European Network for Quality Assurance. Similar regional networks have been established in Asia, as well as in Central and South America abilities (Craft, 2003). These tendencies reflect growing student and graduate mobility and an emerging set of global standards for graduate abilities (Padro, 2015; Groen, 2017). They are particularly relevant to developing countries (Boccanfuso, Larouche & Trandafir, 2015).

According to the State Program for Development of Education in the Republic of Kazakhstan in 2011-2020 (2011), higher educational institutions will be granted academic, financial, and administrative autonomy. Therefore, higher educational institutions should already be developing innovative mechanisms of education quality assurance. One such mechanism is the implementation of the EFQM model. The purpose of this model is to determine areas for improvement that would increase the company's competitive performance; therefore, the result of the model's implementation is the assessment of the level of readiness as the degree of approximation to the

Contribution of this paper to the literature

- The paper describes the validity of International Organization for Standardization model.
- Analysis of personnel quality as well as educational facilities quality is presented by the authors on the basis of questionnaire survey in 3 Kazakh universities.
- This research can be regarded as basis for further investigations on higher education quality assurance.

Table 1. Comparison of quality assurance models

ISO 9001:2001 model	EFQM model
− *Quality assurance policy and procedure*. − Constant control of the activity of the educational institution based on a periodical analysis of the results of its activity. − Quality of students. − Quality of academic staff. − *Quality of student support and resources*. − Information support. − Public information.	The model incorporates two groups of criteria – "Possibilities" and "Results". The "Possibilities" group includes the following criteria: 1) leadership; 2) *politics and strategy*; 3) employees; 4) *partnerships and resources*; 5) processes. The "Results" group includes the following criteria: 6) customer related results; 7) employee related results; 8) business related results; 9) key results.

perfect (ideal) company within the accepted model with a list of areas for improvement that require changes (European Foundation for Quality Management).

The analysis of the ISO 9001:2001 model, which has been implemented in the higher education system of Kazakhstan, allows concluding that it is based on the notion of "what exactly an organization should be doing". The main method in ISO standards is audit, which is why the results of this method simply state the compliance or noncompliance and gives a list of inconsistencies to be eliminated (GOST R ISO 9001-2008). These standards provide only for a qualitative assessment and require filling in multiple documents at that. They force educational organizations to focus on the audit results and timely elimination of discovered flaws. This hinders the improvement of educational activities, to a degree.

Nevertheless, the ISO 9001:2001 model currently shows a tendency of expanding its scope of application. The fact of the matter is that the standards of both accreditation agencies in Kazakhstan that are included in the National Register are also based on the ISO model. Another manifestation of this tendency is the demand for practice-orientated monographs in higher educational institutions (Minzhayeva, 2009).

The features that distinguish the EFQM model from the ISO 9001:2001 model were determined based on comparison criteria (**Table 1**) (Nabi, 2013a).

As the table shows, only two criteria match (criteria with a matching concept are highlighted in italics). The ISO 9001:2001 focuses on constant control of the activity of the educational institution based on a periodical analysis of the results of its activity, while the EFQM model takes into account the possibilities of leadership, personnel, and correct choice of strategy, politics, and partners.

The developed methodological aspects of system design, which provide the required theoretical rationalization of the design technology, should help to develop a mechanism for the design of a higher education quality assurance system. In the context of this study, a design mechanism is a means of describing the relationships that emerge during the interaction of subjects and objects of design during the design process, as well as implementing and assessing the results. This working definition can be specified, but at the current stage of the research, it reflects the essence of further steps. In any case, it would be difficult to confirm the validity of the logic of further studies without defining the terms.

Design is a multifaceted term. First of all, it includes a system of goals, since the design mechanism should be focused on achieving goals. At that, it is necessary to determine the links and relations between the elements of the designed object, to assign the tasks and functions of each element, and identify the responsibilities and powers of the subjects of design during the development and as a result of design.

This multifaceted nature of the mechanism forces using a set of methods. Therefore, it is necessary to proceed from a combination of scientific methods with extensive expert and analytical work, the study of Kazakh and foreign experience, and close cooperation of the developers, implementers, and users of the designed object. The design mechanism should be based on a concise formulation of the design goals. Therefore, it is necessary to stick to the formula of "clear understanding of goals first, development of a mechanism to achieve said goals later".

The development of the mechanism includes the determination of criteria and indices of design effectiveness and a rationalization of the technology used to design the system of higher education quality assurance based on the EFQM model. The implementation of the mechanism requires developing a technique for collecting empirical data for the experimental work, which should be tested in higher educational institutions of Kazakhstan; this should be followed-up by a preparation of recommendations regarding the use of the results of studies in the practice of higher educational institutions based on the confirmation of the technology's validity. According to the most common definition cited at the Russian version of Wikipedia, *validity* is the rationality and applicability of research methods and results in specific conditions. At this stage, this definition is taken as a basis.

Thus, despite the general trend of expanding the scope of use of the ISO model in education quality assurance systems, the EFQM model is preferable from the perspective of Kazakhstan system's integration into the European educational space. At the same time, it is worth mentioning the major advantage of the ISO model, which is that it features a standardized validation of technological processes, which the EFQM model lacks. Therefore, the problem arises regarding the confirmation of the validity of a technology that is developed based on this model.

METHODS

The goals of the study require determining the methods that will be used to assess the effectiveness of design. Assessment methods currently in use mostly focus on the functional aspect with the regulation of processes, rather than their results, being the cornerstone. Researchers and developers should rely on the system criteria and indicators that are based on the initial definition of the design goals system, which then sets the tasks and determines the scope of the design process. The following methods of assessing the effectiveness of educational system design should be distinguished: analogy method, expert method, goal structuring method, and modeling method.

No single method has been created yet that would formalize variables, collect data or assess results. In this case, the personal experience of the researcher is crucial. Therefore, based on personal experience, the offer is to use a set of criteria and indices that characterize the effectiveness of the design of a quality assurance system. The final criterion of effectiveness, in comparison to various versions of the project, *in our opinion*, is the fullest and most sustainable achievement of goals set in the project. However, it is very difficult, even impossible in case of social systems, to bring this criterion to simple indices that would be practically useful and linking each process with its final results. Therefore, the set of effectiveness criteria for the design of a quality assurance system should be formed with regard to the correspondence of the results that are being achieved to the set goals and the correspondence of the system's operation characteristics to the set requirements to its scope and results, i.e. the results of design are assessed from the perspective of effectiveness, while effectiveness is assessed by comparing the result and the efforts made to achieve it.

The following methods were used to determine the indices to be included in the process sheet of the design of the quality management subsystem, inherent quality assurance subsystem, and a subsystem for confirming the quality of the EFMQ-model-based higher education quality assurance system:

1) questionnaire survey to collect information;

2) collection of factual material (figures, indices, financial indicators);

3) analysis and determination of strengths and weaknesses;

4) results of official scoring, commission inspections, attestations, and accreditations.

When organizing the questionnaire survey, it is very important to formulate questions in a way that would ensure that the answers to said questions correspond to what one is trying to find out. Many factual data can be acquired from higher educational institution reports, which are compiled in bulk for various agencies and are posted of official websites, featured in ads, etc. The only thing required is to structure this material and select only the parts of it that correspond to the goals of the study.

Pedagogical studies usually deal with weakly formalized and non-numerical information, which is often unsuitable for methods from exact sciences, for instance, mathematical statistics methods. Using mathematical methods in pedagogy is a current trend that produced a separate scientific field – pedagogical qualimetry. At the same time, the investigation of pedagogical problems traditionally uses general research methods: systems and activity approach, modeling, expert assessment, thought experiment, etc. The group expert assessment method is one of the most common means of formalization of weakly formalized information. Despite having been economic research method at first, it is now used in pedagogical studies. In particular, it was used in the development of a scientific project titled "Scientific and Methodological Framework of the Design of a Higher Vocational Education Quality Assessment Model" (Nabi, & Mendigaliyeva, 2006).

In the context of pedagogical studies, the group expert assessment method consists in specially selected experts conducting an intuitive and logical analysis of a pedagogical problem with a quantitative and qualitative

assessment of their judgments and subsequent treatment of obtained data via mathematical statistics methods (Tatar, & Oktay, 2006). In order to improve the reliability of the expert assessment and eliminate the influence of the subjective opinions of those who select the experts, the survey of experts, treatment of results, and other operations should be carried out with regard to the requirements of appropriate state standards (Stephenson & Yorke, 2013). After the group of experts is surveyed, the results are treated. The raw information set to undergo treatment always features numerical data that express the experts' preferences.

Assume *m* experts assessed *n* objects. Then the results of the assessment can be presented in the form of an expression – x_{ij}, where *i* is the object number and *j* is the expert number. When assessing objects via direct assessment, the x_{ij} values are numbers from a certain number line interval. In order to obtain the group assessment of objects, one can use the mean value of the assessment

$$x_{ij} = \sum_{j=1}^{m} x_{ij} f_j \qquad (i = 1,2\ldots,n)$$

$$\sum_{j=1}^{m} f_j = 1 \tag{1}$$

where f_j are the expert competence coefficients (expert competence coefficients are normalized values).

Expert competence coefficients can be calculated based on the results of expert assessment on the assumption that the competence of experts should be assessed according to the degree of correspondence of their assessments with the group assessment of objects.

The algorithm for calculating expert competence coefficients has the form of a recurrent procedure:

$$i = 1,2\ldots,n \quad (j = 1,2,\ldots m) \quad (t = 1,2,\ldots)$$

$$x_i^t = \sum x_{ij} f_j^{t-1} \tag{2}$$

$$S^t = \sum_{i=1}^{n} \sum_{j=1}^{m} x_{ij} x_i^t \tag{3}$$

$$f_j^t = 1/S^t \sum_{i=1}^{n} x_{ij} x_i^t; \qquad \sum_{j=1}^{m} f_j^t = 1 \tag{4}$$

Calculations start at *t*=1. In formula (1), the initial values of competence coefficients are identical and equal $f=1/m$. Then, according to formula (1), the first approximation group expert assessments equal the arithmetic means of expert assessments

$$x_i' = 1/m \sum_{j=1}^{m} x_{ij} \qquad (i = 1,2,\ldots n)$$

Then the S' value is calculated according to formula (3)

$$S'' = \sum_{i=1}^{n} \sum_{j=1}^{m} x_{ij} x_i$$

and the values of first approximation competence coefficients are calculated according to formula (4).

$$f_j' = 1/S'' \sum_{i=1}^{n} x_{ij} x'$$

By using first approximation competence coefficients, it is possible to repeat the entire calculation process according to formulas (2)…(4) and obtain second approximations x''_i, S'', f''_j.

The group expert assessment method was used to determine the dependency of significance of indicators in the questionnaire, with a view to assessing the quality of personnel. Experts were offered questionnaires and asked to assess the significance of this or that attribute of professional and personal qualities of teachers. An electronic table was developed that allowed obtaining the significance of each attribute of each professional and personal quality.

When designing the quality management subsystem during preliminary preparation, the following was done:

a) requirements to the quality of activity were determined based on the analysis of requirements to the quality of education set in the European educational process;

b) the level of motivation of the personnel to improve the quality of education was determined. Questionnaires were used to that end.

At the engineering design stage, the employers' satisfaction with the questionnaire survey method was monitored.

The level of students' motivation was determined according to the method described in. Although this method was designed for the 11th grades of secondary schools, it is acceptable for the purpose of this study, since the survey involved freshmen. Students were offered to read each unfinished sentence and each answer option thereto carefully and underline two answers that corresponded to their personal opinion. The questions identify cognitive and social motives: broad social, narrow social, avoidance of trouble, approval orientation. The domination of cognitive or social motives was analyzed.

The level of teachers' motivation to improve the quality of pedagogical activity and the reasons that hinder said motivation were determined using questionnaires. The opinion of the academic staff regarding innovative activity, their proficiency in advanced educational technologies, and their level of implementation in pedagogical practice was determined (Semenova, 2009). In addition, the teachers assessed the quality of educational facilities at their disposal (classrooms, laboratories, ICT rooms, educational equipment, etc.).

The design of the inherent quality assurance subsystem during preliminary preparation involved the following:

a) analysis of personnel quality;
b) analysis of educational facilities quality;
c) analysis of educational technology quality.

The analysis was carried out via questionnaire survey. There are many methods that could be used to assess personnel. Considering the qualimetric approach taken in this study, quantitative assessment methods were used. In order to improve the validity of data, participants of assessment procedures were assured that the results would remain confidential. This increases the objectiveness of the assessment and does not create conditions for distrust in the assessment results and the assessors (managers, employees, etc.). In addition, the criteria themselves should be unambiguous and understandable so as not to cause suspicion that the management wishes to acquire certain data in a roundabout way. All the above will facilitate the active participation of personnel in the assessment processes and subsequent elimination of discovered flaws.

Creating an assessment system that meets all the requirements (objectiveness, accuracy, simplicity, etc.) is a difficult task, while existing system all have their strengths and weaknesses. We adapted known methods (Personnel assessment) to the conditions of higher educational institutions. The distinguishing feature of the adapted method is that it involved the head of the department, the colleagues of the assessee, and the assessee him- or herself in the assessment. The combination of these forms of assessment allows increasing the objectiveness of assessment while simultaneously concealing the specific assessor.

The engineering design stage included a monitoring of the implementation of educational and pedagogical technologies with regard to quality requirements within the framework of marketing, competency-based approach in results-oriented education, conditions for achieving academic mobility, innovations, and improvement and update of educational programs. The monitoring used the results of higher educational institution accreditation.

The design of the quality confirmation subsystem during preliminary preparation involved the analysis of criteria and indices of education quality used in the European educational space. The engineering design stage involved the following:

a) the results of higher educational institutions' activity in respect to customers, personnel, and business, as well as the key results of their activity were analyzed;
b) the compliance or noncompliance with the criteria and indices of education quality used in the European educational space was determined.

The results of higher educational institutions' activity in respect to customers, personnel, and business, as well as the key results of their activity were determined by studying the reports on institutional accreditation and processing them using the GOA Basic Assessment Education ver. 2.1. software. This software is convenient because it not only counts the points automatically, but also gives recommendations on how to improve this or that index.

It is necessary to answer the questions in succession across nine blocks that correspond to nine blocks of criteria from the EFQM model (**Figure 1**). The software counts the points and generates a diagram according to the calculated points.
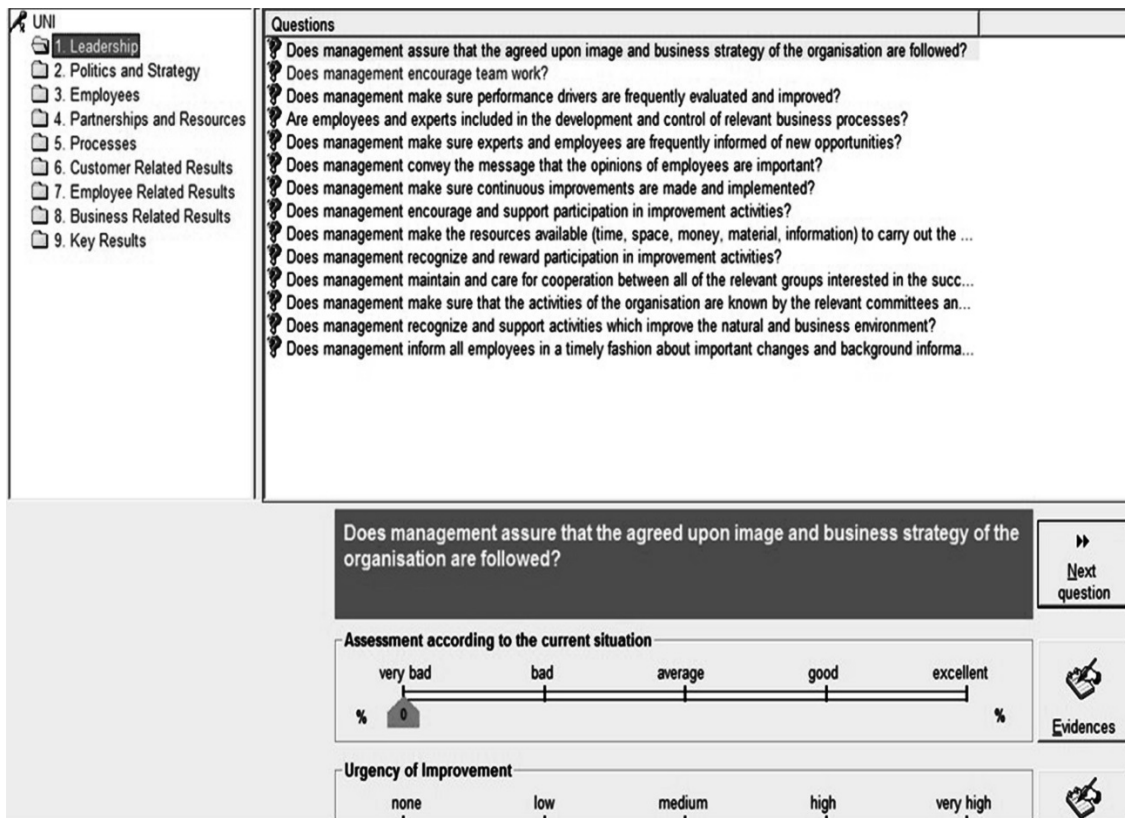
Figure 1. Software interface

The compliance with criteria and indices of education quality used in the European educational space was determined via special calculations. Criteria were calculated based on a RADAR assessment matrix. The following elements of the matrix were distinguished: Approach, Development, Assessment and Overhaul, and Results. Each element has its attributes (McCarthy, Greatbanks & Yang, 2002).

Obtained data are entered on the point calculation list, in which the number of points is calculated as an arithmetic mean across all the components of this criterion. Points are calculated in percentage. In the "Sum" column, percentages for components are summed up; the obtained sums are divided by the number of components, for instance, for the "substantiation" attribute, it is 3, for the "integration" attribute – 2, etc.

The total number of points is calculated. It is necessary to enter the number of points for each sub-criterion and multiply the number of points by the respective factor to obtain the resulting points for each sub-criterion. Then it is necessary to sum up the resulting points across all criteria to obtain the total number of points.

The quality of the educational technology was analyzed according to the criteria that can be distinguished as those that were characteristic of good planning of classes (Laurillard, 2013).

RESULTS

Purpose and Tasks of the Study

The purpose of this study is to confirm the validity of a design technology for a higher education quality assurance system based on the EFQM model, which is why the study sets the following tasks:

1) To determine the validity criteria for the developed technology;
2) To show that the developed technology meets the validity criteria.

The novelty of the study lies in the following:

1) A technology for designing a higher education quality assurance system based on the EFQM model was developed, which is unparalleled;
2) Validity criteria were determined for the developed technology for three types of validity. At that, in the content validity, the criterion that is applicable to technological processes in pedagogical systems was substantiated for the first time in pedagogical theory;

3) The developed technology was proven to meet the validity criteria.

4) The introductory section of the paper featured a working definition of validity to outline the terms in use.

However, there is a broader definition of validation and validity, for instance:

1) Validation: "To establish the soundness, accuracy, or legitimacy" (Validation Dictionary of the English Language);

2) Validity is the extent to which a concept, conclusion or measurement is well-founded and corresponds accurately to the real world. The word "valid" is derived from the Latin validus, meaning strong. The validity of a measurement tool (for example, a test in education) is considered to be the degree to which the tool measures what it claims to measure; in this case, the validity is an equivalent to accuracy (Brains et al., 2011);

3) Validity is essentially a comprehensive characteristic that includes information about whether or not a method is suitable for measuring that for which it was created on the one hand and how effective, efficient, and practical it is on the other hand.

The value of the latter definition lies in its emphasis on the necessity of a pragmatic validation of methods, i.e. assessment of their efficiency, effectiveness, and pragmatic significance.

Researchers distinguish several types of validity, for instance, study (Validation) notes construct, content, criterion, experimental, diagnostic etc. validities, while study (Safontsev, & Fedotova, 2014) distinguishes content, construct, and criterion validity when investigating the validity of pedagogical objects; at that, the author of the study considers modularity, diagnosticity, and qualimetricity to be the criteria of the construct validity of an educational system. Content validity is a non-statistical type of validity that involves "the systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured" (Validation).

It is worth noting that the above definitions of the term "validity" are mostly related to tests (psychological tests, pedagogical tests to determine the level of knowledge, etc.). In regard to design, validity is regarded only in the context of quality management. In ISO, validation is defined as a procedure that gives a large degree of confidence that a specific process, method or system will consistently lead to results that meet the set criteria of acceptability; in particular, validation of technological processes is carried out to prove and provide documented evidence that the process (within the set parameters) is repeatable and produces expected results. The "Resulting Output" of a design process is a project – a product, which note 2 to the term "product" in Paragraph 3.4.2 of ISO 9000:2005 denotes as "software". Information, rather than the material component, presents the main value for the consumer. Requirements of Section 7.3 of ISO 9001:2008 mention the need to verity and validate the result of the design process, i.e. the project itself. Project validation is often misunderstood, since the concepts of the intended purpose of the project and the actual output based on the project are mixed. To validate the project means to confirm the ability to use this project as input requirements for production processes.

Based on this notion, it is possible to conclude that the content criterion of validity is the confirmation of the ability to use this project, which can be expressed in the following parameters:

1) Match of data obtained from higher educational institutions with different statuses;

2) Approximately identical level of designers, i.e. those who realize the project;

3) Similar skill level of experts involved in the obtainment of raw data.

These parameters are based on the accepted methods of experimental work. Their definition will be the most labor-intensive work, since it requires collecting experimental data from several higher educational institutions and said institutions have to be dissimilar at that. If the data for dissimilar higher educational institutions are consistent and, in some cases, similar, then this will be indicative of the fact that the developed technology is applicable regardless of the status of the higher educational institution. Such comparisons have not been made to date, which is why the results of this study may be interesting to both Kazakh and foreign readers. This is one of the features of this study.

The criterion validity was taken based on the opinions of authors of (Melnikova & Khoroshilov, 2014), who believe that the objectiveness of any study comprises of validity and reliability, with validity being divided into three types: objective, instrumental, and theoretical, while the key strategy for achieving validity is to divide the study into several phases and clearly document all actions and conclusions for each phase.

Thus, an important result of this study is that the validity of the technology will be confirmed in three aspects according to the following criteria:

1) Construct validity - modularity, diagnosticity, and qualimetricity;

2) Criterion validity – division of the study into several phases and clear documentation of all actions;

3) Content validity – the ability to use this project in similar conditions.

It is worth noting that while the first two types include known criteria, the content validity, for the first time in pedagogical validity theory, substantiated the criterion that is applicable to technological processes in a pedagogical system.

The validity of the technology is confirmed based on these criteria.

A Design Model for the Higher Education Quality Assurance System

The theory of pedagogical design includes a prognostic model, a conceptual model, a pragmatic model, an instrumental model, a monitoring model, and a reflexive model. In terms of their construction method, models are divided into image, symbol, and image-symbol ones. Many researchers gave the following definition: a *model* is an artificially created object in the form of a scheme, physical constructions, symbolic forms or formulas, which is similar to the studied object or phenomenon and reflects or recreates the structure, properties, interconnections, and relationships between the elements of said object in a simpler fashion (Knapp, 2014). J. Šedivý (2013) mentions that "*Modeling* is a method that is often used in professional and scientific practice in many fields of human activity. The main goal of modeling is not only describing the content, structure and behavior of the real system representing a part of the reality but also describing the processes. The process can be understood as series of transformations that changes the input values to output values. From the system point of view the process is dynamic system in which the values of the characteristic of the system elements are changed under the influence of the external elements. The models are always only approaching of the reality, because the real systems are usually more complex than the models are" (Šedivý, 2013).

The construction of the model, the specification of the dependency between the main elements of the studied object, and the determination of the parameters of the object and the model structure was based on the regularities of pedagogical modeling.

Pedagogy mostly models multifactorial phenomena. Debates concerning the possibility of modeling complex social phenomena are ongoing and, probably, endless. This is related to the fundamental problem of completeness of each constructed model. No model, regardless of how complex it is, is capable of giving a complete understanding of the studied object and accurately predicting its development or describing its motion trajectory in any proper space. This forces researchers to balance on the edge of completeness and validity when constructing models. Certain promise is found in the construction of a complex of models that describe various factors of development of an educational system. It is worth emphasizing that this implies a complex, rather than a random set of models, which would make for an eclectic, arbitrary, and chaotic description. The professionalism of a researcher manifests in the construction of a holistic complex of models.

In this case, the matter at hand is a complex of models, since three models of subsystems (**Figure 2**) were developed in addition to the structural model of design of a higher education quality assurance system. Furthermore, assumptions regarding the means of achieving goals were made and criteria of assessment of expected results were determined. Assessments were made based on quantitative values, since *the authors believe* that qualimetry can be limited to investigating the "measurement" concept, while the very nature of the problem of product quality measurement necessitates using quantitative methods to describe quality (Nabi, 2013[b]).
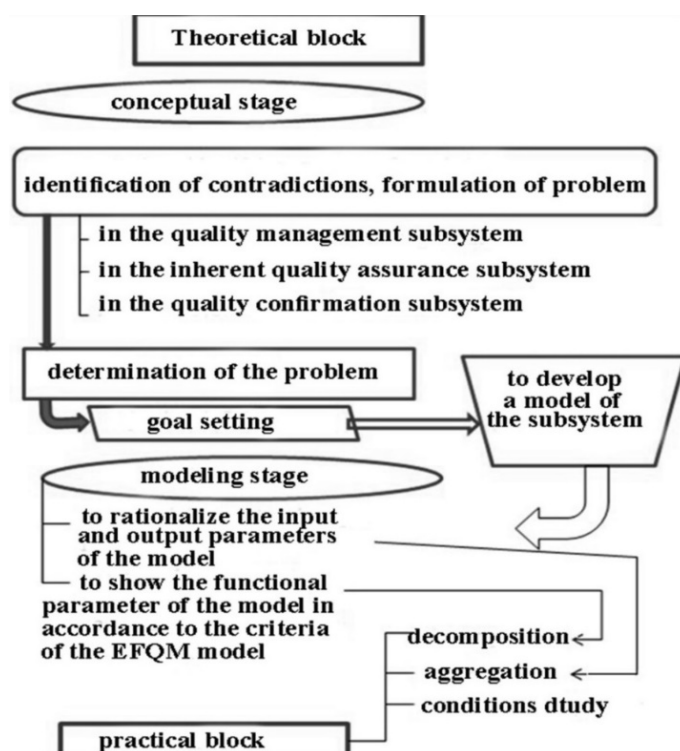
Figure 2. Structural model of design of a higher education quality assurance system

The developed structural model of design of a higher education quality assurance system based on the EFQM model (Nabi, 2014a) is novel and prognostic, since:

a) it allows distinguishing the components of the model and determining their hierarchy, interconnection, and content: the identification of contradictions determines the problem, which determines the goal of design. The identified contradictions and problems of education quality assessment allowed formulating the problem of design: it is necessary to elaborate the theory and practice of design of quality assurance systems despite the limited capabilities for completing the task via conventional means. This problem was solved in the developed models:

-   quality management subsystem;
-   inherent quality assurance subsystem;
-   quality confirmation subsystem.

b) it shows the direction for further studies, since the practical block involves a development of a specific mechanism for the implementation of developed models.

The Design Technology for a Higher Education Quality Assurance System based on the EFQM Model

The developed method for selecting methodological approaches is unparalleled: five stages of the method allow determining the parameters for the analysis and comparison of approaches, determining the strengths and weaknesses of each approach, and selecting them with regard to the four features of the EFQM model that were determined during previous studies.

The interdisciplinary approach was taken when rationalizing the principles of design of a higher education quality assurance system based on the EFQM model and developing methodological approaches (Nabi, 2014b). Another original feature of this study is the discovered compliance of the developed principles to the identified features of the EFQM model and its criteria (Nabi, 2013c) (**Table 2**).

Table 2. Compliance of the developed principles to the identified features of the EFQM model and its criteria

EFQM model features	Specific principles of design of a higher education quality assurance system	EFQM model criteria
Makes it so both the leaders of the organization and all personnel have to have "qualitative culture"	Focus on the top officials of the organizations that use the designed project	Leadership
	Regard for the psychological aspects of the design and operation of the designed object	1) Employees (personnel); 2) Employee related results
Allows assessing the achieved results and using them to find ways to coming closer to becoming a perfect (ideal) company	Workability principle	1) Processes; 2) "Results" group; 3) Partnerships and resources
	Openness principle	
	Correlation of managerial actions and internal self-organization trends in a developing system	
Aimed at determining areas for improvement	Workability principle	1) Politics and strategy; 2) Processes
	Modularity principle	
	Regard for multiple ways for developing the system	
Allows expressing the results of activity quantitatively (in points)	Ability to control and monitor processes	Key results

In previously published studies (Nabi, 2014b; Nabi, 2013d) that focus on the results of theoretical and methodological investigations, the authors developed a design technology for a higher education quality assurance system based on the EFQM model (Nabi, 2014c). The substantiation of the design stages was a difficult task. In literature, the opinions on this matter differ widely: from two (for instance, study (Nabi, & Shaprova, 2010)) to 15 stages (for instance, study (Nabi, Tokmagambetov, & Ibishev, 2012), while paper (8 Stages Of Design & Construction) offers eight stages – from the "Initial Contact" to the "Maintenance Stage".

We substantiated three design stages, which is why the design technology was also divided into three stages:

- preliminary preparation, which consisted in the realization of the practical block in the developed models (models of the quality management subsystem, inherent quality assurance subsystem, and quality confirmation subsystem);

- engineering design – work based on analytical notes on the execution of the first stage in accordance with the "operation" parameters of the developed models with regard to the fact that in the models, said parameters corresponded to the RADAR index matrix from the EFQM model;

- detailed design, which consisted in the development of detailed documentation: provisions, plans, flowcharts, estimations, innovative educational technologies, methods, etc.

The main component of this technology are process sheets for each subsystem. The first column of each sheet lists the design stages that were rationalized above; following columns list the tasks of each stage, the nature of activity of each design subject, and the result that was achieved after completing the task, which is prepared by trained designers.

Results of Experimental Work

As noted above, measurement materials (questionnaires and tests) and assessment criteria that were systematized in scoresheets were developed for the collections of data for the assessment of the quality of each object. Obtained data were treated using specially developed electronic tables.

Experimental work on the implementation of the design technology for a higher education quality assurance system based on the EFQM model was done at the Kazakh Leading Academy of Architecture and Civil Engineering (KAZGASA), the Kazakh-American University (KAU), and the S. Seifullin Kazakh Agrotechnical University (KATU).

In accordance with the described methods, the general conclusion regarding the formation of learning motivation was based on the analysis of the interconnection between the general attitude to learning and the formation of learning motivation. High level of general attitude to learning and prevalence of cognitive motives of learning corresponded to the high level. Moderate level of general attitude to learning and prevalence of social motives of learning corresponded to the moderate level. Low level of general attitude to learning and prevalence of social motives of learning corresponded to the low level (the overall prevailing motive is "avoidance of trouble").

An employer survey was carried out to determine the requirements set by employers to graduates and to investigate the image of graduates of said higher educational institutions on the labor market. The treatment of answers to the question: "Which professional knowledge and personal qualities, in your opinion, do the graduates that come to your company lack?" showed that the graduates of the three higher educational institutions were

Percentage of respondents who distinguished the following indicators
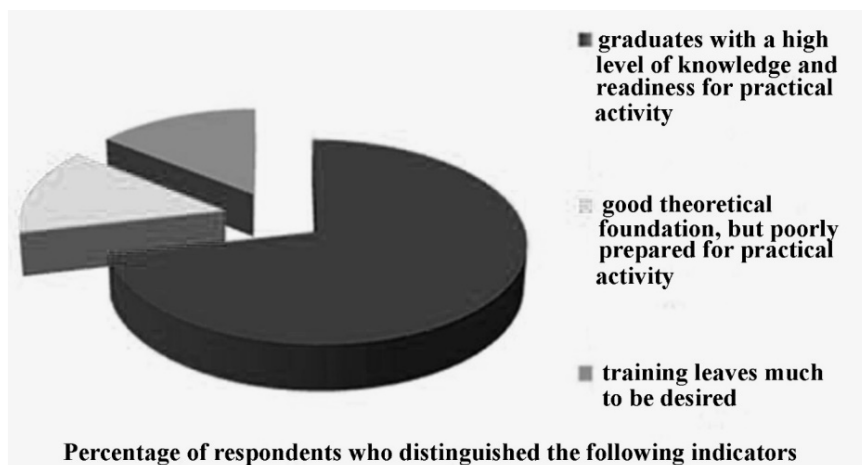
Figure 3. Illustration of the image of S. Seifullin Kazakh Agrotechnical University graduates

insufficiently prepared for practical activity, lacked independence and initiative (this concerns the graduates of the Kazakh Leading Academy of Architecture and Civil Engineering), understanding of the actual demands of the market (this concerns the graduates of the Kazakh-American University), and theoretical knowledge (this concerns the graduates of the S. Seifullin Kazakh Agrotechnical University).

When answering the question "What, in your opinion, is the image of graduates on the labor market?", most respondents identified them as "graduates with a high level of knowledge and readiness for practical activity" (**Figure 3** shows an example).

Since the method for assessing personnel that was used in this study is more suitable for assessing company personnel, the significance factors of questionnaire indicator had to be recalculated to assess the quality of personnel via group expert assessment. The experts determined the specific gravity (significance) of attributes of professional and personal qualities as follows (**Table 3**):

Table 3. Adjusted specific gravity of attributes of professional and personal qualities in teachers

Attributes of professional and personal qualities	Specific gravity
professional competency – in-depth knowledge in a special field, pedagogical mastery	0.226
recognition of responsibility for the quality of students' independent work and academic achievements	0.164
ability to organize and plan activity in a clear manner	0.165
ability to perform one's functions independently	0.169
activity and initiative in learning new computer and information technologies	0.163
ability to maintain a high working ability in extreme conditions	0.115

The investigation of personnel quality by the example of several departments showed that a significant part of the academic staff were professionally competent – they had in-depth knowledge in a special field and pedagogical mastery (74.4% of teachers had above-average or average indices). The problem lies in activity and initiative in learning new computer and information technologies, the average index whereof is lower than other indices. A profile of each teacher's professional and personal qualities was built based on obtained data with regard to the data from **Table 3**. **Figure 4** shows an example of a profile of an MOV teacher with the highest indices.
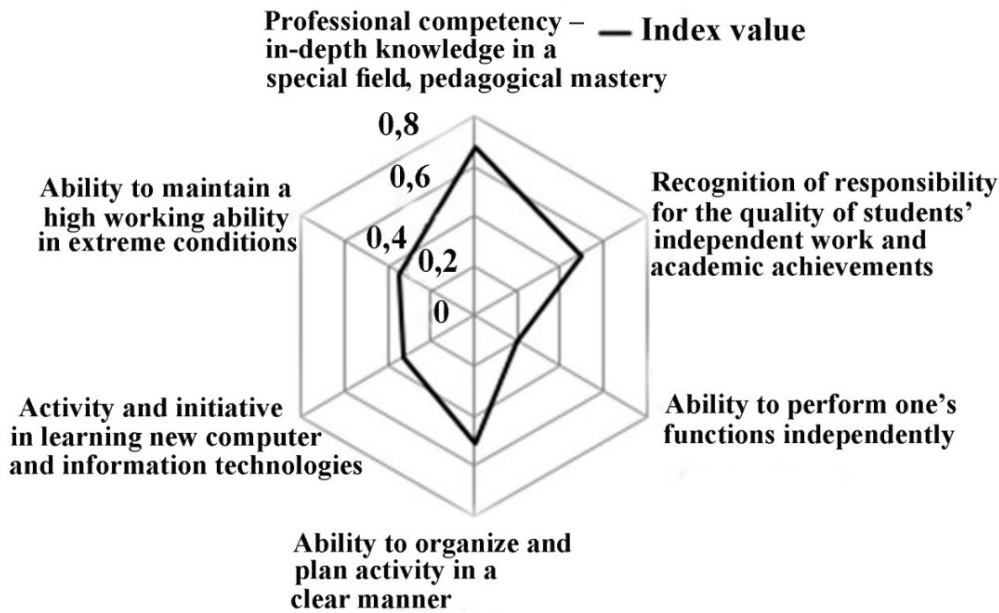
Figure 4. Profile of an MOV teacher
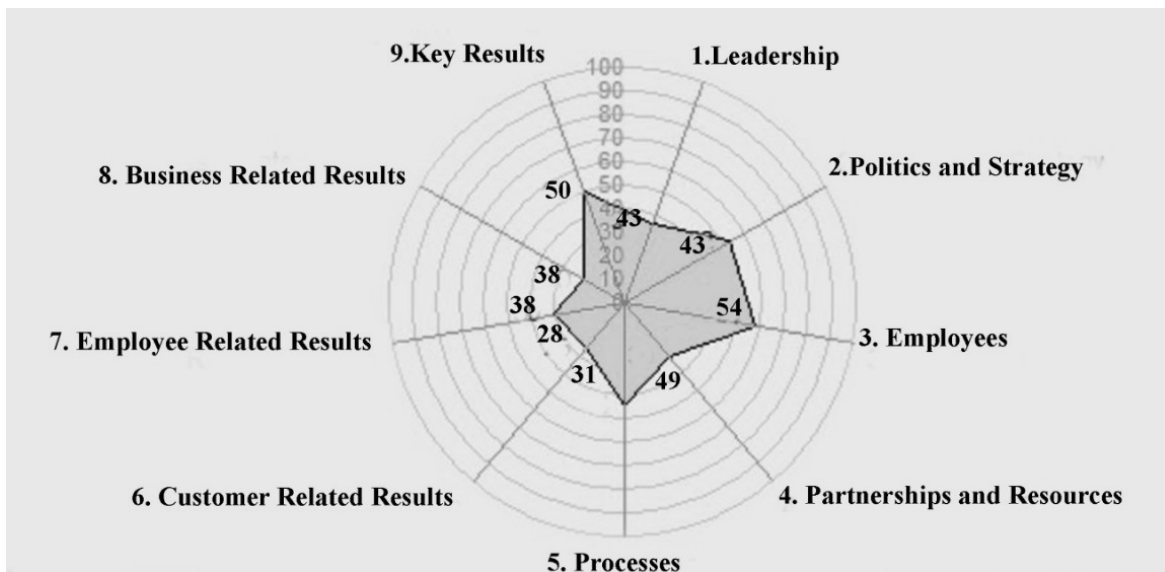
Figure 5. Results of activity of the S. Seifullin Kazakh Agrotechnical University

Investigation of the quality of educational facilities at the teachers' disposal showed that it was assessed at 3.43 points out of 5 on average. The survey included 97 teachers, according to whom, the greatest weakness of educational facilities was the educational equipment.

The results of customer related, employee related, and business related activities and key results of higher educational institutions were prepared using special software and presented in the form of a diagram (**Figure 5**).

The analysis of the quality of the educational technology showed that only 50.8% of teachers consolidated and tested knowledge in practice in simulation forms (planned games, roleplay); teachers did not plan or prepare parts of classes with students (**Table 4**).

Table 4. Results of analysis of the quality of the educational technology

Criteria that are indicative of a good planning of classes	Percentage of students that noted the presence of the criterion
1) Class plans are in line with the goals of the discipline and occupational training.	71.9
2) Goals and requirements (criteria of successfulness) of classes are clearly formulated.	74.4
3) Learning forms often change.	47.9
4) Sufficient time is devoted to questions and discussions.	71.5
5) Learning of facts comes after the understanding of higher principles and regularities.	61.8
6) Knowledge is consolidated and tested in practice in simulation forms (planned games, roleplay).	50.8
7) Students' needs are taken into consideration in the academic goals of classes.	65.3
8) Students are treated as partners that bear responsibility for learning and understanding.	70.1
9) Students are actively involved in the planning and realization of classes.	53.2
10) Parts of classes are prepared and formed by students (together with the teacher).	2.78
11) Planning facilitates active forms of learning and reciprocal learning of students.	64.3
12) Supplementary learning materials, textbooks, and visual aids are professionally orientated.	69.5

DISCUSSION

In order to assess the obtained results in terms of goal achievement, it is necessary to find out if the developed technology matches the set validity criteria.

As was shown above, the model of design of the higher education quality assurance system has a modular structure and is qualimetric and diagnostic. Assessment is an integral part of any quality assurance system, since in order to manage any process it is first necessary to be able to measure its parameters. Without quantitative assessments of quality, it is impossible to study the informational aspects of the product quality problem. Based on the above, it is stressed that the design technology for a higher education quality assurance system based on the EFQM model meets the criteria of construct validity. It is worth noting that probability-based design is used for such systems, since the two theorems regarding the incompleteness and consistency of formal systems, proven by K. Gödel (2010) and the principle of uncertainty of humanities systems, formulated by M. Archer (2013) allow concluding that the uncertainty will be significant in the design of social, including educational, systems.

We built a matrix of functions, criteria, and indices of higher education quality used in the European educational space, in which each function of the higher education quality assurance system used in the European educational space correlated with certain criteria and indices. This correlation was discovered for the first time in Kazakh pedagogical science. At the same time, this matrix has its flaws: the functions, criteria, and indices of the quality assurance systems are presented incompletely, some phrasings of indices are vague. However, the latter is not the fault of the authors, but rather of the creators of standards that this study was based on. Fortunately, this circumstance is taken into account in EURASHE, which reviewed the Standards and guidelines for quality assurance in the European Higher Education Area (ESG) with the involvement of a wide range of experts, with a view to making changes.

In the developed design technology for a higher education quality assurance system based on the EFQM model, each preliminary stage is intended to achieve its specific goal in a way that would give a real opportunity to proceed to the completion of tasks of the following stage; at that, the results of each stage are documented, thus extending and enhancing the results of the previous stage. The final results of the work are largely determined by the interconnection of results obtained at individual stages of the work. Hence, the technology provides criterion validity.

The content validity is confirmed using the data of experimental work. Examples for all indices are presented below. In addition, **Figure 6** shows the results of the activity of the S. Seifullin Kazakh Agrotechnical University.
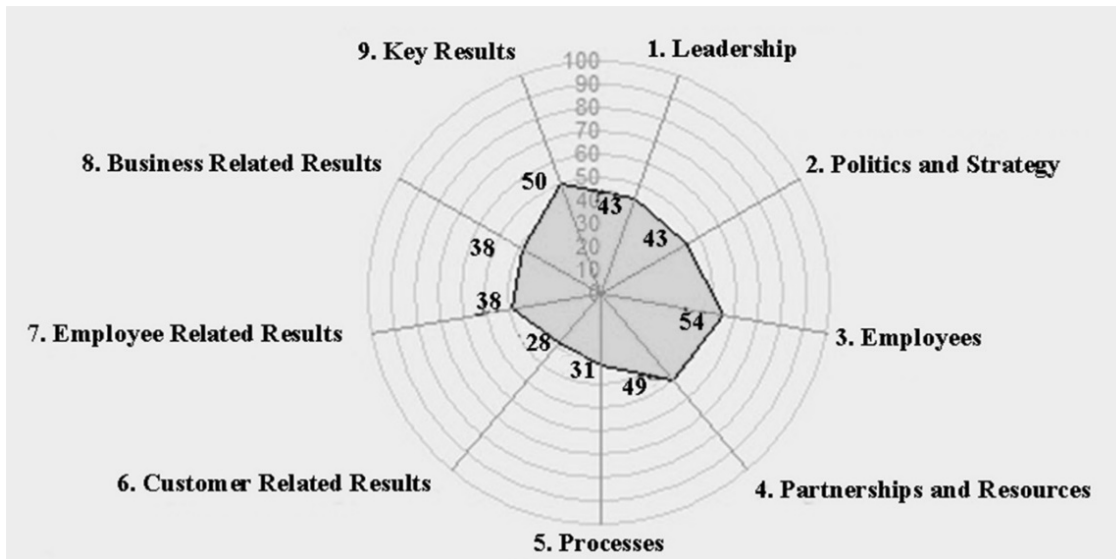
Figure 6. Results of the activity of the S. Seifullin Kazakh Agrotechnical University

When comparing this diagram to the one presented in **Figure 5**, one can see no significant differences between the indices of the two higher educational institutions. The trend of low "Customer Related Results", "Employee Related Results", and "Business Related Results" is noted. This trend is related to the fact that Kazakhstan does not pay enough attention to the integration of higher educational institutions and business, while the low customer and employee related results are caused not by the fact that higher educational institutions do not realize the importance of this category, but by the fact that the data were obtained from institution accreditation reports, which were prepared by Kazakh accreditation agencies, the standards whereof, unlike the EFQM model, lack these indices. The EFQM model assesses the *presence of evidence* for each component according to standards:

- no evidence or random evidence – 0
- some evidence – 25%
- evidence – 50%
- obvious evidence – 75%
- exhaustive evidence – 100%.

Table 5 presents a comparison of the main indices of experimental work among the three higher educational institutions.

The level of the learning motive in the Table was separated from the social, position, assessment, and game motives, considering the importance of cognitive motives. The quality of personnel was also shown via the most important criteria and mean data. The quality of the educational technology was shown via the largest and smallest data, as well as by mean data.

The presented data show that the results are mostly similar, with only the level of learning motives among Kazakh Leading Academy of Architecture and Civil Engineering students being higher than that of students of other higher educational institutions. This is caused by the fact that agrarian specialties are not in demand; they are usually enrolled into by poorly trained enrollees; the Kazakh-American University is a private university, which is why its status also affects the image of the higher educational institution. The presence of the "approximately identical level of designers" parameter is confirmed by the fact that each group that realized the project had managers of structural units – experienced teachers. The level of skills of experts that were involved in obtaining raw data was identical: 95% of experts had PhD and Sc.D. degrees.

To sum up, quality in higher education is regarded as not a uni-dimensional concept and is in fact best described as a set of dimensions. Thus, V. Teeroovengadum, T. Kamalanabhan & A. Seebaluck (2016) believe it is relevant to adopt the dimensions of the SERVQUAL model, which proposes five dimensions, namely, responsiveness, assurance, tangibles, empathy and reliability. An important problem to be solved is that most models including the SERVQUAL model take into account only the element of functional quality and neglect the technical quality aspect, including the case in the higher education context (Kang, 2006).

Table 5. Main indices of the experimental work, compared across the three higher educational institutions

Indices		KAU	KAZGASA	KATU
Percentage of students with a high level of learning motive		10.0	17.68	11.66
Problems in specialist training (percentage of employers that noted this index)	Lack of basic theoretical knowledge	33.3	10	29
	Poor readiness for practical activity	66.7	50	29
	Poor understanding of the actual needs of the company and the labor market	33.3	10	21
Graduate characteristic (percentage of employers that noted this index)	Graduates with a high level and readiness for practical activity	0	30	14.1
	Good theoretical basis, but insufficient readiness for practical activity	66.7	50	70.5
Personnel quality (points out of the maximum 3)	Professional competency	2.7	2.7	2.6
	Recognition of responsibility for the quality of students' independent work and academic achievements	2.1	2.0	1.7
	Mean index	1.93	2.15	1.83
Quality of educational facilities (points out of the maximum 5)		2.97	3.33	4.0
Educational technology quality (percentage of students that noted this criterion)	Class plans are in line with the goals of the discipline and occupational training	86.0	85.6	76.5
	Parts of classes are prepared and formed by students (together with the teacher)	0	6.0	2.35
	Mean data	69.36	62.9	65.9

CONCLUSIONS

The analysis of the prospects for the development of education in the Republic of Kazakhstan allowed concluding that in conditions of autonomy, higher educational institutions should adjust their quality assurance mechanisms and switch from the coercion model to the improvement model – the EFQM model.

The developed theoretical and methodological framework of system design enabled rationalizing the design technology. Its implementation implied a close interaction between developers and designers and the presence of a clear method for collecting empirical data. Before the technology could be recommended for use in the practice of higher educational institutions, its validity had to be confirmed.

This confirmation resulted from the completion of the following tasks: determine the validity criteria for the developed technology; show that the developed technology met the validity criteria.

The completion of these tasks determines the novelty of this study, since, for the first time in Kazakhstan, not only design technology for a higher education quality assurance system was developed, but also the possibility of its realization was proven.

This predetermines the practical significance of the study: higher educational institutions can use its results independently to design a higher education quality assurance system based on the EFQM model or develop their own technologies with regard to the peculiarities of the institution.

Another important result of this study is that it distinguished three directions, in which the validity of a technology should be confirmed. At that, it produced a theoretical result: it substantiated the criterion that is applicable to technological processes in a pedagogical system. This determines this study's contribution to the theory of pedagogical validation.

Thus, based on the above, the conclusion is that the construct, criterion, and content validity of the design technology for a higher education quality assurance system based on the EFQM model was confirmed, i.e. the goal of the study was achieved.

It is pertinent to point out that this research can be regarded as basis for further investigations on higher education quality assurance. Thus, it is possible to compare the results obtained after the implementation of the described system both in technical and humanitarian universities. Moreover, it would be interesting to describe the features of ISO 9001:2001 model in developing countries and countries with the highest level of state social protection and development.

ABBREVIATIONS

ISO – International Organization for Standardization

EFQM **-** European Foundation for Quality Management

ACKNOWLEDGEMENT

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Analysis of Students' Learning Satisfaction in a Social Community Supported Computer Principles and Practice Course

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ABSTRACT

The study compares the learning satisfaction of two student groups, one takes the fully online course–Introduction to Internet of Things, and the other takes the small private online course (SPOC). In the research framework, learning satisfaction is the dependent variable, and learning engagement, learning presence, video perception, platform perception, and design perception are independent variables. This work adopts online questionnaire survey to collect data from the two student groups. As to research method, Multiple Regression Analysis (MRA) is utilized to test proposed research framework. The results of MRA show that platform perception generates students' learning satisfaction for SPOC, while video perception and design perception generate students' learning satisfaction for fully online course. This empirical study elucidates the factors influence learner's satisfaction and contributes to theory and practice in the domains of online courses.

Keywords: learning satisfaction, Small Private Online Course (SPOC), fully online course, Multiple Regression Analysis (MRA)

INTRODUCTION

The paradigm shifts from Massive Open Online Courses (MOOCs) to Small Private Online Courses (SPOCs) in the past three years. Oremus (2013) writes a review titled as "forget MOOCs" and claims that free online classes should not replace teachers and classrooms, and they should make them better. Regardless of the different teaching model, learning satisfaction is still the most significant concern in the fields of education. Therefore, this study investigates the factors influence students' learning satisfactions.

Following the introduction, Section 2 presents a review of the relevant literature and proposes the hypothesis to be tested. Section 3 introduces the research method. Section 4 presents the data analysis. Section 5 gives the conclusion of the study.

LITERATURE REVIEW

Researches on learning satisfaction are very much. When one research explores learner, instructor, course, technology, design, and environmental dimensions affect learners' satisfaction (Sun, Tsai, Finger, Chen, & Yeh, 2008), the other investigates the relationship among collaborative learning, social presence, and satisfaction (So & Brush, 2008). This study expects to integrate any related factor in the research framework. Therefore, this study presents SPOCs first, then reviews the relevant literature on each dimension.

Contribution of this paper to the literature

- This empirical study elucidates the factors influence learner's satisfaction and contributes to theory and practice in the domains of online courses.
- The results show that platform perception generates students' learning satisfaction for the SPOC, while video perception and design perception generate students' learning satisfaction for fully online course.
- An important implication for educators is that in addition to promote students' platform perception, enhancing video and design perceptions are also significant tasks.

SPOCs

To solve the low completion rates of MOOCs, Fox who is a professor at Berkeley University of California proposed SPOCs in 2013. As opposed to MOOCs, this model advocate that if MOOCs are used as a supplement to classroom teaching rather than being viewed a replacement for it, they can increase instructor leverage, student throughput, student mastery, and student engagement (Fox, 2013). The approach is also known, less acronymically, as "hybrid" or "blended learning" (Oremus, 2013). SPOCs is characterized by improving teaching effectiveness (Wang, Wang, Wen, Wang, & Tao, 2016). The teaching model of SPOCs is based on the high-quality video content of MOOCs. Students can understand the basic knowledge of a subject before the class. Thus, teachers can practice high-level teaching content, answer questions, or offer other exercises and extra learning materials in the entity classroom to create a complete learning experience.

Learning Engagement

Sun and Rueda (2012) have a clear statement of definition: "In academic settings, engagement refers to the quality of effort students make to perform well and achieve desired outcomes". According to past research, learning engagement is related to students' learning outcomes, learning satisfactions, school identity, and future development (Carini, Kuh, & Klein, 2006; Hu, Kuh, & Li, 2008; Zhao & Kuh, 2004). Fredrick, Blumenfeld, and Paris (2004) identify three types of engagement: behavioral, emotional and cognitive engagement. Fredricks, Blumenfeld, and Paris (2004) outline three different ways that behavioral engagement has been defined, including positive conduct (e.g., following the rules, attendance, absence of disruptive behavior), involvement in learning and academic tasks (e.g., effort, persistence, concentration, and attention), and involvement in school-related activities. Emotional engagement refers to students' affective reactions in the classroom, including interest, boredom, happiness, sadness, and anxiety (Connell & Wellborn, 1991; Skinner & Belmont, 1993). Cognitive engagement, which refers to the level of thinking skills used by students (Blumenfeld, Puro, & Mergendoller, 1992; Corno & Rohrkemper, 1985), incorporates thoughtfulness and willingness to exert the effort necessary to comprehend complex ideas and master difficult skills (Fredricks, Blumenfeld, & Paris, 2004). In other words, cognitive engagement involves self-regulation or being strategic (Fredricks, Blumenfeld, & Paris, 2004). Sun and Rueda (2012) suggest that online activities and tools such as multimedia and discussion boards may increase emotional engagement in online learning, although they do not necessarily increase behavioral or cognitive engagement.

Learning Presence

To define the functioning of this community of inquiry, Garrison, Anderson, and Archer (2000) propose three overlapping elements—social presence, cognitive presence, and teaching presence. They suggest that all three elements are essential to a critical community of inquiry for educational purposes, and they can enhance or inhibit the quality of the educational experience and learning outcomes. Shea and Bidjerano (2010) suggest that learning presence represents elements such as self-efficacy as well as other cognitive, behavioral, and motivational constructs supportive of online learner self-regulation. Cognitive presence means the extent to which the participants in any particular configuration of a community of inquiry can construct meaning through sustained communication, and it is a vital element in critical thinking, a process, and outcome that is frequently presented as the ostensible goal of all higher education (Garrison, Anderson, & Archer, 2000). Short, Willams, and Christie (1976) define social presence as the "degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships". It means the degree to which a person is perceived as a "real person" in mediated communication. Anderson, Liam, Garrison, and Archer (2001) define teaching presence as the design, facilitation, and direction of cognitive and social processes to realize personally meaningful and educationally worthwhile learning outcomes. The three categories of teaching presence are design and organization, facilitating discourse, and direct instruction.

Video Perception

According to the past research, the video is deemed as the strong learning media. Yousef, Chatti, and Schroeder (2014) claim that video-based learning (VBL) has unique features that make it an effective Technology-Enhanced Learning (TEL) approach. Zhang, Zhou, Briggs, and Nunamaker (2006) discover that students in the e-learning environment that provided interactive video achieved significantly better learning performance and a higher level of learner satisfaction than those with non-interactive video, without video, and traditional classroom environment. Guo, Kim, and Rubin (2014) find that shorter videos, informal talking-head videos, Khan-style tablet drawings are more engaging, and that students engage differently with lecture and tutorial videos.

Platform Perception

The use of discussion forums is found to correlate with better student grades and higher student retention (Coetzee, Fox, Hearst, & Hartmann, 2014). Besides discussion forum, there are lots of resources and functions on any MOOCs platform, such as lecture videos, presentation slides, exercises, online group discussion, instant interaction with teacher and teaching assistant, cloud-tutoring. After using the platform, learners would form their perceptions. For example, the function is helpful to their learning or not. This dimension is to explore students' perceptions towards the platform.

Design Perception

In Sun, Tsai, Finger, Chen, and Yehs' study (2008), perceived usefulness and perceived ease of use are proved to influence learner satisfaction. They are together affiliated to the design dimension. Cheung and Vogel (2013) find that perceived ease of use and perceived usefulness are found to influence the attitude of students toward the collaborative technology. Perceived ease of use predicts usefulness and is found to be a stronger predictor of attitude than perceived usefulness.

Learning Satisfaction

Many researchers emphasize that satisfaction is one of the most important factors determining the quality of online instruction (Allen & Seaman, 2010; Garrison & Cleveland-Innes, 2005; Moore & Kearsley, 2012). So and Brush (2008) indicate that student perceptions of collaborative learning have statistically positive relationships with perceptions of social presence and satisfaction through the analysis of quantitative data, and find that course structure, emotional support, and communication medium are critical factors associated with student perceptions of collaborative learning, social presence, and satisfaction through interview data.

This study generalizes that positive learning engagement, learning presence, video perception, platform perception, and design perception can most likely have high learning satisfaction. The five factors operate together for generating great learning satisfactions. Therefore, the study proposes the following hypothesis.

H1. Learning engagement, learning presence, video perception, platform perception, and design perception in combination to generate students' high learning satisfactions.

RESEARCH METHOD

Research Framework

The study explores the relationship among learning engagement (LE), learning presence (LP), video perception (VP), platform perception (PP), design perception (DP), and learning satisfaction (LS). Learning satisfaction is the output variable, and learning engagement, learning presence, video perception, platform perception, and design perception are potential causes. The research framework is as **Figure 1**.
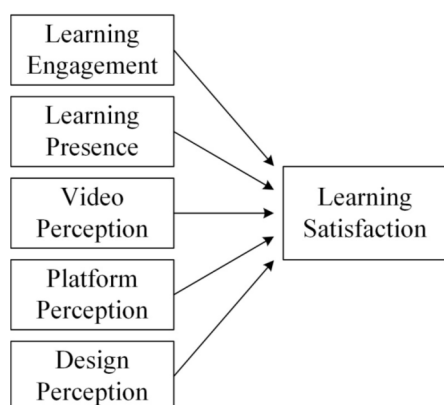
Figure 1. Research framework

Context and Participants

There are some popular MOOCs platforms: ShareCourse, ewant, TaiwanLIFE, OPENEDU, etc. Here, this study takes the course – Introduction to Internet of Things (IoT) on ShareCourse for example. The participants of this study consist of two groups. One group takes the fully online course, and the other group takes the online course collocating with Personal Computer Principles and Practice course for freshman students. The 18-hour online course includes six topics: IoT architecture and applications, sensor/network/application technologies, sensor node platforms, routing protocols for sensor networks, wireless communication technologies for IoT, and IoT framework and standards. Sudents watch the video first, and the teacher would lead following discussions and create some learning activities in the class. After finishing all the topics, students should fulfill the online self-assessment and take an online exam. After class activities include an online quiz, discussion, group learning, etc. The blended learning strategy is expected to enhance students' learning satisfactions. Students taking the fully online course would be the control group. The study would compare the two groups for advanced understanding of the impact of different learning strategies on learning satisfaction.

Measures

The study includes six dimensions, learning engagement (behavioral engagement, emotional engagement, and cognitive engagement), learning presence (teaching presence, social presence, and cognitive presence), video perception, platform perception, design perception, and learning satisfaction. The measurement, referring to previous studies and emending to fit this study, is as follows.

Learning Engagement (LE) (References: Sun & Rueda, 2012)

(1) Behavioral engagement
    1) I follow the rules of the online course.
    2) When I am in the online course, I just 'act' as if I am learning.
    3) I can consistently pay attention when I am taking the online course.
    4) I complete my homework on time.

(2) Emotional engagement
    1) I like taking the online course.
    2) The online classroom is a fun place to be.
    3) I am interested in the work at the online course.
    4) I feel happy when taking an online course.

(3) Cognitive engagement
    1) I check my schoolwork for mistakes.
    2) I study at home even when I do not have a test.
    3) I try to look for some course-related information on other resources such as television, journal papers, magazines, etc.

4) When I read the course materials, I ask myself questions to make sure I understand what it is about.

5) If I do not know about a concept when I am learning in the online course, I do something to figure it out.

6) If I do not understand what I learn online, I go back to watch the recorded session and learn again.

7) I talk with people outside of school about what I am learning in the online course.

Learning presence (LP) (References: Shea & Bidjerano, 2010)

(1) Teaching presence

   I.   Design & Organization

      1) The instructor clearly communicates important course topics.

      2) The instructor clearly communicates important course goals.

      3) The instructor provides clear instructions on how to participate in class learning activities.

      4) The instructor clearly communicates relevant due dates/time frames for learning activities.

   II. Facilitation

      1) The instructor is useful in guiding the class towards understanding course subjects in a way that helps me clarify my thinking.

      2) The instructor contributes to keep course participants engaged and participating in the productive dialogue.

      3) The instructor helps maintain the course participants on the task in a way that helps me to learn.

      4) The instructor encourages course participants to explore new concepts in this course.

      5) The instructor encourages course participants to explore new concepts in this course.

   III. Direct instruction

      1) My instructor provides useful illustrations that help make the course content more understandable to me.

      2) My instructor presents helpful examples that allow me to better understand the content of the course.

      3) My instructor provides clarifying explanations or other feedback that allow me to better understand the content of the course.

(2) Social presence

   I.   Affective expression

      1) Getting to know other course participants gives me a sense of belonging in the course.

      2) I can form distinct impressions of some course participants.

      3) Online or web-based communication is an excellent medium for social interaction.

   II. Open communication

      1) I feel comfortable conversing through the online medium.

      2) I feel comfortable participating in the course discussions.

      3) I feel comfortable interacting with other course participants.

   III. Group cohesion

      1) I feel comfortable disagreeing with other course participants while still maintaining a sense of trust.

      2) I believe that my point of view is acknowledged by other course participants.

      3) Online discussions help me to develop a sense of collaboration.

(3) Cognitive presence

   I.   Triggering event

      1) Problems posed increase my interest in course issues.

      2) Class activities pique my curiosity.

      3) I feel motivated to explore content related questions.

   II. Exploration

      1) I utilize a variety of information sources to explore problems posed in this course.

      2) Brainstorming and finding relevant information help me resolve content related questions.

      3) Online discussions are valuable in helping me appreciate different perspectives.

III. Integration

   1) Combining new information help me answer questions raised in course activities.

   2) Learning activities help me construct explanations/solutions.

   3) Reflection on course content and discussions help me understand fundamental concepts in this class.

IV. Resolution

   1) I can describe ways to test and apply the knowledge created in this course.

   2) I have developed solutions to course problems that can be applied in practice.

   3) I can implement the knowledge created in this course to my work or other non-class related activities.

Video perception (VP) (References: Guo, Kim, & Rubin, 2014)

1) I engage more with shorter videos.

2) I engage more with talking-head videos.

3) I engage more with pre-production videos.

4) I engage more with videos where instructors speak faster.

5) I engage more with lecture videos where the first-time watching experience is optimized.

Platform perception (PP) (Resources: Self-developed)

1) The presentation slides are helpful for my learning.

2) The exercises before or after videos are useful to my learning.

3) The discussions on the forum are helpful to my learning.

4) The online group discussions are helpful to my learning.

5) The instant interactions with the teacher and teaching assistant are useful to my learning.

6) The cloud-tutoring is helpful to my learning.

Design perception (DP) (Resources: Sun, Tsai, Finger, Chen, & Yeh, 2008)

(1) Perceived usefulness

   1) Using the platform would enhance my effectiveness in the course.

   2) Using the platform would improve my performance in the course.

   3) I would find the platform useful in the course.

(2) Perceived ease of use

   1) It would be easy for me to become skillful at using the platform.

   2) Learning to operate the platform would be easy for me.

   3) I would find it easy to get a platform to do what I want it to do.

   4) I would find it easy to get a platform to do what I want it to do.

Learning satisfaction (LS) (References: So & Brush, 2008)

1) As a result of my experience with this course, I would like to take another online course in the future.

2) This course is a useful learning experience.

3) My level of learning that takes place in this course is of the highest quality.

4) My level of learning that takes place in this course is of the highest quality.

5) Overall, the instructor for this course meets my learning expectations.

6) Overall, this course meets my learning expectations.

The respondents are requested to indicate the extent to which they agree or disagree on those questions above, based on their experience. For each item, five-point Likert scales are utilized (1 = strongly disagree and 5 = strongly agree). The last part of the questionnaire is demographic questions, including gender, grade, and experience of online course.

Table 1. Multiple regression models predicting learning satisfaction—SPOC

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.914[a]	.836	.812	.33168

a. Predictors: (Constant), DP, LP, LE, PP, VP

Anova[b]						
	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.595	5	3.919	35.624	.000[a]
	Residual	3.850	35	.110		
	Total	23.446	40			

a. Predictors: (Constant), DP, LP, LE, PP, VP
b. Dependent Variable: LS

Coefficients[a]					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	-.403	.391		-1.030	.310
LE	.115	.169	.089	.680	.501
LP	.067	.170	.053	.395	.695
VP	.256	.240	.209	1.063	.295
PP	.754	.181	.674	4.156	.000
DP	-.088	.222	-.073	-.397	.694

a. Dependent Variable: LS

DATA COLLECTION

Web-based questionnaire survey is executed to collect data. The questionnaire is carried out on Google docs. The respondents consist of two groups: one is students taking the fully online course—Introduction to IoT, the other is students of SPOC. The blended course is online course collocating with Personal Computer Principles and Practice course. The sample is 43 for the former, and 41 for the later.

DATA ANALYSIS

The study first runs the descriptive analysis towards the demographic data using SPSS. For the SPOC, about gender, male is 75.6%, and female is 24.4%. About grade, freshman is the most, 95.1%; junior and senior are 2.4% respectively. About the experience of taking online course, one course is the most, 70.7%; two courses is the runner-up, 22.0%; more than three courses is the least, 7.3%. For the fully online course, about gender, male is 83.7%, and female is 16.3%. About grade, freshman is the most, 95.3%, and junior is 4.7%. About the experience of taking online course, one course is the most, 60.5%; two courses is the runner-up, 23.3%; more than three courses is the least, 16.3%.

Then, the study adopts Multiple Regression Analysis (MRA) to test the research framework. MRA is a symmetric test that elucidates the "net effects" of variables on a dependent variable with a set of independent variables (Woodside, 2014). MRA would come out some causes that are significant and responsible for high learning satisfactions. **Table 1** and **2** include MRA findings for predicting learning satisfaction in the SPOC and the fully online course separately. The study enters all five variables to verify the framework. For the SPOC, R^2 is 0.836, and adjusted R^2 is 0.812, standing for 81.2% variation in Y explained by X. The model is significant in Anova analysis. The β values are 0.089, 0.053, 0.209, 0.674, -0.073 for LE, LP, VP, PP, and DP, but only PP is significant (p=0.000). No collinarity exist because the VIF is between 3.670 and 8.251.

For the fully online course, R^2 is 0.857, and adjusted R^2 is 0.838, standing for 83.8% variation in Y explained by X. The model is significant in Anova analysis. The β values are -0.098, 0.245, 0.256, 0.213, 0.392 for LE, LP, VP, PP, and DP, but only VP and DP are significant (p=0.021 and 0.002). No collinarity exist because the VIF is between 2.945 and 8.087.

Table 2. Multiple regression models predicting learning satisfaction—fully online course

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.926[a]	.857	.838	.29412

a. Predictors: (Constant), DP, PP, VP, LE, LP

Anova[b]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	19.257	5	3.851	4.519	.000[a]
	Residual	3.201	37	.087		
	Total	22.457	42			

a. Predictors: (Constant), DP, PP, VP, LE, LP

b. Dependent Variable: LS

Coefficients[a]					
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
1 (Constant)	-.290	.318		-.913	.367
LE	.105	.136	-.098	-.772	.445
LP	.254	.183	.245	1.385	.174
VP	.281	.117	.256	2.404	.021
PP	.204	.131	.213	1.558	.128
DP	.439	.133	.392	3.294	.002

a. Dependent Variable: LS

CONCLUSION

The study executes an online questionnaire survey, adopts MRA to test the proposed framework for learning satisfaction. The results of MRA show that platform perception generates students' learning satisfaction for the SPOC, while video perception and design perception generate students' learning satisfaction for fully online course. Learning engagement and learning presence are not significant for generating high learning satisfaction. The possible reasons may be that students' backgrounds are computer science and information engineering and they are not used to social communication. Therefore, the social interaction in the course is not favorable, and their focuses are still on the video, platform, and platform design only.

The findings illustrate that platform perception for the SPOC, video perception and design perception for fully online course, are more direct than learning engagement and learning presence to generate students' learning satisfaction. This is an important implication for educators that in addition to promote students' platform perception, enhancing video perception and design perception are also significant tasks. For SPOCs, educators can make effort on presentation slides, the exercises before or after videos, the discussions on the forum, the online group discussions, the instant interactions with students, and the cloud-tutoring. For fully online courses, educators can devote to make shorter, talking-head, instructors speaking faster, optimizing first-time watching experience, and re-watching and skimming videos. In addition, to strengthen the perceived usefulness and perceived ease of use of the platform is very crucial for learning satisfaction.

Inevitably, the study has a limitation. The limitation is that participants are almost freshmen, and the proportions of two groups are both up to 95%. Comparing to other older students, their experiences of taking courses are not enough. Maybe this is the reason that learning engagement and learning presence are not significant for generating learning satisfaction. In conclusion, there are two suggestions for future research. First, researchers can choose other grades, departments, or courses to test the proposed research framework to see if the result is different. Then, is there any dimension not included in the framework affecting students' learning satisfaction? Researchers can try to discover these dimensions. The achievement of this study is expected to contribute to the academic research. The study explores the factors impact on students' learning satisfaction, and the result can offer reference for academic research on technology education. Furthermore, the research results can be applied to the practice and supply a great help to the educators.

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Optimization of the Subject Matter of Profile Training Disciplines for Bachelors' Vocational Education on the Basis of Occupational Standards

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ABSTRACT

Applicability of the issue under study is conditioned by the need in development of principal educational programs by higher education institutions with accounting for requirements of appropriate occupational standards and necessity in reviewing of the requirements of occupational standards and reflecting them within the scope of competences formed. The paper is aimed at substantiation of the subject matter of profile training disciplines for vocational education of bachelors within the context of competence and process approaches and with accounting for occupational standards. The leading method of study of this issue is modeling which allows considering the issue under study as a process of recognized accounting of requirements of appropriate occupational standards wherein employers' opinions are fixed in the regulatory mode. The structural-functional model of selection of the subject matter of profile disciplines for the training program is developed; the following algorithms are developed: 1) of analysis of occupational standards; 2) of comparing of occupational standards with curriculum disciplines; 3) of analysis of the subject matter of labour functions, labour actions, knowledge and skills when developing working programs and assessment resources funds; the model has been successfully tested on the example of profile training of vocational education bachelors. The paper presents the structure-functional model of selection of the subject matter of profile disciplines of the educational program with taking into account of occupational standards requirements which define competences acquired by a graduate, i.e. his/her ability to use knowledge, skills and personal qualities in accordance with the occupational activity; the process approach to implementation of this model is applied.

Keywords: bachelor, educational standard, process approach

INTRODUCTION

The Relevance of the Research

The following modifications of Federal Law "On education in the Russian Federation" are in effect from July 1, 2016: formation of requirements of federal state educational standards of vocational education (FSES) to results of acquisition of the principal educational program (PED) of vocational education in terms of professional competence shall be realized on basis of appropriate occupational standards (when available) (Federal Law on education…, 2012). In this connection, higher education institutions shall work out PED with taking into account requirements of respective occupational standards (OS). When working out PED, requirements of occupational standards should be analyzed and reflected within competences formed.

Contribution of this paper to the literature

- The structural-functional model of selection of the subject matter of profile disciplines of the bachelorship educational program has been developed, with accounting for requirements of occupational standards.
- Use of the process approach at developing of the model realization algorithms has been substantiated.
- It has been proved that use of the model will serve to the purpose of optimization of the subject matter of profile training at selecting didactic units of the curriculum on basis of requirements of occupational standards and further monitoring of competencies maturity.

For staff training in the higher education system, higher schools use FSES on basis whereof PEDs are developed. FSESs are worked out, approved and modified by Government of the Russian Federation (On entering changes in Labor Code…, 2015).

FSES is a collection of mandatory requirements to education of a certain level and/or to a profession, specialty and field of study approved by the federal body of executive authorities performing functions on formulation of the state policy and statutory regulation in the educational sphere (Federal Law on education, 2012).

PED is a complex of regulatory and guidance documentation which regulates the subject matter, arrangement and quality assessment of training of students and graduates in a certain specialty (Guzanov et al., 2015).

Objectives and Tasks of the study

This paper is aimed at substantiating of the subject matter of disciplines of training of vocational education bachelors in profile within the context of competency and process approaches with taking OSs in consideration. The following tasks were defined as major: analysis of OSs reflecting application aspects of training of vocational education bachelors in profile; theoretical elaboration of the model of selecting the subject matter of PED profile disciplines on OS basis; finding requirements to the subject matter of profile disciplines; experimental work on the model approbation.

LITERATURE REVIEW

To work out the PED efficiently, its general content and the content of the curriculum disciplines should be substantiated in a competent manner. It is evident that a new practice of PED working out is being formed in the educational process, when this or that certain practical problem corresponding to occupational activity types is put into the basis of scope of training, e.g. in papers of Dremina et al. (2016), Yefimova (2016), Shaidullina et al. (2015b), Cai et al. (2017).

New trends conforming to requirements of the modern educational process are becoming more and more discernable: pedagogical modeling, pedagogical monitoring and process approach in course of selection of PED content (Zeer et al., 2016; Dorozhkin et al., 2016; Shaidullina et al., 2015a; Konysheva & Ibragimova, 2017; Levina et al., 2017; Shushara & Khuziakhmetov, 2017; Cherdymova et al., 2017).

PED content in profile-oriented training of vocational education (VE) bachelors should be of complex character (Dorozhkin & Zeer, 2014) and allow a graduate to manifest readiness for performing occupational activities within FSES of VE bachelor training, and activities related to application aspects of the training which are defined by the profile and scopes singled out therein (Guzanov et al., 2016b). Topics of application aspects shall be determined by appropriate OSs.

In papers of Western specialists, the modern society is regarded as "learning" and featured with "permanent educational culture" (Field (USA), 2000). The need in constant upgrading of occupational competences, when knowledge are becoming obsolete rapidly, conditioned development of *Life Long Learning* concept which was widely spread in late 1990s. To basic trends of the educational policy of developed countries one may relate: development of specialists' motivation for training for the whole of their lives. Growing needs in pedagogical staff able to realize these educational functions is just a natural consequence of this phenomenon (Fominykh et al., 2016); here we can also note forming its social-occupational significance (Livingstone, 1999), formation of long-term perspective of occupational activity (Malikh et al., 2016). At the same time, we have to admit that the existing system of vocational-pedagogic education cannot properly provide high-quality training of teachers in knowledge-intensive and high-tech branches of economy (Zeer & Streltsov, 2016).

MATERIALS AND METHODS

Research Methods

In process of the research, the following methods were applied: theoretical method of modelling – in course of developing the structural-functional model of selection of the subject matter of the educational program profile disciplines; empirical method of studying of the experience of work of educational entities – for development of algorithms of (1) analysis of occupational standards, (2) comparing of occupational standards with curriculum disciplines; (3) analysis of the subject matter of labour functions, labour actions, knowledge and skills when developing working programs and assessment resources funds; experimental method (teaching experiment) – at the stage of approbation of the developed model and algorithms on the example of vocational training bachelors profile training; method of pedagogical observations – when setting the problem of a study; methods of analysis and generalization were also used when studying Russian and foreign scientific-pedagogical literature.

Research Experimental Facility

Federal State Autonomous Educational Institution for Higher Education "Russian State Vocational Pedagogical University"

Research Phases

The problem was researched in three stages:

At the 1st stage, theoretical analysis of OSs was performed which reflected application aspects of profile-oriented training of VE bachelors, analysis of FSESs which matched the training profile and existing methodological approaches in pedagogical special literature, as well as thesis papers in the problem and theories and techniques of pedagogical researches; the problem, target and methods of research were singled out and the experimental research plan was made up;

At the 2nd stage, theoretical elaboration was performed in relation to the OS-based model for selection of subject matter of profile-oriented curriculum disciplines. As a final result, requirements to the subject matter of profile-oriented disciplines were established which have to be considered when developing working programs and as items to be checked when working out assessment resources funds for assessing the conformance to requirements of occupational standards;

At the 3rd stage, an experimental work was performed aimed at approbation of the model on the example of training of VE bachelors in the profile "Machine-building and metal processing", scope "Certification, metrology and quality management in machine-building"; theoretical and practical results were specified, and the obtained results were generalized and systemized.

RESULTS

The Model Structure and Content

The proposed model is built with taking into account of the process approach points, according whereto the activity is represented as a total of interrelated process, where an "output" of a previous process is an "input" into the next one. The client's requirements shall be the starting point for a dedicated process execution, and, as a final result, satisfaction of requirements and consideration of potential changes in their scope shall be defined.

A package of profile-oriented formed competences defined on basis of interrogation of employers, and the list of disciplines of the PED curriculum are taken as the client's requirements.

As dedicated interrelated processes, the following are proposed:

1. Selection and analysis of occupational standards (OSs) related to the profile (dedicated scope) of training.
2. Comparison of OSs and integrated labor functions (ILF) with the curriculum disciplines (modules).
3. Analysis of the subject matter of OSs labor functions (LF), comparison of OS LFs with the curriculum disciplines (modules).
4. Analysis of the subject matter of working actions, skill and knowledge (WA, S & K) of OSs, detection of "reference units" for formation of the subject matter of training on the profile (dedicated scope) disciplines.
5. Development of working programs and resources funds for assessing on disciplines (modules) with considering of the OS requirements.
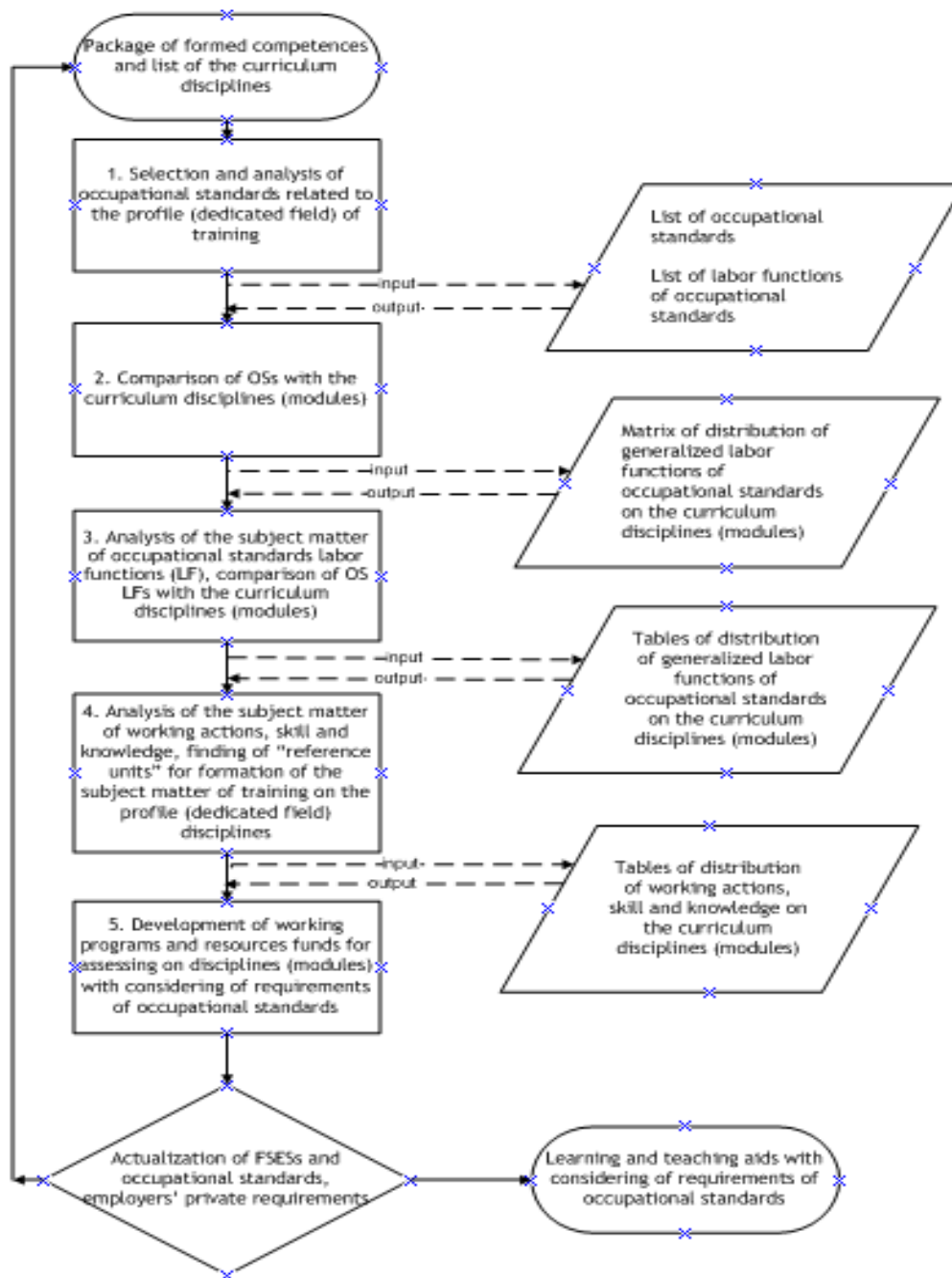
Figure 1. Stages of the model implementation

"Inputs" and "outputs" are defined for each process. To account for possible changes in scope of requirements, the activity on actualization of OSs and FSES shall be utilized. The developed model is shown in **Figure 1**.

Further on, let us consider utilization of the developed model in course of formation of the subject matter of profile-oriented training of VE bachelors in the profile "Machine-building and metal processing", scope "Certification, metrology and quality management in machine-building".

Bachelors are trained in various fields and profiles of training. A certain scope of training can be singled out within a profile. The list of fields of training of bachelors was approved by Order of Ministry of Education and Science of the Russian Federation dd. 12.09.2013 under No. 1061 (On approval of the list of specialties …, 2013).

The bachelorship FSES is worked out in the field of training without accounting for the profile. However, when PED is worked out, the profile and dedicated scope of training shall be accounted.

The standard establishes competences which reflect preset results of training in all fields. For instance, the FSES of training field 44.03.04 "Vocational training (by industries)" (Federal State Educational Standard …, 2015)

Table 1. Structure of the bachelorship program in the field of training 44.03.04 Vocational training (by industries), within the profile "Machine-building and metal processing"

Structure of bachelorship program		Volume of bachelorship program in points of credit (POC)
Unit 1	Disciplines (modules)	210
	Basic part	96
	Variable part	114
Unit 2	Practical trainings	21
	Variable part	21
Unit 3	State final examination (SFE)	9
	Basic part	9
The total volume of bachelorship program		240

establishes competences of a VE teacher which are common for the entire field. In PED, competences are adapted to the profile by adding supplementary competences to the curriculum, basing on employers' needs reflected in questionnaires for interrogation of employers and in the OS.

Thus, PED is developed by its field in accordance with FSES and the training profile. It is worth mentioning that one profile can integrate multiple scopes of training. For instance, within the profile "Machine-building and metal processing" such scopes can be singled out as "Technology and equipment of machine-building" and "Certification, metrology and quality management in machine-building", etc. The scope shall be also described in the subject matter of PED.

Using the text of the explanatory note to PED (Principal Vocational Education Program …, 2015), we will present a brief description of basic provisions characterizing the PED of training of bachelors in the field 44.03.04 Vocational training (by industries) in the training profile "Machine-building and metal processing", scope "Certification, metrology and quality management in machine-building".

The objectives of bachelorship PED are development of students' personality qualities and formation of soft universal (general scientific, socio-personal, instrumental) and professional competences necessary for training of workers and specialists in professions and specialties in scopes of activity related to issues of technical regulation, metrology and quality management of machine-building products in education institutions realizing educational programs of secondary vocational education and supplementary vocational education, training course network of enterprises and entities, in centers for training, retraining and advanced training of workers and specialists, plus in employment agencies.

The labor intensity of assimilation of the principal educational program by a student for the whole training period, in accordance with FSES of higher education in the field 44.03.04 Vocational training (by industries) shall be equal to 240 credit points and shall include all types of the student's classroom and independent work, practical work and the time assigned for control of quality of assimilation of the higher education PED by the student, regardless the mode of study, applied educational techniques, realization of the program by multiple entities executing educational activities with use of the network form, realization of training by an individual curriculum, abbreviated training included.

In accordance with FSES of higher education in the field 44.03.04 Vocational training (by industries), the structure of the bachelorship program in the field of training 44.03.04 Vocational training (by industries), within the profile "Machine-building and metal processing" includes units shown in **Table 1.**

Results of acquisition of bachelorship PED shall be defined by competences acquired by a graduate, i.e. his/her ability to use knowledge, skills and personal qualities in accordance with the occupational activity tasks. Bachelor's competences in the field of training 44.03.04 Vocational training (by industries), within the profile "Machine-building and metal processing" shall be defined on basis of FSES and the analysis of results of interrogation of potential employers.

The following profile-specialized competences (PSC) were defined in result of project planning of PED of training of vocational education bachelors on the profile of interest within the dedicated scope:

- PSC 1: ready to take part in development and realization of technological processes of processing and monitoring of machinery parts in process of training of blue- and white-collar workers and middle ranking specialists in the area of technical regulation of the appropriate qualification level;

- PSC 2: able to take part in practical assimilation of quality management systems at an entity and in an educational institution;

- PSC 3: able to take part in fulfilling tasks on development, revising, actualization and application of statutory documents in the area of technical regulation and quality management in process of training of a worker (specialist) of the appropriate qualification level;

- PSC 4: ready to perform works on metrological support of production and an educational institution;
- PSC 5: ready to take part in preparation and conducting of compliance assessment (Guzanov, Sokolova & Migacheva, 2015).

The above listed competences are the basis for selection of the subject matter of PED application aspects which is reflected in appropriate curriculum disciplines (Principal vocational educational program…, 2015).

By now a curriculum plan has been developed possessing units common for the entire profile and elective modules the disciplines whereof is defined by a dedicated scope of training. See below the description of the curriculum with specifying points of credit (POC) per each unit and module.

A competence-oriented curriculum consists of three large units: disciplines (modules), practical trainings, and final qualification.

A unit of disciplines (modules) consists of the following sections:

- basic part 3420 POC;
- variable part 4468 POC

The basic part shall include:

- module of general scientific disciplines 1404 POC;
- module of general vocational disciplines 1476 POC;
- vocational-qualification module 540 POC

Compliant to the goal of work, we will single out disciplines reflecting the subject matter of training which is specific for the scope of certification, metrology and quality management. Such a subject in the module of vocational-qualification disciplines is "Practical training on profession" 540 POC, as it supposes specific matters for the dedicated scope, i.e. it will change the subject matter related to measuring of parameters of machine-building details.

The variable part shall include compulsory disciplines which are subdivided into:

- general technical module 1728 POC;
- profile module 1116 POC;
- elective disciplines 1624 POC

The general technical module is common for the entire profile and includes disciplines which reveal basics of machine-building and material processing. The profile module includes subjects which reveal the dedicated scope. The following disciplines shall reflect specific matters of the scope:

- Quality management 216 POC;
- Metrology, standardization, certification 108 POC;

The dedicated disciplines are deepened in the section "elective disciplines" wherein subjects within elective modules are contemplated.

The section "elective disciplines" consists of seven elective modules. Each module includes two disciplines from different dedicated scopes. Below disciplines from these modules are listed which conform to the scope "Certification, metrology and quality management in machine-building":

- Basics of designing of measuring mechanisms 180 POC;
- Metrological support and standardization of production 180 POC;
- Methods and equipment of measurements, tests and control 252 POC;
- Technical inspection in machine-building 216 POC;
- Acknowledgement of compliance of machine-building products 144 POC;
- Qualimetry 108 POC;
- Modern quality management conceptions 144 POC

The unit of practical trainings is of high significance (756 POC), as it fixes up competences which are formed on disciplines of profile and elective modules. In final, one may say that PED of training of vocational education bachelors in the profile "Machine-building and metal processing", scope "Certification, metrology and quality management in machine-building" includes not only requirements of FSES but also potential employers' opinions. In accordance with modern requirements of occupational standards, requirements of appropriate OSs should be taken into account in process of PED developing, wherein employers' opinions are fixed in the regulatory mode.

Thus, the above description, the set of competences formed (PSCs), and the list of disciplines of the curriculum are an input for realization of the processes included into the model. Realization of the dedicated processes – element of the model – will be shown in subsequent sections of our paper.

Selection and Analysis of Occupational Standards (OSs) Related to Profile (Dedicated Scope) of Training

The educational program of higher education covers a number of OSs. That is why analysis and comparison of labor functions will allow more accurate stating of the training results, which will help in planning of the educational process to the chair and in reaching of compliance to requirements of a number of standards and being in demand on the modern labor market.

The following OSs corresponding to the scope of certification, metrology and quality management were chosen for the analysis:

– specialist in metrology (OS 1),
– specialist in product certification (OS 2),
– specialist in product quality (OS 3).

The following criteria were used for selection of OSs: commonality of content of the labor covered by the OSs and of the dedicated scope of training of bachelors; the level of education (bachelorship) and qualification levels integrated into the OSs (Batrova et al., 2008; Guzanov et al., 2016a).

Further on, detailed analysis of integrated labor functions (ILF) and labor functions (LF) of each OS on the 5th and 6th qualification levels (On approval of qualification levels…., 2013).

Two ILFs are singled out in the occupational standard "Specialist in metrology" (2014). See below the description thereof.

ILF "Metrological recording and performing of simple operations on metrological support of an existing production".

Code: A.

Qualification level: 5.

Requirements to education and training: secondary vocational education; higher education – bachelorship.

Requirements to practical working experience: None.

Possible job titles:

– Technician;
– 2nd category technician;
– 1st category technician;
– Metrologist technician;
– 2nd category metrologist technician;
– 1st category metrologist technician.

Now let us single out labor functions LF included into ILF with the appropriate code:

– Performing of precise measurements for determination of actual values of parameters under control A/01.5;
– Record management, maintaining and actualization of production-technical and normative documentation A/02.5;
– Keeping and maintaining in good working order of working calibration standards for reproduction of units of measurement, verifying and calibration instruments A/03.5;
– Verification (calibration) of simple measuring tools A/04.5;
– Metrological recording of tools for measuring, tests and control, working calibration standards, reference specimens, techniques of measuring and testing A /05.5.

ILF "Metrological support of development, production, tests and operation of products".

Code: B.

Qualification level: 6.

Requirements to education and training: secondary vocational education; higher education – bachelorship.

Requirements to practical working experience: higher education without requirements to the employment history, or secondary vocational education and history of employment as 1st category metrologist technician for at

least three years, or as other job titles occupied by specialists with secondary vocational education, for five years at least.

Possible job titles:

– Engineer;

– 2nd category engineer;

– 1st category engineer;

– Metrologist engineer;

– 2nd category metrologist engineer;

– 1st category metrologist engineer;

– Specialist in metrology.

LFs included into ILF, with appropriate codes:

– Performing of especially precise measurements for determination of actual values of parameters under control B/01.6;

– Metrological supervision on observance of standards and regulations for provision of uniformity of measurements, of the state and application of measuring tools B/02.6;

– Conducting of works on control and upgrading of the reference base, verification instruments and measuring tools B/03.6;

– Verification (calibration) of measuring tools B/04.6;

– Establishing of verification frequency for measuring tools and plotting of calendar plans and graphs of conducting of verifications B/05.6;

– Metrological expertise of technical documentation B/06.6;

– Development and attestation of techniques of measuring and testing B/07.6;

– Attestation of test equipment and special measuring tools B/08.6;

– Development and implementation of special measuring tools B/09.6;

– Development and implementation of standards and other normative documents in the scope of metrological support B/010.6;

– Certification and tests of measuring tools in purpose of approval of a type B/011.6;

– Composing of local checkout circuits per types of measurement B/012.6.

Two ILFs are singled out in the occupational standard "Specialist in certification of products" (2014). See below the description thereof.

ILF "Performing works on acknowledgement of conformance of products (services) and the quality management system".

Code: A.

Qualification level: 5.

Requirements to education and training: higher education – bachelorship.

Requirements to practical working experience: None.

Possible job titles: Engineer for certification of products (services).

LFs included into ILF, with appropriate codes:

– Performing of measures on results of state supervision, sectoral and cross-sectoral control of implementation and observance of standard and technical specifications in scope of products quality, preparation of products (services) to acknowledgement of conformance and attestation A/01.5;

– Maintaining of records and composing of reports on the entity's activity in certification of products (services) A/02.5;

– Development of elements of the document circulation system in the entity, statement of requirements to the subject matter and structuring of the technical and organization-managerial documentation A/03.5;

– Development and preparation of measures related to implementation of standards and technical specifications for products manufactured by the entity (services rendered by the entity) A/04.5.

ILF "Organization of performing works on acknowledgement of conformance of products (services) of the entity".

Code: B

Qualification level: 6.

Requirements to education and training: higher education - specialty, magistrate.

Requirements to practical working experience: history of employment in the specialty, including on managerial posts - for three years at least.

Possible job titles: deputy head of division for products (services) certification.

LFs included into ILF, with appropriate codes:

– Organization of works on acknowledgement of conformance of products (services) and the quality management systems B/01.6;

– Organization of works on conducting of an internal audit of the entity's quality management system B/02.6.

This integrated labor function (B) is an exception, as it does not suit the criteria established above (requirements to education, requirements to practical working experience), but it is included into the subject matter of training of bachelors, so we will include it into our analysis.

Four ILFs are singled out in the occupational standard "Specialist in quality of products" (2014). See below the description thereof.

ILF "Performing works on management of quality of products operation".

Code: A.

Qualification level: 6.

Requirements to education and training: higher education – bachelorship.

Requirements to practical working experience: None.

Possible job titles: engineer for management of quality of products operation.

LFs included into ILF, with appropriate codes:

Determination and agreeing of requirements to products (services) established by customers, as well as requirements not established by customers but needed for operation of products (services) A/01.6;

– Review of claims and complaints to quality of products, works (services), composing of final conclusions and maintaining of correspondence on results of considering thereof A/02.6;

– Development of corrective actions on management of non-conforming products (services) in course of operation A/03.6.

ILF "Performing works on management of quality of processes of products manufacture and services rendering".

Code: B.

Qualification level: 6.

Requirements to education and training: higher education – bachelorship.

Requirements to practical working experience: None.

Possible job titles: engineer for management of quality of processes of products manufacture and services rendering.

LFs included into ILF, with appropriate codes:

– Analysis of reasons which cause deterioration of the quality of products (works, services), development of plans of measures aimed at elimination thereof B/01.6;

– Development of techniques and instructions on current control of quality of works in process of manufacture of products, in tests of finished products and execution of documents certifying the quality thereof B/02.6.

ILF "Performing works on management of quality of products and services projection".

Code: C.

Qualification level: 6.

Requirements to education and training: higher education – bachelorship.

Requirements to practical working experience: None.

Possible job titles: Engineer for management of quality of products and services projection.

LFs included into ILF, with appropriate codes:

Table 2. Interconnected labor functions of sampled occupational standards

OS 1	OS 2	OS 3
Records management, maintaining and actualization of production-normative documentation	Development of elements of the records management system in the entity, stating of requirements to the subject matter and structuring of the technical and organization-managerial documentation	-
Development and implementation of standards and other normative documents in scope of metrological support	Development and preparation of measures related to implementation of standards and technical specifications for products manufactured by the entity (services rendered by the entity)	Studying of advanced national and international experience in development and implementation of quality management systems, composing of analytical reports on possibility of using such experience in the entity

– Analysis of the data obtained at various stages of manufacture of products, performing works (rendering services) on basis of quality indexes characterizing the designed and manufactured products, works (services) C/01.6;

– Studying of advanced national and international experience in development and implementation of quality management systems, composing of analytical reports on possibility of using such experience in the entity C/02.6;

– Development of measures aimed at prevention of manufacture of products, performing works (services) not conforming to the established requirements C/03.6.

ILF "Performing works on management of entity resources quality".

Code: D.

Qualification level: 6.

Requirements to education and training: higher education – bachelorship.

Requirements to practical working experience: None.

Possible job titles: engineer for management of entity resources quality.

LFs included into ILF, with appropriate codes:

– Composing of a final conclusion on conformance of the quality of raw stocks, materials, semi-finished materials, components delivered to the entity to standards and technical specifications, and execution of documents for submitting claims to suppliers D/01.6;

– Development of drafts of procedures and local normative acts on training of the entity's employees in field of quality D/02.6.

Let us analyze the sampled labor functions. It's possible to suppose that some from the selected labor functions of various standards are close in their sense, but there are also specific ones inherent to a certain standard. Let us bring to light those labor functions which are interconnected to each other in the scope "Certification, metrology and quality management", with summarizing the results in **Table 2**.

Approbation of the conducted analysis of requirements of OSs was performed in framework of proceedings of conference "Technical regulation in United economic space" which was held on May 20, 2016 in Russian State Vocational Pedagogical University. It was found out that LFs similar in their sense are present in two standards at least (from those mentioned above). These are functions related to performing measurements; maintaining, development and actualization of normative documentation; performing certification; management of the entity's employees; reviewing claims and complaints to quality of products; implementation of control of the system of products quality management (Sokolova et al., 2016).

Functions which are determined in one OS only shall be regarded by us as specific labor functions. For instance, such LFs as "Keeping and maintaining in good working order of working calibration standards for reproduction of units of measurement, verifying and calibration instruments", "Verification (calibration) of simple measuring tools" are specific for the standard "*Specialist in metrology*". For the standard "*Specialist in product quality*" they will be "Development of corrective actions on management of non-conforming products (services) in course of operation". The standard *"Specialist in products certification"* shall be specific in scope of such functions as "Maintaining of records and composing of reports on the entity's activity in certification of products (services)".

Results of the conducted analysis should be used in projecting of subject matter of profile disciplines of educational programs, in determination of training results. When developing an educational program, general labor functions should be accounted for in the profile part disciplines, while specific functions should be reflected in disciplines of elective modules. Results of the conducted analysis speak for necessity to use the proposed technique both for development of programs and for identification of the training outcomes.

Table 3. Matrix of distribution of integrated labor functions per the curriculum disciplines

Disciplines	Occupational standards							
	OS 1		OS 2				OS 3	
	ILF A	ILF B	LF A	ILF B	ILF A	ILF B	ILF C	ILF D
Practical trainings on specialty	+	+	-	-	-	-	-	-
Quality management	-	-	-	-	+	+	+	-
Metrology, standardization and certification	+	+	+	+	-	-	-	-
Basics of designing of measuring mechanisms	-	+	-	-	-	-	-	-
Metrological support and standardization of production	+	+	-	-	-	-	-	-
Methods and equipment of measurements, tests and control	-	+	-	-	-	-	-	-
Technical inspection in machine-building	+	+	-	-	-	+	+	+
Acknowledgement of compliance of machine-building products	-	-	+	+	-	-	-	-
Qualimetry	-	-	-	-	+	-	+	-
Modern quality management conceptions	-	-	-	-	+	-	+	+

The final result of the process performed in such a way will be an "output": a list of OSs related to the profile (dedicated scope) and labor functions thereof (common for the profile and specific for the dedicated scope).

Comparison of Occupational Standards and Integrated Labor Functions with Disciplines of PED Curriculum

Let us analyze interconnections of disciplines of the profile and elective modules and OS ILFs singled out above. Results of the analysis shall be presented in **Table 3** which is an "output" from Process 2.

Reviewing the produced matrix, we come to the conclusion that not each of integrated labor functions will be covered by the subject matter of each discipline (module). In particular, "Practical trainings on specialty" shall cover only ILF 1 of OS. "Quality management" shall cover only ILFs A, B, C of OS 3. The module "Metrology, standardization and certification" shall cover all ILFs of OS 1 and OS 2. The discipline "Metrological support and standardization of production" fully covers the subject matter of OS 1. The subject matter of the disciplines "Methods and equipment of measurements, tests and control" include ILF B of OS 1. The discipline "Technical inspection in machine-building" covers all ILFs of OS 1 and ILFs B, C, D of OS 3. "Acknowledgement of compliance of machine-building products" covers all ILFs of OS 2. "Qualimetry" is included into ILFs A and C of OS 3. "Modern quality management conceptions" is also included into ILFs A, C, D of OS 3.

This matrix shall be an "input" into Process 3.

Analysis of the Subject Matter of Labor Functions and Their Comparison with Disciplines of PED Curriculum

Now let us perform detailed analysis of the necessary subject matter of disciplines in accordance with OS provisions. We will find out LFs of each OS and distribute them per the curriculum disciplines. Results shall be presented in **Tables 4**, **5**, **6** which are an "output" from Process 3.

Reviewing **Tables 4**, **5**, **6**, we come to the conclusion that the same LFs from a certain occupational standard are distributed to different disciplines. To explain why such a distribution exists, it is needed to analyze the LFs subject matters. Let's examine working actions (WA), necessary skills (S), and necessary knowledge (K) for each labor function and distribute them per disciplines for making the subject matters of raining in disciplines more definite, in the application aspect.

Table 4. Distribution of OS LFs "Specialist in metrology" per the curriculum disciplines (fragment)

Discipline	Labor functions included in ILF A	Labor functions included in ILF B
Practical trainings on specialty	A/01.5 Performing of precise measurements for determination of actual values of parameters under control. A/02.5 Record management, maintaining and actualization of production-technical and normative documentation.	B/01.6 Performing of especially precise measurements for determination of actual values of parameters under control.
Metrology, standardization and certification	A/01.5 Performing of precise measurements for determination of actual values of parameters under control. A/02.5 Record management, maintaining and actualization of production-technical and normative documentation.	B/02.6 Metrological supervision on observance of standards and regulations for provision of uniformity of measurements, of the state and application of measuring tools. B/010.6 Development and implementation of standards and other normative documents in the scope of metrological support.
Basics of designing of measuring mechanisms	-	B/09.6 Development and implementation of special measuring tools.

Table 5. Distribution of labor functions for "Specialist in product certification" per the curriculum disciplines (fragment)

Discipline	Labor functions included in ILF A	Labor functions included in ILF B
Metrology, standardization and certification	A/01.5 Performing of measures on results of state supervision, sectoral and cross-sectoral control of implementation and observance of standard and technical specifications in scope of products quality, preparation of products (services) to acknowledgement of conformance and attestation. A/02.5 Development of elements of the document circulation system in the entity, statement of requirements to the subject matter and structuring of the technical and organization-managerial documentation.	B/01.6 Organization of works on acknowledgement of conformance of products (services) and the quality management systems. B/02.6 Organization of works on conducting of an internal audit of the entity's quality management system.

Table 6. Distribution of labor functions for "Specialist in product quality" per the curriculum disciplines (fragment)

Discipline	Labor functions included in ILF A	Labor functions included in ILF B	Labor functions included in ILF C	Labor functions included in ILF D
Quality management	A/01.5 Determination and agreeing of requirements to products (services) established by customers, as well as requirements not established by customers but needed for operation of products (services). A/02.5 Review of claims and complaints to quality of products, works (services), composing of final conclusions and maintaining of correspondence on results of considering thereof. A/03.5 Development of corrective actions on management of non-conforming products (services) in course of operation.	B/01.6 Analysis of reasons which cause deterioration of the quality of products (works, services), development of plans of measures aimed at elimination thereof. B/02.6 Development of techniques and instructions on current control of quality of works in process of manufacture of products, in tests of finished products and execution of documents certifying the quality thereof.	C/01.6 Analysis of the data obtained at various stages of manufacture of products, performing works (rendering services) on basis of quality indexes characterizing the designed and manufactured products, works (services). C/03.6 Development of measures aimed at prevention of manufacture of products, performing works (services) not conforming to the established requirements.	

Analysis of the Subject Matter of Working Actions, Knowledge and Skills

Analysis of the subject matter of WA, K & S is one of the grounds for development of "reference units" when forming the subject matter of training in discipline**M** in a dedicated scope. Supporting on the "output" from Process 3 on each of dedicated LFs, let us distribute a standard WA, K & S package per the curriculum disciplines.

Necessary skills and knowledge which are universal for the whole profile shall regarded as profile disciplines. Working actions, necessary skills and necessary knowledge which correspond to the scope "Certification, metrology and quality management" shall be regarded as a part of the subject matters of elective modules.

Results of the analysis shall be presented in **Tables 7**, **8**, **9** which are an "output" from Process 4.

Table 7. Distribution of labor functions subject matters for "Specialist in metrology" per profile disciplines and elective modules (fragment)

Discipline	Working actions	Skills needed	Knowledge needed
Practical trainings on specialty	A/01.5: Preparation for conducting measurements for determining of actual values of parameters to be controlled. Processing of the measurement results. Recording of the measurement results in the documentation.	A/01.5: Using measuring tools, ordinary universal and special measuring equipment necessary for performing measurements. Obtaining, interpreting and documenting the measurement results.	A/01.5: Physical principles of operation, scope of application and principal restrictions of measuring methods and equipment. Technical characteristics, design peculiarities, intended use and application principles of measuring equipment (ME) used in the entity's field of activity
	B/01.6: Identification of the item parameters influencing section of ME. Identification of allowable error (uncertainty) of measurements. Selection of methods and ME. Selection of variants of using ME and conditions of conducting of measurements. Preparation for conducting measurements for determining of actual values of parameters to be controlled. Conducting of a measuring experiment. Processing of the measurement results. Recording of the measurement results in the documentation.	B/01.6: Choosing optimal methods and measuring equipment. Using the measuring equipment necessary for conducting of measurements. Obtaining, interpreting and documenting the measurement results. Calculating errors (uncertainties) of measurement results.	B/01.6: Normative and methodical documents regulating issues of selection of methods and measuring equipment. Physical principles of operation, scope of application and principal restrictions of measuring methods and equipment. Technical characteristics, design peculiarities, intended use and application principles of measuring equipment.
Metrology, standardization and certification	-	A/01.5: Using measuring tools, ordinary universal and special measuring equipment necessary for performing measurements. Obtaining, interpreting and documenting the measurement results. Executing of production-technical documentation in accordance with current requirements.	A/01.5: Normative and methodical documents regulating issues of selection of methods and measuring equipment. Physical principles of operation, scope of application and principal restrictions of measuring methods and equipment.
	-	A/02.5: Executing of production-technical documentation in accordance with current requirements.	A/02.5: Procedure of composing and rules of execution of technical documents in the entity. Basic terminology and definitions in scope of metrology. Form of submitting of measurement results and errors (uncertainties) thereof.
	-	B/010.6: Developing drafts of standards and normative documents.	B/010.6: Normative and methodical documents regulating issues of developing of standards and normative documents. Requirements to subject matter of standards and normative documents.
Basics of designing of measuring mechanisms	B/09.6: Development of a statement of work for designing of measuring mechanisms. Implementation of special measuring equipment.	B/09.6: Determining of necessity to develop special measuring equipment. Reviewing of methods and equipment for measuring of physical values.	B/09.6: Normative and methodical documents regulating issues of developing of measuring equipment. Physical principles of operation, scope of application and principal restrictions of methods and equipment of measuring. Practical and theoretical basics of realization of phases of measuring equipment designing.

"Practical trainings on specialty" was included into **Table 7**, as it implies specific features for the dedicated scope. The discipline "Metrology, standardization and certification" includes necessary knowledge and necessary skills which will be deepened and broadened in modules "Metrological support and standardization of production", "Methods and equipment of measuring, tests and inspection", "Technical inspection in machine-building".

In **Table 8**, necessary knowledge and skills which are common in their content were included into the profile discipline "Metrology, standardization and certification". Working actions and knowledge corresponding to them were included into the elective mode "Acknowledgement of compliance of machine-building products".

Table 8. Distribution of the subject matter of labor functions of the occupational standard "Specialist in certification" per profile disciplines and elective modules

Discipline	Working actions	Skills needed	Knowledge needed
Metrology, standardization and certification	-	A/01.5: Executing technical documentation certifying quality of products (services).	A/01.5: Basic concepts of standardization and acknowledgement of compliance.
	-	A/02.5: Developing and executing basic types of normative documents, quality records, as well as package of documents of the entity's quality management system.	A/02.5: Basic provisions of the national and international normative base in scope of document circulation of quality management systems.
	-	A/03.5: Developing and executing basic types of normative documents, quality records, as well as package of documents of the entity's quality management system.	A/03.5: Basic provisions of the national and international normative base in scope of document circulation of quality management systems.
	-	A/04.5: Developing and executing basic types of normative documents, quality records, as well as package of documents of the entity's quality management system.	A/04.5: Basic provisions of the national and international normative base in scope of document circulation of quality management systems.

Table 9. Distribution of the subject matter of OS LF "Specialist in product quality" per profile disciplines and elective modules

Discipline	Working actions	Skills needed	Knowledge needed
Quality management	-	A/01.5: Composing technical documentation for provision of consumers' requirements to products (services).	A/01.5: National and international normative base in scope of management of products (services) quality.
	-	A/02.5: Applying actual normative documentation on reviewing of claims and complaints to quality of products, works (services).	A/02.5: National and international normative base in scope of management of products (services) quality.
	-	A/03.5: Applying actual normative documentation on development and use of method of control of (qualitative and quantitative) indicators of quality of products (services) in the entity.	A/03.5: National and international normative base in scope of management of products (services) quality.
	-	B/01.6: Applying actual normative documentation in scope of management of manufacture of products (rendering services).	B/01.6: National and international normative base in scope of management of products (services) quality.
	-	B/02.6: Applying actual normative documentation in scope of management of manufacture of products (rendering services).	B/02.6: National and international normative base in scope of management of products (services) quality.

In **Table 9**, the discipline "Quality management" includes necessary knowledge and necessary skills which will be deepened and broadened in modules "Technical inspection in machine-building", "Qualimetry", "Modern concepts of quality management".

In the presented tables, someone and the same working actions with respective necessary knowledge and necessary skills were included from one LF, which are formed at their studying; it should be taken into account when forming intra- and inter-subject connections of the training subject matter. There are also necessary knowledge which were related to other disciplines of the profile; it can be regarded as a kind of "ordering" for their content.

lFs include WA, K&S. All these characteristics take part in formation of bachelor's competences. Thus, one have to account for each LF of the selected OSs when forming the subject matter of modules.

OS is not the only criterion for selection of the discipline subject matter. We also have to account for pedagogical principles and didactics in part of selecting the content.

"Outputs" of Processes 1-4 are "input" into Process 5 "Development of working programs and assessment resources funds per disciplines with considering of OS requirements".

Thus, following the model, we obtain educational learning materials on disciplines structured with accounting for requirements of the OS. Use of the process approach implies defining of satisfaction of requirements and consideration of potential changes in their scope. For that, the element "FSES and OS actualization" is envisaged in our model which is a decision-making block on necessity of entering modifications into the academic and methodological complex of a discipline. If requirements of OS get changed, it is necessary to enter appropriate changes into educational learning materials.

DISCUSSIONS

Studying of pedagogical literature allows stating of insufficiency of special researches devoted to the issue of selection of subject matter of disciplines with considering of labor functions in accordance with occupational standards under conditions of real practical working activity.

Selection of subject matter of training is generally accepted on basis of pedagogical approaches of S.I. Arkhangelsky (1980), Babansky (1988), Lednev (1989). At present, the competence approach is applied for selection of the subject matter which is described in papers of Zeer (2003). Provisions of this approach are developed in works of practicing pedagogues, such as Guzanov et al. (2015), Kopylov (2012).

When developing PED, it is also necessary to use the normative-legal base of education: Federal State Educational Standard (2015), Federal Law "On Education in the Russian Federation" (2012).

The necessity to consider the market's demands when developing PED conditioned introduction of OSs and requirement to consider provisions thereof when developing PED: methodical recommendations on development of principal educational programs and supplementary vocational programs with consideration of appropriate occupational standards (2015), the occupational standard "Specialist in metrology" (2014), the occupational standard "Specialist in products certification" (2014), the occupational standard "Specialist in products quality" (2014).

Thus, use of OSs is necessary both in development of FSESs and results of training by PED, and in drafting of educational disciplines, which is proved by researches by Guzanov et al. (2016a), Sokolova et al. (2016).

Resting upon the abovementioned grounds, one can propose the following provisions for discussion.

To identify the actual subject matter of training within the dedicated scope, it is necessary to consider opinions of potential employers. They are established in occupational standards. Three occupational standards were selected for the dedicated scope. From all working functions of the occupational standards those were singled out which can be fulfilled by the personnel with the qualification "bachelor", and their analysis was conducted. Results of the analyses showed that there are functions common for two standards and specific for each of standards. Common functions should be reflected in the profile disciplines as a whole; specific actions should be reflected in disciplines' variable parts conforming to the scope of certification, metrology and quality management in machine-building.

The selected labor functions may be distributed per respective profile disciplines and the curriculum elective modules. After that, knowledge, skills and working actions shall be particulated which are included into the labor functions; to our mind, it should play an important role in formation of the training subject matter.

The provisions set forth above should be taken into account when developing education-methodical complexes of educational disciplines. When occupational standards are revised or modified, the complex of methodical materials shall be subject to respective revision, on accordance with the updated subject matter of the standards.

Having regard to the above, one can suppose that while monitoring results of training, it is necessary to review conformance of knowledge, skills and firm grasping of the PED graduate to requirements of not only educational but also of occupational standards.

CONCLUSION

As a result of the conducted study, a structural-functional model of selection of the subject matter of profile disciplines of the educational program with taking into account of occupational standards requirements was developed.

The proposed model has been structured with consideration of the process approach provisions.

The following processes were proposed as dedicated interconnected processes necessary at selection of training subject matter, with taking into account of occupational standards requirements:

1. Sampling and analysis of OSs related to the training profile (dedicated scope).
2. Comparison of OSs and integrated labor functions (ILFs) with the curriculum disciplines (modules).
3. Analysis of subject matter of OSs labor functions (LFs), comparison of OS LFs with the curriculum disciplines (modules).
4. Analysis of subject matter of working actions, knowledge and skills (WA,K&S) of OS, finding out of "reference units" for formation of the training subject matter per the profile disciplines (dedicated scope).
5. Development of working programs and assessment resources funds per disciplines (modules) with taking into account OS requirements.

"Inputs" and "outputs" have been identified for each process. Activity in actualization of OS and FSES is used as registration of possible changes in the scope of requirements.

The model was successfully approbated on the example of PED for training of vocational education bachelors in the profile "Machine-building and metal processing" in scope of certification, metrology and quality management in machine-building.

The model is aimed at adaptation of teachers to new conditions of their occupational activity in the sphere of education and is focused on working-out of methodological support of disciplines of the PED curriculum in part of training on profile disciplines in the dedicated scope.

The results submitted herein can be used by leading teachers for sampling of didactical units of the curriculum disciplines; it means that the paper is of practical nature and serves to optimization of the subject matter of profile training on basis of requirements of occupational standards and further monitoring of maturity of competences.

ACKNOWLEDGEMENT

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Assessment of Student Views on the Communicative Behaviours of Instructions

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ABSTRACT

This study, which was conducted to identify the views of students regarding the communication behaviours of instructors with the role of education administrators, aims to reflect the communication behaviours of instructors in the classroom management and the students' behaviours in the communication styles within the class environment. Therefore, the communication behaviours of instructors in classroom management were identified and then, it was asserted whether such behaviours vary based on the several independent variables, and finally the demographic characteristics of the students taking part in the scale were assessed. Based on the data obtained from such results, the views of instructors on the communication behaviours in the classroom management and their consideration for the lesson were obtained. The inventory of Samsa (2005) "Measuring Communication Behaviors of Instructors" used in the quantitative research was adapted and 5 different dependent variables were obtained. 1. Form of Address, 2. Lecturing, 3. Use of Grammar, 4. Respect to the environment, 5. Clarity of communicationarethe sub dimensions of the scale. In this context, data was collected through a questionnaire, and the statistical analysis of data was conducted through Statistical Package Program.

Keywords: science education, technology education, biology education, environmental education, educational technology

INTRODUCTION

The use of mass communication tools used by people to communicate regardless our location and time and place is at the highest level. It is true that our life is surrounded by an important communication link and we are in communication and contact with other individuals and objects unavoidably. People may influence each other's behaviours and unify as groups through communication (Pradhan & Chopra, 2008). Communication is considered as a precessor for the performance of management activities and management process tasks. The realization of organisational objectives is possible through an effective communication together with the the accomplisement of processes such as planning, coordination, control, active sharing, participation and motivation. The cooperation, concentration and team work are based on effective communication in every step of the organisational activities (Rusu, 2010). In other words, the importance of communication in an organization can be emphasized as "no organization will exist without communication" (Simon, 1957; Adrignola & Spaynton, 2013). Communication skills, as one of the most important needs of the administrators in the performance oftheir managerial roles, can be generally defined as making other people work generally during an interaction (Hargie, 2011). The success of organizations is based on the effective and efficient communication skills of administrators and their members. Hence, the communiction process is one of the most significant processes in the success of administrators and efficiency of organizations. There is no individual or institution that does not require communication within a social structure as communication is a bridge required for understanding among people, establishment of human relations and their maintenance (Thomson, 2011; Geçimli, 2007; Pondy, 1992). Communication is an act used by an individual to influence the other partyvia several symbols and tools (Dökmen, 1989). Under such circumstances,

Contribution of this paper to the literature

- It is considered that high communication perceptions of individuals would influence their performances in terms of communication skills and the development of communication skills of teachers would solve the problems in a more constructive way.
- One of the steps to enhance the quality of education at school is to identify the level of communication skills of instructors in the classroom management and avoid any deficiency.
- The instructors should care about the language that they use while talking and avoid any unnecessary repetitions and give more effort to use an appropriate, simple, fluent and clear way of expression.

this is an absolute communication method in education. The effective realization of this activity is definitely based on the communication on the communication between the teacher and students (Bolat, 1996).

Communication is the most crucial component in establishing positive connections between the teacher and students in active classroom management. The teacher should provide abilateralinteraction platform within class for positive learning-teaching environment. The teacher should not havea very harsh attitudeagainst students; on the contrary, they should direct them to get motivated and be eager. For a good teacher-student interaction, the teacher and students should love and understand each other, establish concreterelations and also should have mutual trust (Erdoğan, 2010). Within such circumstances, the in-class communication is interpersonal communication. When interpersonal communication is healthy so the education environment would be. Pursuant to various researches, the sensitiveness, tolerance, mutual respect and friendliness of teachers are important for learning. An inattentive verbal discourse, a wrong behaviour or facial expression may cause a negative situation with regard to the students or their learning (Pala, 2006). For this reason, teachers should show the highest attention and care on their acts. While some experts defend that techniques and skills are effective in quality education, some argue that the personal characteristics are effective. However, there is a consensus regarding the effect of personal characteristics of the teachers on the in-class behaviours (Miron, 1983; Oddens, 2004; Özabacı & Acat, 2005; Saracaloğlu, 2000; Sünbül, 1996). On the other hand, there are challanges in giving correct in-class behaviours to the new instructors and there is a disagreement in relation with the experienced teachers and their adopting such behaviours.

The education of students in parallel with the objective of education system is based on the teachers who have a say in their profession and they should have some roles respectively. Such roles can be classified under five groups in terms of the relations of teachers with their students, colleagues, school administration and parents (Özden, 2003). Effective communication skills have an important role in terms of professional and personal occupational and characteristics of teachers.

Education which is provided to teachers to be sufficient and good (Korthagen, 2004) is foundat the levels of personality, environment, competence, idea, behaviour or duties. Upon the obtained trainings, the problem of instructors or level of problem or the type of support should be identified. A well-trained teacher would comply with such conditions (Korthagen, 2004). Programs providing teacher training use the approach of using theoretical courses for the teachers based on student training approaches (Oddens, 2004). The knowledge of overcoming issues through innovative roles or tasks on the instructors is a step bringing out the universal features through aiming at giving them skills (Şişman & Acat, 2003; Volmari, 2004).

In the studies conducted by Ausubel and Robinson (1969), Brophy and Good (1986), Berktin (1974), regarding the question forthe type of communication skills that teachers should have, the teachers and students were asked to make a list, which indicated that the teachers generally take the in-class academic processes as basis whicle students underline the features standing out in the daily communication processes (Güçlü & Güçlü, 1996). At the same time, there are some other studies conducted by Bolat (1989) and Bayram (1992) regarding the communication skills of teacher showing that the perceptions of teachers and students vary (Arslantaş, 1998).

Hence, the aim of this study is to identify the views of students with regard to the communication behaviours of teachers in the class management as well as to reflect the views of students regarding the communication styles in classroom management. Thus, this study aimed at determining the views of instructors with regard to evaluating their communication behaviours in classroom management. In a sense, considering that the performances of candidate teachers in relation to their communication behaviours might be identified through observation, it is possible to deliver the understanding, perception and self-belief of students in terms of acquiring such skills.

The identification of how communication related behaviours of instructors are assessed by students is important in terms of determining the success levels of the instructors in communication and helping to fulfill the deficiencies. As the discourse of communication is important in the communication as the foundation of class management, the perception and impact on the addressee is significant too. Feedback is vitally important in a healthy communication.

Regarding the communication skills of candidate teachers, the abovementioned findings standing out the features in the daily communication processes lead the researcher to question the perceptions of candidate teachers in relation with the basic communication skills considered as the most basic teacher quality. It is considered that high communication perceptions of individuals would influence their performances in terms of communication skills and the development of communication skills of teachers would solve the problems in a more constructive way.

METHOD

The quantitative research "Assessment of Student Views on the Communicative Behaviours" which consists of quantitative sections is a screening model research identifying the student views. Screening models are the research approaches aiming at describing a past or existing situation as it is (Karasar, 1994).

Under the quantitative research, the communication behaviours of instructors in classroom management were identified and then, it was analysed whether such behaviours vary based on several independent variables *(age, gender, nationality, using communication skills, and curriculum)*. After that, five different sub-dimensions were developed and adapted as a result of factor analysis obtained in line with the views of studentsregarding the communication styles in classroom management. When it was investigated under 5 **different dependent variables**, it formed sub-dimensions as *1. Form of address, 2. Lecturing, 3. Use of Grammar, 4. Respect to the environment, 5. Clarity of communication,* and afterwards such behaviours were analyzed whether they varybased on several independent variables *(age, gender, class, nationalities, locations they lived the longest, using theircommunication skills, any previous training on communication, their satisfaction on the educational programs, the type of high school they graduated from)*

Factor analysis was utilised in this research in consideration of the data obtained. Afterwards, the content analysis was used in the analysis and interpretation of the quantitative data obtained from the participants. In addition to using SPSS 23.0 program for the quantitative data, correlation, t-test and F-test statistical techniques were conducted.

Population and Sample

The students from the private universities located in Northern Cyprus, who actively continue their education in the academic year of 2016-2017 comprise the population of research. The Stratified Random Sampling method was used to select a representative sample for the population of study, as it would be difficult to reach the whole study population in terms of time, cost and control. The participating students will be stratified according to their departments and a number of certain students from each department would be included into the sample based on their weight of their category. Afterwards, a selection process will take place through simple random sampling method from these categories. Accordingly, the number of participants that should be selected from the population of the research consisting of 1815 students is 317 considering the level of confidence with 95% and sampling error with 5% (Krejcie & Morgan, 1970).The departmental distribution of students constituting the sample group is as follows: (Mathematics: 26, Classroom Teaching: 29, Science: 79, Special Education: 61, Social Sciences: 7, Computer and Instructional Technology Education: 14, English Teaching: 19, Preschool Teaching: 61, Art Teaching: 4, Physical Science Education: 10, Geography: 7) and the total number of students is 317.

Data Collection Techniques

A personal information form was applied to the participants by the researcher. At the same time, "Communication Behaviors Evaluation Scale" was applied to the sample group. The inventory "Measuring Communication Behavior of Instructors" developed by Samsa in 2005 was used to collect the data of this research. Data collection tool consists of three sections. The first part consists of the questions aiming at determining personal information. The second part consists of the questions aiming to determine the level ofinstructors in showing communication behaviours that are defined in the inventory, and finally the third part consists of the questions aiming to find out the frequency that instructors show communication behaviours. The inventory "Measuring Communication Behavior of Instructors" consists of 42 questions. The items in the first part of the scale were assessed as "all of them" 4, "most of them" 3, "a part of them" 2, "none of them" 1 based on 4 likert type scale. The items in the second part of the scale were valued as "always" 4, "frequently" 3, "occasionally" 2, "never" 1 based on 4 likert type scale. The reliability of the inventory "Measuring Communication s of Instructors" was tested by Samsa and found as 0.89 (2005).

The general purpose of the research is to determine the views of students regarding communication styles in classroom management. The sub-dimensions were found following the assessment based on the 5 dependent variables *1. Form of address, 2. Lecturing, 3. Use of Grammar, 4. Respect to the environment, 5. Clarity of communication*, all generated as a result of exploratory factor analysis in respect to the results from the sample group of research,

Table 1. Test results of KMO and Bartlett's Test

Kaiser-Meyer-Olkin Sample Competency Measurement		0.813
Bartlett's Test of Sphericity	Approximate chi-square value	12629.234
	df	595
	p	0.000

Table 2. Described Difference Matrix

	Inception Eigenvalues			Converted Sum of Squared Weights		
	Total	Variation Percentage	Cumulative Percentage	Total	Variation Percentage	Cumulative Percentage
1	8.410	24.030	24.030	5.799	16.569	16.569
2	4.121	11.776	35.805	4.626	13.217	29.786
3	2.440	6.972	42.777	3.438	9.823	39.609
4	2.135	6.101	48.878	2.953	8.436	48.045
5	1.769	5.054	53.932	2.060	5.887	53.932
6	.623	4.636	58.568			
7	.494	4.269	62.837			
8	.367	3.906	66.743			
9	.165	3.328	70.071			
10	.071	3.059	73.129			
11	.026	2.931	76.060			
12	.934	2.669	78.729			
13	.908	2.595	81.325			
14	.807	2.306	83.631			
15	.734	2.098	85.728			
16	.669	1.913	87.641			
17	.660	1.886	89.527			
18	.578	1.653	91.180			
19	.544	1.555	92.735			
20	.462	1.319	94.054			
21	.447	1.276	95.331			
22	.382	1.091	96.422			
23	.361	1.032	97.454			
24	.332	.948	98.402			
25	.198	.566	98.968			
26	.106	.303	99.271			
27	.089	.255	99.526			
28	.051	.145	99.671			
29	.046	.131	99.802			
30	.024	.068	99.870			
31	.018	.051	99.922			
32	.014	.041	99.963			
33	.008	.024	99.987			
34	.004	.010	99.997			
35	.001	.003	100.000			

which used "Measuring CommunicationBehaviors of Instructors" and they were adapted accordingly. The scale was structured with 5 factor scale, and in consideration of the content and structures of the items in these factors; "Form of address" consists of 12 items (8, 15, 18, 22, 24, 25, 26, 27, 29, 34, 37, 41), "Use of Grammar" consists of 13 items (3, 4, 10, 19, 20, 21, 23, 28, 35, 38, 39, 40, 42), "Lecturing" 7 items (5, 12, 13, 14, 31, 32, 33), "Respect to the environment" 5 items (2, 6, 9, 11, 30) and "Clarity of communication" 5 items (1, 7, 16, 17, 36) respectively. Sub-dimensions were analyzed whether they vary according to several variables *(age, gender, class, nationalities locations they lived the longest, evaluating communication skills, whether they received any training on communication before, their satisfaction on the educational programs, the type of high school they graduated from)*.

Validity of Communication Behaviour Scale

Exploratory factor analysis of communication behaviors assessment scale

First of all, KMO and Bartlett's Test results were evaluated in order to determine whether the scale is suitable for factor analysis. The items whose factor loads were under 0.30 value were excluded from the analysis.

According to **Table 1**, Bartlett test developed by Bartlett is the sphericity test testing the integrity of the main mass. The sphericity test value is calculated as 3938.966 in the analysis. This value is significant at level of significance of 0.00, which shows that there is a relation between the variables in the main mass.

The fact that KMO value is above 0.60 and around 0.81 has shown that the sample size is sufficient for applying factor analysis (Cerny & Kaiser, 1977). The difference description level of the factors as a result of the factor analysis made in SPSS are given in the **Table 2**.

Table 3. Factor Loads

	Factors				
	Form of Address	Lecturing	Use of Grammer	Respect to the Environment	Clarity of communication
37. Causes meaning gap (expression deficiencies) while aiming to keep the text short.	0.737				
18. Way of expression is clear, certain and absolute.	0.730				
26. Distracts the fluency of speech by halting constantly (at the sounds such as a, e, ı).	0.688				
24. Has a comprehensive vocabulary for the form of address.	0.671				
41. Avoids using unnecessary Word during talking.	0.661				
29. Avoids embodying abstract concepts during a lecture.	0.660				
22. Gives consideration to use proper grammer in writing.	0.641				
15. Constantly interrupts during talking and takes the talking turn of others.	0.572				
8. Empathizes while listening.	0.557				
34. Uses sentences that will not bore people while listening and lead them to listen.	0.554				
25. Ignores the perception levels of listeners in choosing words.	0.485				
20. Avoids unnecessary repetitions lest prolong the texts.		0.771			
23. Reiterates the important points with words and statements during lecturing.		0.764			
39. Constantly critisize the listener instead of listening.		0.762			
42. Meanings used in the text is appropriate to the competence of readers.		0.758			
28. Avoids emphasizing the important points during a lecture.		0.514			
10. Avoids giving clear and certain answers in answering questions.		0.493			
21. Uses soft, relaxing tone of voice in addressing.		0.487			
40. Words used in talking do not comply with the grammer rules.		0.483			
19. Sentences do not make any sense during talking.		0.452			
38. Offenses the others during a lecture through mocking attitudes.		0.449			
32. Acts fast and anxious during a lecture.			0.812		
13. Have various typos in writings.			0.808		
31. Uses appropriate words in exact places under writings.			0.659		
12. Uses a form of address that is close to the students.			0.650		
14. keeps the period of a lesson more than normal.			0.584		
33. Gives care to the concent order of writing.			0.583		
4. Has a comprehensive vocabulary in addressing people.				0.570	
11. Gives care to wear appropriately.				0.549	
3. Uses meaningful sentences in writing.				0.531	
2. Constantly deal with other things during communication.				0.502	
9. Respects the ideas of others.				0.436	
6. Always turns the face to the board during lecturing.				0.407	
17. Avoids jabbering while talking.					0.760
36. Focuses only the other person while talking rather than dealing with other things.					0.759

As seen in **Table 2**, the difference decription rate of 4 factors with an eigenvalue more than 1 was found as 53,93% cumulatively. According to the factor analysis, the difference of such factors with an eigenvalue more than 1refers to the description level. Considering that this rate should be minimum 50%, this rate is sufficient enough in the reflection of difference description level. The factor load of each factor is given in **Table 3**.

Pursuant to **Table 3, the dependent variables via the factor analysis results are categorised under five sub-dimensions.**

1. Form of Address
2. Lecturing
3. Use of grammar
4. Respect to the environment
5. Clarity of communication

The first factor is "the Form of Address", which represents the 16.57% of total difference. The second factor is "Lecturing" representing the 13.21% of total difference. The third factor is "Use of Grammar" and the fourth factor is "Clarity of Communication" referring to the 5.88% of total difference.

Confirmatory factor analysis of communication behavior assessment scale

Upon the generation of a structure with 5 factors comprised of 35 items, AFA results were taken as a basis and the model of scale with a 5 dimension structure was tested with DFA. The generated data were analyzed by statistics program.
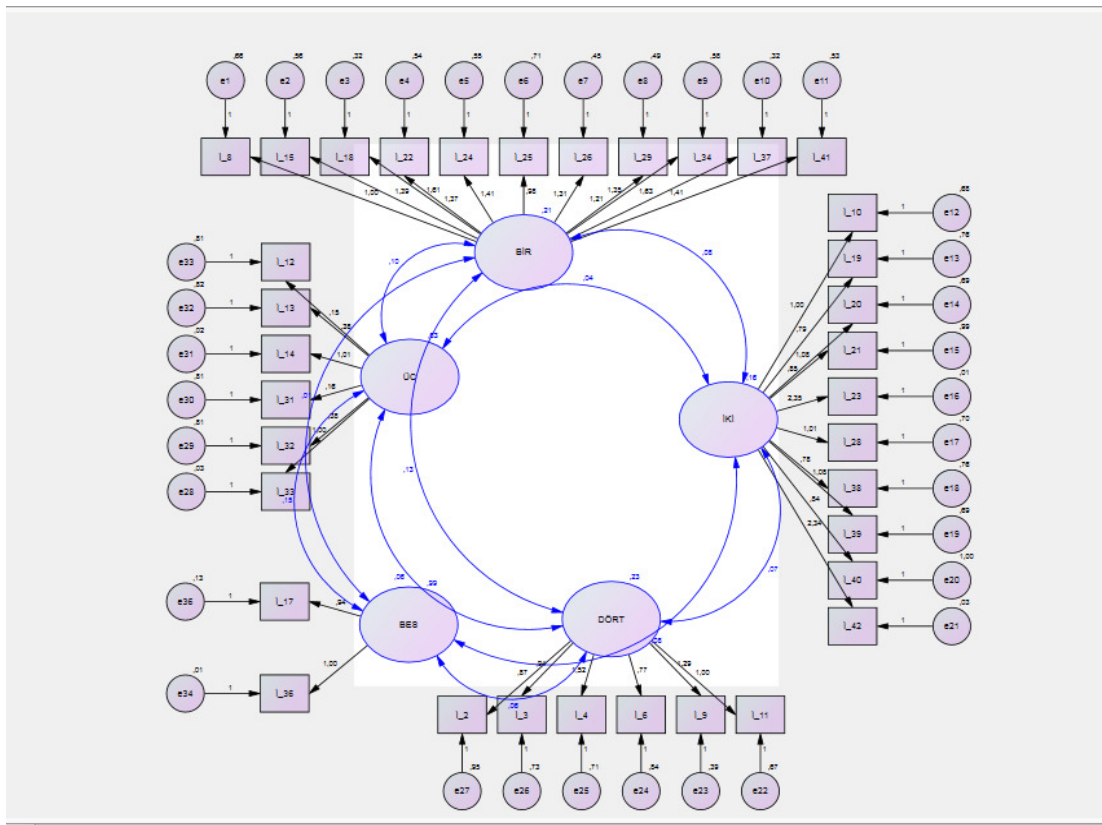
Figure 1. Standardized Results and DFA

Table 4. Fit Indices for Confirmatory Factor Analysis

χ²	df	p	χ²/ df	CFI	RMSEA
883.132	199	0.000	4.438	0.916	0.073

First of all, that χ²/ df value is between 3 and 5, which demonstrates that the model is appropriate for the observed structure (Byrne, 1998).

While the value between 0.90-0.95 is acceptable for goodness of fit indexes, the value above 0.95 signifies a high coherence (Dickey, 1996; Stapleton, 1997; Byrne, 2013). The CFI value in **Table 6** as 0.916 shows that the model is compatible with the data. On the other hand, the error (incompatibility) indices of the model are foreseen to be between 0.05-0.08; the model might be considered as good when the value is under 0.05. Particularly, the index value of the Mean Squared Error (MSE) is close to 0.00 demonstrates a good compatibility. The MSE value less than 0.05 indicates that there is a minimal error between the observed and produced matrixes and there is a perfect compatibility (Browne & Cudeck, 1993). The calculation of mean squared error (MSE) value for the model in this study is 0.073, namely; between 0.08 and 0.05, which demonstrates that the error ratio between the observed and produced matrixes is at an acceptable level. In this case, the 5 factor scale generated as a result of exploratory factor analyses can be considered a scale with good construct validity.

Reliability of Communication Behavior AssessmentScale (İBE)

In this phase, the validity and reliability analyses for the scale were performed that were used in the research process and measured through scoring. Cronbach's Alpha test statistics were used for the validity and reliability of the questionnaire.

As it can be seen in **Table 5**, it was concluded that; the reliability of sub-dimension Form of address under the Communication Behavior Assessment Scale is α=0.888, Lecturing as α=0.857 quite reliable; the use of grammar with α=0.822 is quite reliable; Respect to the environment with α=0.793 is quite reliable; and finally the Clarity of communication with α=0.863 is quite reliable respectively. Thus, these values are sufficient for this research.

Table 5. Reliability of Communication Behavior Assessment Scale

	Cronbach's Alpha	Item Number
WForm of address	0.888	11
Lecturing	0.857	10
Use of Grammar	0.822	6
ERespect to the environment	0.793	6
QClarity of communication	0.863	2

Table 6. Reliability and Validity Analysis of the Scale

	Frequency of Instructor	Frequency of Behaviour
NItem Numberfrom the Scale	42	42
Cronbach's Alfa	0.886	0.865

Reliability and validity analysis of the scale

In relation with communcaition scale, the reliability analysis results in relation with the frequency levels of instructors and their behaviours are in **Table 6**.

The alpha values calculated as a result of reliability analysis in **Table 6** for the instructor frequency and behaviour frequency were found to be respectively 88.6% and 86.5%. Considering the related values, we can say that the scale is reliable. Furthermore, no item was found to decrease the reliability considerably and that should be exempted from the scale.

For the application of questionnaire, the necessary consent was taken and afterwards, a pilot interview was held by selecting an equivalent sample group to the actual sample group. Therefore, it has been detected whether the questions were clear and understandable and the answers reflected the questions that were asked. Later on, during the preparation of interview question again, the professionals, experts of computer and education management and Turkish language linguists for spelling rules were consulted, and an assistance was taken pursuant to whether the questions are clear and understandable, cover the subject herein and provide the required information. Considering that the interview questions would generate the necessary data, the data collection was launched and then applied to the classes. The instructors of the related classes were asked for permission and the scale was applied to the students before the lessons. After the application, the invalid questionnaires due to the reasons such as leaving incomplete, empty, making more than one choice, etc. were excluded and the remaining 317 questionnaires were taken under assessment.Firstly, the communicationbehaviours of instructors in the classroom management were identified and then, the analysis was conducted whether such behaviours vary based on variousvariables, and the demographic characteristics of the students participating the scale.

In this research, the content analysis was used in the analysis and interpretation of the quantitative data obtained from the participants. In addition to using statistics program for the quantitative data, correlation, t-test and F-test statistical techniques were conducted.

Data Analysis

Statistics package program was used in the analysis of the data obtained from the Communication Behavior Assessment Scale applied to the sample group. *Kolmogorov-Smirnov* tests were conducted to test whether dependent variable scores were normally distributed. As a result of these tests conducted for all dependent variables, the values of $0.678 \leq D(317) \leq 0.453$, $0.232 \leq p \leq 0.546$ were obtained. In this context, it was identified that each of the dependent variables showed normal distribution. As the binary correlation coefficients between dependent variables are higher than 0.84 value, the independent groups showed that the use of *t*-test and ANOVA data analysis methods is suitable (Maxwell, 2001). Upon a result of significant difference in the ANOVA test, first the homogeneity of differences were analyzed and in case of homogeneous differences the Scheffe Test and if not then Tamhane's T² Test were performed. The level of significance is accepted as .05 in the interpretation of all results. The frequency analysis was used for the findings regarding the demographic and personal information of the sample group participants. Frequency analysis (f) was conducted to tabulate the data as numbers and percentages (%) in order to describe the characteristics of the distribution of the scores or values belonging to the variables. The data of contrary items with regard to communication in the scale was inverted and included in calculations in the course of analysis. Similarly, the related factswere transposed verbally and the inclusion of contrary items under the scale was prevented. The levels of statements in the scale were prepared on the basis of 4-way likert scale principle; the average of the statements close to 1 signify the most negative/rare while the statements close to 4 represent the most positive/strict. The limits regarding the mentioned levels are given in **Table 8**.

Table 7. *t* Test Results by Gender

		N	Average	SD	t	p
WFORM OF ADDRESS	Female	153	1.77	0.58	-1.039	0.300
	Male	164	1.85	0.72		
LECTURING	Female	153	2.13	0.61	-2.809	0.005
	Male	164	2.33	0.64		
USE OF GRAMMAR	Female	153	2.42	0.62	-2.648	0.008
	Male	164	2.62	0.66		
ERESPECT TO THE ENVIRONMENT	Female	153	2.23	0.62	0.221	0.825
	Male	164	2.22	0.64		
QCLARITY OF COMMUNICATION	Female	153	2.53	0.98	-0.008	0.994
	Male	164	2.53	1.00		

Table 8. Gender Based T Test

		N	AAve.	SD	F	p
WFORM OF ADDRESS	18-29 ages	292	1.85	0.71	1.473	0.030
	30-35 ages	25	1.81	0.58		
	Total	317				
LECTURING	18-29 ages	292	2.31	0.67	3.553	0.231
	30-35 ages	25	2.17	0.56		
	Total	317		0.63		
USE OF GRAMMAR	18-29 ages	292	2.51	0.68	0.931	0.395
	30-35 ages	25	2.52	0.63		
	Total	317		0.65		
ERESPECT TO THE ENVIRONMENT	18-29 ages	292	2.25	0.68	0.454	0.636
	30-35 ages	25	2.18	0.55		
	Total	317		0.63		
QCLARITY OF COMMUNICATION	18-29 ages	292	2.48	1.03	1.680	0.188
	30-35 ages	25	2.66	0.93		
	Total	317		0.99		

FINDINGS

This section of the research includes the findings obtained as a result of the analysis through appropriate statistical method for the data generated in order to explain the demographical information for thesample group and resolve the sub-problem of research, and the interpretation of such findings.

As seen in **Table 7**, upon the result of independent groups *t* test performed to identify whether "Form of Address" scores reflect significant difference in terms of gender variable, the differencebetween arithmetic averagess of the groups was not found significant (p>0.05).

Upon the result of independent groups *t* test performed to identify whether "Lecturing" scores reflect significant difference in terms of gender variable, the difference between arithmetic averagess of the groups was found significant (p<0.05).Consequently, the way of lecturing of male participants is higher than female participants.

Upon the result of independent groups *t* test performed to identify whether "Use of Grammar" scores reflect significant difference in terms of gender variable, the difference between arithmetic averagess of the groups was found significant (p<0.05). Consequently, the use of grammar by female participants is higher than male participants.

Upon the result of independent groups *t* test performed to identify whether "Respect to the environment" and "clarity of communication" scores reflect significant difference in terms of gender variable, the difference between arithmetic averagess of the groups was not found significant (p>0.05).

As seen in **Table 8**, upon the result of independent groups *t* test performed to identify whether "Form of Address" scores reflect significant difference in terms of age variable, the difference between arithmetic averagess of the groups was found significant (p>0.05). Thus, form of address of the participants between the ages of 18-29 is found as higher than the participants at the age of 30 and above.

Upon the result of independent groups *t* test performed to identify whether "Lecturing", "Use of Grammar", "Clarity of Communication", "Respect to the Environment" scores reflect significant difference in terms of age variable, the difference between arithmetic averagess of the groups was not found significant (p>0.05)

Table 9. ANOVA by Nationality

		N	Ave.	SD	F	p	Difference
FORM OF ADDRESS	TRNC	59	1.66	0.52	1.391	0.246	
	TR	128	1.85	0.59			
	TR+TRNC	92	1.85	0.77			
	Other	38	1.87	0.73			
	Total	317	1.82	0.65			
LECTURING	TRNC	59	1.99	0.58	4.35	0.005	TR+TRNC>TRNC TR+TRNC<TRNC
	TR	128	2.27	0.60			
	TR+TRNC	92	2.36	0.68			
	Other	38	2.23	0.65			
	Total	317	2.24	0.63			
USE OF GRAMMAR	TRNC	59	2.61	0.69	0.712	0.545	
	TR	128	2.47	0.60			
	TR+TRNC	92	2.55	0.68			
	Other	38	2.56	0.71			
	Total	317	2.53	0.65			
RESPECT TO THE ENVIRONMENT	TRNC	59	2.20	0.58	0.348	0.791	
	TR	128	2.19	0.57			
	TR+TRNC	92	2.27	0.67			
	Other	38	2.26	0.75			
	Total	317	2.23	0.63			
CLARITY OF COMMUNICATION	TRNC	59	2.59	0.94	0.552	0.647	
	TR	128	2.59	0.90			
	TR+TRNC	92	2.47	1.07			
	Other	38	2.41	1.14			
	Total	317	2.53	0.99			

As seen in **Table 9**, upon the result of ANOVA performed to identify whether the results of "Form of Address", "Use of Grammar", "Respect to the Environment", "Clarity of Communication" reflect significant difference in terms of nationality variable, the difference between arithmetic averagess of the groups was not found significant (p>0.05).

Upon the result of ANOVA performed to identify whether the score of "Lecturing" reflect significant difference in terms of nationality variable, the difference between arithmetic averagess of the groups was found significant (p>0.05). Hence, the lecturing of participants with TRNC and TR nationalities is higher than the participants with TR and TRNC nationalities.

As seen in **Table 10**, upon the result of ANOVA performed to identify whether the results of "Form of Address" reflect significant difference in terms of the department of study variable, the difference between arithmetic averagess of the groups was found significant (p>0.05). Theform of address of the participants from Music Department is higher than the participants from the Classroom Teaching, Psychological Counseling and Guidance and Pre-school Teaching.

Table 10. ANOVA by Department

		N	Average	SD	F	p	Difference
WFORM OF ADDRESS	Turkish Teaching	26	1.89	0.80	2.314	0.012	Music > Classroom Teaching Music > Psychological Counseling and Guidance Music > Pre-school Teaching
	Classroom Teaching	29	1.62	0.53			
	Psychological Counseling and Guidance	79	1.80	0.62			
	Special Education	61	1.84	0.73			
	Social Sciences	7	2.01	0.56			
	Computer Education and Instructional Technology	14	2.14	0.65			
	English Teaching	19	1.48	0.51			
	Pre-school	61	1.75	0.59			
	Painting	4	2.45	1.12			
	Music	10	2.23	0.39			
	Geography	7	2.16	0.57			
	Total	317	1.82	0.65			
LECTURING	Turkish Teaching	26	2.39	0.59	1.932	0.041	Music > Classroom Teaching
	Classroom Teaching	29	1.99	0.65			
	Psychological Counseling and Guidance	79	2.17	0.65			
	Special Education	61	2.37	0.65			
	Social Sciences	7	2.36	0.52			
	Computer Education and Instructional Technology	14	2.26	0.39			
	English Teaching	19	2.05	0.74			
	Pre-school	61	2.22	0.61			
	Painting	4	1.98	0.91			
	Music	10	2.75	0.34			
	Geography	7	2.23	0.49			
	Total	317	2.24	0.63			
USE OF GRAMMAR	Turkish Teaching	26	2.49	0.66	0.566	0.841	
	Classroom Teaching	29	2.55	0.63			
	Psychological Counseling and Guidance	79	2.58	0.65			
	Special Education	61	2.56	0.73			
	Social Sciences	7	2.43	0.37			
	Computer Education and Instructional Technology	14	2.38	0.47			
	English Teaching	19	2.46	0.83			
	Pre-school	61	2.51	0.62			
	Painting	4	1.92	0.83			
	Music	10	2.60	0.48			
	Geography	7	2.60	0.48			
	Total	317	2.53	0.65			
ERESPECT TO THE ENVIRONMENT	Turkish Teaching	26	2.55	0.58	1.545	0.123	
	Classroom Teaching	29	2.22	0.61			
	Psychological Counseling and Guidance	79	2.25	0.61			
	Special Education	61	2.15	0.60			
	Social Sciences	7	2.02	0.56			
	Computer Education and Instructional Technology	14	2.44	0.64			
	English Teaching	19	2.03	0.64			
	Pre-school	61	2.18	0.66			
	Painting	4	1.75	0.87			
	Music	10	2.30	0.57			
	Geography	7	2.31	0.70			
	Total	317	2.23	0.63			
QCLARITY OF COMMUNICATION	Turkish Teaching	26	2.58	1.03	1.050	0.401	
	Classroom Teaching	29	2.69	1.04			
	Psychological Counseling and Guidance	79	2.43	1.05			
	Special Education	61	2.59	0.88			
	Social Sciences	7	2.86	1.07			
	Computer Education and Instructional Technology	14	2.79	1.12			
	English Teaching	19	2.11	1.10			
	Pre-school	61	2.57	0.92			
	Painting	4	1.75	0.96			
	Music	10	2.50	0.94			
	Geography	7	2.86	0.56			
	Total	317	2.53	0.99			

Upon the result of ANOVA performed to identify whether the score of "Lecturing" reflect significant difference in terms of the department of study variable, the difference between arithmetic averagess of the groups was found significant ($p > 0.05$). Hence, the lecturing of participants from the music department is higher than the participants from Classroom teaching.

Table 11. Anova by Communication Skills

		N	Ave.	SD	F	p	DDifference
WFORM OF ADDRESS	Good	25	1.79	0.84	1.600	0.204	
	MAverage	235	1.79	0.62			
	Bad	57	1.96	0.69			
	Total	317	1.82	0.65			
LECTURING	Good	25	2.32	0.78	1.531	0.218	
	MAverage	235	2.20	0.61			
	Bad	57	2.35	0.65			
	Total	317	2.24	0.63			
USE OF GRAMMAR	Good	25	2.57	0.77	0.068	0.934	
	MAverage	235	2.52	0.64			
	Bad	57	2.53	0.67			
	Total	317	2.53	0.65			
ERESPECT TO THE ENVIRONMENT	Good	25	2.14	0.65	3.113	0.046	Medium > Good
	MAverage	235	2.19	0.63			
	Bad	57	2.41	0.59			
	Total	317	2.23	0.63			
QCLARITY OF COMMUNICATION	Good	25	2.40	1.19	0.654	0.521	
	MAverage	235	2.57	0.98			
	Bad	57	2.44	0.93			
	Total	317	2.53	0.99			

Upon the result of ANOVA performed to identify whether the score of "Use of Grammar", "Respect to the Environment", "Clarity of Communication" reflect significant difference in terms of the department of study variable, the difference between arithmetic averagess of the groups was not found significant (p>0.05).

As seen in **Table 11**, upon the result of ANOVA performed to identify whether the results of "Form of address", "Lecturing", "Use of Grammar", "Clarity of communication" reflect significant difference in terms of the communication skill variable, the difference between arithmetic averagess of the groups was not found significant (p>0.05).

Upon the result of ANOVA performed to identify whether the score of "Respect to the Environment", reflects significant difference in terms of the communication skill variable, the difference between arithmetic averages of the groups was found significant (p<0.05). It was observed that the participants with an average communication skills have higher level of respecting to the environment than the participants with good communication skills.

CONCLUSION AND RECOMMENDATIONS

This section indicates the findings from the research and results based on interpretation and includes recommendations pursuant to such results.

Results

1. Pursuant to the significance relation of dependent variables based on the *gender variable*, upon the result of independent groups *t* test performed to identify whether "*Form of Address*", "*Respect to the Environment*", "*Clarity of Communication*" scores reflect significant difference in terms of gender variable, the difference between arithmetic averagess of the groups was not found significant (p>0.05).Additionally, the result of independent groups *t* test performed to identify whether "Lecturing" scores reflect significant difference in terms of gender variable, the difference between arithmetic averages of the groups was found significant (p<0.05. Therefore, the lecturing levels of male participants is higher than female participants. As a result of the independent groups *t* test performed to identify whether "Use of Grammar" scores reflect significant difference in terms of gender variable, the difference between arithmetic averagess of the groups was found significant (p<0.05 Hence, the use of grammar by female participants is higher than male participants. The fact of same student expectations under the scopes of different classes indicates that the interaction styles and attitudes of teachers are known (Coates, 2015).

2. Pursuant to the significance relation of dependent variables based on the *age variable*, upon the identification whether "*Form of Address*" scores reflect significant difference in terms of age variable, the difference between arithmetic averagess of the groups was found significant. Thus, the form of address of participants between the ages of 18-35 is observed higher than the participants at the age of 36 and above. No significant differencewas found in the scores of "*Lecturing*","*Use of Grammar*","*Respect to the environment*", "*Clarity of communication*"based on the age variable. The study of Masuda et al. (2005) aimed to reflect the interaction of race,

gender and experiences with the psychological support covered theJapanese studentsand American university students. In consideration with the study results, Japanese people need more psychological support and have more respect for the experts working in the domain ofmental health than those without any experience.

3. Pursuant to the significance relation of dependent variables based on the *nationality variable*, upon the identification whether "*Form of Address*", "*Use of Grammar*", "*Respect to the Environment*", "*Clarity of Communication*", the difference was not found significant; while the there is a significant difference based on the scores of "*Lecturing*". Hence, the lecturing levels of participants both with TRNC and TR nationality are higher than the participants with TR and TRNC nationalities.

4. Pursuant to the significance relation of dependent variables based on the *department of study variable*, the "*Form of Address*" scores reflect significant difference in terms of department of study variable. The form of address of the participants from the Music Department is higher than the participants from the Classroom Teaching, Psychological Counseling and Guidance and Pre-school Teaching. Furthermore, a significant differencewas found in "Lecturing" scores according to the department of study variable. The lecturing levels of the participants from the Music Department is higher than the participants from the Classroom Teaching. In consideration with the other dependent variables, no significant differencewas found in the scores of *"Use of Grammar","Respect to the environment"*, *"Clarity of communication"* according to the department of study variable.

In a research of the attitudesof classroom teaching students and instructors towards the perceptions fit to democracy (Erdem & Sarıtaş, 2006), the attitudes for lecturing in parallel with their own ideas, not behaving negative to the students with opposite opinions, their ideals, judgments of the students to be friends with the students, coping with the problems of the students, understanding the students in the class, making them adapt have been found very low. In the similar topics like "students working on the out-of-class problems", the openness to criticism, arguing during the class, giving the opportunity to change the place of student are very crucial attitudes.

5. Pursuant to the significance relation of dependent variables based on the *communication skill variable*, the "*Form of Address*", "*Lecturing*", "*Clarity of Communication*" scores do not reflect significant difference in terms of communication skills variable. Therefore, the significant difference was only found in "Respect to the environment" scores according to the communication skills variable. It was observed that therespect to the environment levels of the participants with average communication skills are higher than the participants with good communication skills.

The study conducted concerning the assessment of cognitif awareness and motives of students from the classroom teaching in relation with several socio-demographic variables (Saban, 2008), the students from different age clusters have similar averages under the sub-scales other than the averages of "effort" sub-scale (X 17-19 age= 4.15, X 20-22 age=4.02, X 23 and above=3.88) in case of assessment the cognitive awareness and motive by the ages of students.

In consideration of general results, we can conclude that the teachers, students and class are at the core of education and training activities. The first exposure of students with the instructor and high level of communicationoccur within the classroom. Many students may finish their school without any communication with their instructors out-of-the classroom. Therefore, the quality of education at school mainly depends on the classroom, quality of classroom and quality of in-class. One of the steps toenhance the quality of education at school is to identify the level of communication skills of instructors in the classroom management and avoid any deficiency.

RECOMMENDATIONS

The following recommendations could be developed in line with the results of this research.

i. The instructors should care about the language that they use while talking and avoid any unnecessary repetitions and give more effortto use an appropriate, simple, fluent and clear way of expression.

ii. The instructors should avoid using sentences that could be misunderstood and misinterpreted.

iii. The instructors should care about using body language more efficiently.

iv. The instructors should have more sincere relations with their students and also have a close contact with them.

v. Even though the instructors do not make any comprise from using academic language, they should write more simple and clear, and they should not consider academic language as making incomprehensible sentences. .

vi. The students should improve themselves so that they understand the level of academic wording.

vii. The instructors should avoid unnecessary repetition in their grading.

viii. The instructors should empathize with students and minimize the distances with the students.

ix. Organizations that can bring instructors and students closer in out-of-class environments might be organised.

x. Effective communication skills can be developed provided to individual efforts and acquiring the training accordingly.

xi. Further studies similar to this should be conducted regarding the communication status of students in from the perspective of instructors and the deficiencies should be identifiedand resolved in the respectively.

xii. Within the scope of similar studies and results generated under the inventory used in this research, 5 dependent variables of the inventory was determined. Thus, the scale used in this study was redeveloped and a new inventory has been introduced to the literature. This inventory is suggested to be used in different sections and, therefore, the interpretation of the results will become easier and there will be a possibility for comparison.

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Risk in Implementing New Electronic Management Systems at Universities

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ABSTRACT

Rapid development of using information technology in *higher education* contributes not only into its efficiency but also may cause a variety of risks affecting implementation of some other educational process aspects. Understanding the significance of the risks and their subsequent study and assessment allows for timely adjustments in implementation of certain informational and educational technologies in the educational process. The paper focuses on the issues related to identification of the major risks while introducing and implementing educational innovations, and those related to introduction of the *learning management system* (LMS) in higher education institutions, their impact assessment and influence on the efficiency throughout the entire educational process. The results of the study have been summarized using risk mapping and sensitivity analysis methods. These methods allowed us to visualize the level of each risk distinguished in the study according to the degree of its influence on the educational process and probability of its occurrence. The study was based on the survey findings and students' interviews and aimed to identify whether they understand and realize the difficulties and complexities in the procedure of innovative technologies implementation by their university. The authors have developed a list of risks occurring while introducing and implementing innovations in the educational process which in their turn will reflect the peculiarities of the higher education institution using modern learning techniques. Moreover, the paper discusses the risk sensitivity study results. They are presented as an expert appraisal of risks related to their influence on the resultant as integrated assessment, i.e. the *Wheel Model* of *risk* management. In the course of the study it has been found that, despite the difficulties of innovation implementation, the innovative programs having been introduced improve the educational process and ensure appropriate quality of human capital, or workforce. Reasonable conclusions from the experience of the state-of the art innovation introduction into university teaching-learning process confirm its practical significance, its ability to encourage university students and increase their participation and independence in learning, thus contributing to development of their skills that meet the requirements of an economist position and in future will help them be successfully engaged into innovation economics. These students' skills and competencies meet the requirements of innovative processes in the economy, despite the fact that the process involves certain risks. The paper materials may be of practical value to professionals involved in the development and implementation of innovative educational technologies at universities.

Keywords: innovation, risks, educational technology, higher education

Contribution of this paper to the literature

- The authors offer a list of questions to identify possible deterioration in the quality of education caused by partial turn down in introduction of new methods into educational process.
- The paper presents risk assessment of education quality deterioration as it is reflected and understood by university students. The assessment is based on indicators of risk emergency probability and their impact; it is used for further development of risk maps that had been developed by the authors earlier.
- Risks were identified, the sensitivity analysis of risks was carried out, influence determinants leading to either increase or decrease of the risks were established.
- With the aim of deepening the study and ensuring its clarity the Wheel Model of risks has been built to provide a comprehensive risk assessment in a higher educational institution on the basis of considering boundaries for risk indicator influence.

INTRODUCTION

The Relevance of the Research

The specific conditions of the modern information economy (knowledge economy) are characterized by new patterns of innovations development *and* technology upgrading at the global level especially those related to education and training. Their study is able to ensure competitive training of specialists. The Republic of Tatarstan adopted Social and Economic Development Strategy of the Republic for the period up to 2030 (Development Strategy for socio-economic development of the Republic of Tatarstan for the period up to 2030, 2015) where special importance is given to the role of human capital which is considered as one of the major competitive advantages in Russia; and its optimization has been always considered as a priority for the country. The current region investment policy is aimed at the development of not only industrial projects (Kvon & Vaks, 2017), but also projects related to human capital formation and development.

Higher educational institutions training highly qualified specialists are of great significance as their training is considered to be a tool for developing highly skilled and motivated personnel (Galushkin, 2015). In addition, the authors have examined student as a future subject of professional activity (Khasanova et al., 2015; Shushara & Khuziakhmetov, 2017; Khrulyova & Sakhieva, 2017) and indicated that quantitative and qualitative changes of human capital are able to make a significant influence on labour market and its participants. The need to increase competitiveness of human capital has been discussed in the works of Vaks (2015, 2016).

Introduction and implementation of innovative technologies in the educational process may be connected with risks. Historically, the concept of risk was defined as person's awareness of some probable hazardous event or phenomenon in the present or future associated (or not associated) with his actions. Educational environment, thus, is a fairly specific community characterized by its own particular risks (Levina et al., 2017; Mukhametzyanova, 2016) and they require special consideration. In connection with the foregoing, we should add that the relevance of the research is that it attempts through certain inner risks analysis and assessment provide insight into innovative technologies introduction in higher educational system of Russia. Decrease in negative effect of these risks provides the increase in competitiveness of future labor market participants.

Purpose and Objectives of the Study

The aim of the study is to analyze the impact of innovative educational technology application and the occurring risks in the process of training competitive professionals through implementing innovative technologies into educational activities, in particular, the use of electronic training management system at universities.

The following objectives of the study were defined:

1. Assessment of the implementation impact of a virtual learning environment and Blackboard Learn course management system on the educational process from the point of view of students.
2. The study and characterization of the emerging risk impact on the quality of educational activities while using Blackboard Learn.
3. Conducting sensitivity analysis and designing risk maps to generalize the results and outcomes of the study carried out to assess risks perceived by students.

The analysis is based on surveys of third- and fourth-year students majoring in Economics, full-time study, and processing of the obtained results.

LITERATURE REVIEW

Innovative transformation of socio-economic processes requires appropriate changes to be made both in production and in educational spheres. The concept involving active incorporation of the integrated approach into engineering education is currently under way. It implies innovative principles of designing syllabus, close to true production conditions related to material support and equipment of learning, as well as a special approach to teaching, i.e. creating an environment to support e-learning (Kvon et al., 2017; Kong et al., 2017).

The study of risks in education and, first and foremost, the risks associated with university education quality assurance is considered to be, in our opinion, the most important factor to form a competitive professional actor (participant) in learning process. Moreover, when providing quality learning in professional training, innovative aspects are becoming of great significance and their efficiency analysis should be based on the integrated approach combining both market and public authorities requirements to future participants in labor relations as well as individual requirements of learners and the teaching staff directly involved into the learning process.

Thus, introduction of innovative educational technologies is simultaneously accompanied by occurrence of diverse external and internal risks. The importance of risk reduction in the education sector has been recognized and considered on the government level. Thus, among other key issues in the innovation economy both at the level of the Republic of Tatarstan and the Russian Federation the risk of skilled human resource shortage holds a unique position (Development Strategy for socio-economic development of the Republic of Tatarstan for the period up to 2030, 2015). That means that the need to reduce risks by increasing the degree of innovations in the economy of the country and its educational sector in order to create a competitive human capital has been officially stated.

Innovation drives economic growth. Mukhametzyanova (2016) has identified the following risks according to their decreasing importance:

— labor force participants with no required theoretical knowledge and practical experience in its application to solve the tasks set ;

— low degree of readiness to participate fully in the labour relations and lack of adequate assessment of personal and professionally important qualities;

— lack of competence in the field of teamwork ability.

In our further research we conducted a questionnaire survey to clarify how risks are understood by students. The results was presented in our paper. It should be noted that despite the undeniable advantages of electronic management system in education its implementation, like any other innovation, evoked teaching staff's resistance. According to data available (Khasanova et al., 2017; Cao et al., 2017), there have been seven types of risks reflecting teachers' and students' views on the problems of innovative technique implementation. Moreover, the authors conducted a SWOT analysis, i.e. scanned the internal and external environment in educational institutions which were implementing new educational techniques (Khasanova et al., 2017).

Aspects of insufficient teamwork competencies of educational process actors were presented by Mukhametzyanova et al. (2016) paper. In connection with the above mentioned we should point out the need for educational process actors to form a socio-psychological competence through their professional activity, which is also reflected in the work of the above mentioned author (Muhametzyanova et al., 2016). The research data were used to continue the work in this direction by Ibatullova et al. (2015). The author believes that any implementation of a new approach in the educational process should take into account the peculiarities of students' adaptation to it, thus ensuring interrelation of social and psychological adaptation.

Methodical approaches to create a system for monitoring risks arising from any organization activities regardless of their scope, qualitative and quantitative risk assessments, developing anti-risk events are presented in the work of Rykhtikova (2009).

The concept of mandatory implementation of the educational innovations into teaching process was developed by Dürkheim (1995) who extended his research and presented a model of innovative development of an educational system and due to insufficient technological support focused on methodological factors, though in fact, suggested a pretty innovative approach to organize the student community.

Issues of innovation networking and their impact on social education in educational framework were considered in Shisharina (2016). The work deals with aspects of socialization and educational innovation influence on mobility of a modern economic system.

As it was mentioned above, we consider educational risk study and, first of all, consider risks associated with providing quality higher education (Khasanova et al., 2017; Mukhametzyanova, 2016; Kvon & Vaks, 2017) as the most important factor to form competitive professionals. In our opinion, innovative aspects in achieving professional actors' quality training is now gaining in significance and its efficiency analysis should be based on the integrated approach combining the market and public authority requirements to future participants in

professional labor relations and personal requirements expressed by students and teachers as certain direct participants in the educational process.

Influence of educational techniques on the competitiveness of human capital was discussed in the works of Vaks (2016) with special attention paid to the need to introduce innovative educational technologies to ensure functional and comprehensive educational process in the framework of inclusive education.

Khasanova et al. (2015) discussed the economic aspects of educational technologies implementation through formation of an attitude to the personality of a student, the need of human capital to strive for self-development, study by increasing the activity and independence, as well as through formation of student's personal qualities such as initiative and responsibility. Full and robust implementation of this approach requires innovative solutions available in the education system and in particular those related to their implementation. The investment development of the region is considered in aggregate by Kvon & Vaks (2017) taking into account both production and social aspects.

According to Deb (2014) information technology provides numerous new opportunities; and what is special, in the educational sphere they allow to work with a large number of education providers making little account of territorial remoteness because on-line tutorials and video-conferences allow to organize learning with virtual environments, Interactive Multimedia and virtual reality.

Specifics of side effects of information technologies use while implementing them in educational process are considered in the work of Spitzer (2014) that basically evaluates the features of primary and secondary education; however, considers that in higher education it addresses multi-task implementation issues in training technical professionals and concludes that it leads to problems in maintaining the focus to achieve the educational aim. Therefore, we may say that information technology in education is fraught with significant risks.

Hidden ambivalent nature of the use of information technologies in education has been explored by Shamshina & Koryuhina (2015). They considered the issues of education continuity, particularly when using informal learning technologies such as open distance education. Information technology is an essential condition to ensure this openness; however, if there is no transparency in management they may disseminate harmful or incorrect information.

At the same time, information technologies are being actively introduced at universities. Thus, at the University of Wisconsin–Green Bay (also known as UW–Green Bay or UWGB) 2014 - 2017 Information Technology Strategic Plan (Information Technology Strategic Plan 2014-2017, 2013) has been developed to focus on the use of information technology and create competitive learning advantages at the University. Hence, we can see that despite the presence of side effects, the system of higher education considers it necessary to use information technology but takes into account emerging risks and tries to reduce their consequences.

The importance of information technology in educational projects is also presented in the work of Cândido De Oliveira et al. (2014). He exposed results and outcomes of the study that made it possible to assess the impact of risks arising in the implementation of this sort of projects. The study was conducted on the basis of a survey conducted by experts in this field. The article allowed the authors to identify and prepare the mismatch weights of impacts related to individual types of risks caused by experts' special understanding of the existing problems. The dissonance discussed is caused by significant role of technological resources in contrast to theoretical aspects of risk planning.

The work of Granito & Chernobilsky (2012) considered important aspects of the impact of education support technical means on motivation and aspiration of students to learn new information which was accomplished through implementation of a long-term project. Special attention is paid to the preservation of information. The study was conducted on the basis of repeated students' testing and the results were converted into numerical score to estimate the information retention degree using the Likert scale.

Mansell (1999) is internationally known for her work on the social, economic, and political issues arising from new information and communication technologies. As early as in 1999 she wrote about importance of including all countries, particularly developing ones, in the modern information society (Mansell, 1999). There she focused on the technical component of creating the network infrastructure on the level of organizations and countries, as well as the importance of proper assessment of technological features and implementation strategies, presented basic principles for actions and stages of implementation. Her publications include numerous articles on information society policies by influencing policy makers to acknowledge the complexity of change in the digital world and the legitimate claims of stakeholders, including citizens (Mansell & Tremblay, 2013). Many of her recommendations were repeated in UNESCO's recommendations for the United Nations review of the Millennium Goals. The report was approved for publication by UNESCO and world distribution in Arabic, Chinese, English, French, Portuguese, Spanish and Russian in 2014, in time to influence the final deliberations on the Millennium Goals that bear on how policies concerned with digital technologies can contribute to inclusive development.

Security issues that need to be followed regardless of their area of application have been considered in the work Nikolić & Ružić-Dimitrijević (2009). The paper discusses the risks and assesses the threats arising because e-stored information may be easily altered or lost. Moreover, the article presents a universal algorithm for quantitative risk assessment that allows comparing the obtained results and taking measures to prevent the risks.

MATERIALS AND METHODS

The leading method to study the problem is a quantitative method of risk assessment based on the sensitivity analysis; it is the calculation methods which uses indicators of probability and risk impact. To ensure transparency of the methods used we offer mapping and designing the risk *wheel*. These methods allow us to provide accuracy of the calculations made.

Basis for the Pilot Study

The research is based on the results of the pilot experiment conducted at the Institute of Economics and Social Technologies which is a part of Kazan National Research Technical University named after A.N. Tupolev (Kazan, Russia). The survey involved 255 third-and fourth-year students majoring in Economics. This work is the final stage in the research conducted by the authors in their attempts to assess results of introduction and implementation of information educational technologies in higher education system. Part of the students had already participated in earlier surveys on the topic.

Research Methodology

In this work the following theoretical and empirical methods have been used:

1) Theoretical analysis of scientific, pedagogical and methodological literature on the topic of research related to educational risks.

2) Questionnaire survey to obtain initial original information on the problem based on interviews with a pre-designed questionnaire and observations of students during this process.

3) Quantitative risk assessment based on the risks probability indicators that influence the way electronic technologies are being implemented in the educational system, and their impact.

4) Expert evaluation method based on the sensitivity analysis to identify the most important types of risks under the conditions of specific determinants changing.

5) Mapping and Wheeling as methods to ensure visibility of the study and generalize integrated risk indicator estimates using criteria selected by the authors.

Steps in Conducting the Experiment

A combination of interdependent steps has been used to provide structural content of the studies, ensure their meeting the goals and achieving the desired result.

In the first phase of the study a set of preparatory operations was carried out which involved compiling a list of questions to be included in the survey questionnaire. Further, the first step was continued with procedure of interviewing students using the developed list of questions, and finally, the results of the survey were compiled and presented in the form appropriate for processing.

The second step dealt with selection of available research methods which could lead to achievement of the goals set. Processing, synthesis and preliminary analysis of the data were carried out in accordance with theoretical methods and other methods available. Results evaluation of this process was carried out in terms of the best empirical research method to achieve the goal.

The third step was the phase when the priority methods of empirical research were defined, risk maps and the *wheel* were designed, as well as analysis and results assessment were made, and, finally, conclusions made allowing us to appraise the level of objective achievement.

RESULTS

To identify risks we studied how students understand risks of implementing electronic management in education. With this purpose we proposed a questionnaire that considered several types of risk.

The survey involved 255 students studying economics.

Two indicators were proposed to be assessed:

Table 1. Processing of students' questionnaires on risk impact and its assessment

Risks	Subjective risk assessment by student	Probability of risk occurrence	Risk impact on education
R1 - the risk of employee leaving *and* no timely employee refresh engagement resulting in aging of the personnel and determining unwillingness of employees to study and apply advanced techniques in their educational process; this in its turn hinders innovations of the university.	High	150	114
	Medium	57	87
	Low	48	45
	No risk	0	9
	Total	255	255
R2 - risk of reducing students' potential opportunities to master new knowledge as a result of insufficient training at school, and constraining the ability of students to understand and apply innovative technologies implemented by the university.	High	126	141
	Medium	63	84
	Low	63	24
	No risk	3	6
	Total	255	255
R3 - the risk of deterioration of the reputation and prestige of the university in specific areas of study leading to development and acceleration of negative changes in the quality of the students' abilities and skills, as well as reduction in quantity of those students who are interested in obtaining educational services.	High	48	141
	Medium	78	81
	Low	108	30
	No risk	21	3
	Total	255	255
R 4 - the risk of decrease of the teaching staff interest related to the quality of rendered educational services apparent in no commitment to implementation of innovations, insufficient for fair evaluation of teachers ' work	High	69	162
	Medium	123	63
	Low	45	27
	No risk	18	3
	Total	255	255
R5 - risk associated with education cost rising due to either state budget funding limits or internal reasons, but causing an ambivalent result: on the one hand, students have an additional incentive to critically assess the level of learning competencies quality and, on the other hand, the reduction of finance limits affects the ability of the university to develop and implement innovations.	High	186	165
	Medium	60	66
	Low	6	18
	No risk	3	6
	Total	255	255
R 6 – risk of stress factor increase caused by diversification of the tasks that the teaching staff faces after innovative educational technologies have been implemented; they involve combination of functions i.e. teaching, supervising and information services and, partially, engineering services to work with information technology that leads to significant increase of transferring the load and responsibility on teachers as they have to complete a course on innovative technologies, appreciating their potential and peculiarities in application	High	147	117
	Medium	57	95
	Low	42	43
	No risk	9	0
	Total	255	255
R 7 - subjective assessment risk related to discrepancy in volumes and complexity of implementing educational innovations and scheme of payment adopted in the university; this leads to loss of motivation in learning how to use new technologies because of no extra duty payment	High	150	84
	Medium	57	135
	Low	39	30
	No risk	9	6
	Total	255	255

– the probability of each risk occurrence;
– the degree of risk impact on the effectiveness of the educational process (while introducing and implementing e-learning resources).

Indicators (the probability of a risk occurring and the degree of its influence) were measured and broken into three positions:

– high
– medium;
– low.

It should be noted that some students didn't consider negative factors included in the questionnaire as risky ones (maybe didn't know what to answer, or were not sure). Therefore, we had to introduce the fourth position: no risk.

The list of risks and the way they were distributed in students' responses on risk assessment, and their impact are presented in **Table 1**.

Table 2. The coordinates to build risk maps

Risks	Risk probability	Risk impact degree
R1 - the risk of employee leaving *and their* no timely employee refresh engagement	0.28	2.33
R 2 - risk of reducing students' potential opportunities to master new knowledge	0.22	3.08
R 3 - the risk of deterioration of the reputation and prestige of the university in specific areas	0.10	3.01
R 4 - the risk of teaching staff interest decrease in terms of the quality of rendered educational services	0.16	3.60
R 5 - risk associated with education cost rising	0.43	3.78
R 6 - risk of stress factor increase caused by diversification of the tasks that the teaching staff faces	0.28	2.43
R 7 - subjective assessment risk related to discrepancy in volumes and complexity	0.29	2.35

As we have reported earlier, the data obtained allowed us to build a risk map (Khasanova et al., 2017). However, in this paper, the authors propose to consider and describe the algorithm for constructing maps and adjust the existing results of studies conducted.

Questionnaire responds and survey were studied in the following way. To build a map we needed the formula and coordinates of the above-mentioned parameters (probability and impact of risks). For this we used the weighted arithmetic mean formula (1) applied to our data from **Table 1**.

$$\bar{x} = \frac{\sum xf}{\sum f} \tag{1}$$

Where

x is the index (or indicator) under study i.e. probability of risk occurrence and the degree of its influence;

f stands for weight index.

In this work weight indices have been calculated for average value range for parameters (probability and impact) which the authors (subjectively) attributed to high, medium and low, respectively. We got coordinates calculated for plotting and presented them in **Table 2**. To avoid repetition of the risk features we used their abridged descriptions.

To clarify the results obtained we should explain that the backbone here is in distinguishing and allocation of zones which would be a kind of index for their further management (analysis, evaluation and development of anti-risk measures). The zones provide visibility in grouping the risks. Zones have been distinguished as three zones with defined borders: green (acceptable risks and do not cause any harm or threats for the organization); yellow (risks may cause harm and their presence in the educational process needs to be discussed) and red (risks pose a real threat that could disrupt educational activities). Each zone has certain boundaries that need to be identified. We have chosen the following boundaries:

Green zone probability values are in the range from 0 to 0.25, yellow - from 0.26 to 0.5, red - above 0.51.

Similarly, for risk influence degree index the following boundaries were set:

Green zone: 0 - 3.5;

Yellow zone: 3.51 - 5;

Red zone: more than 5.1.

The updated risk map (compared to the previous one by Kasanova (Khasanova, 2017, Bulletin No. 3) is of the following type (**Figure 1**).

Looking at the map we can see that the green zone covers the following risks:

R 2 - risk of reducing students' potential opportunities to master new knowledge;

R 3 - the risk of deterioration of the reputation and prestige of the University in specific areas.

The yellow zone comprises all other risks (R1, R 4 through R 7).

The study has demonstrated that there are no risks in the red zone which is good and means that there are no threats to the university which could disrupt educational activities and implementation of new technologies
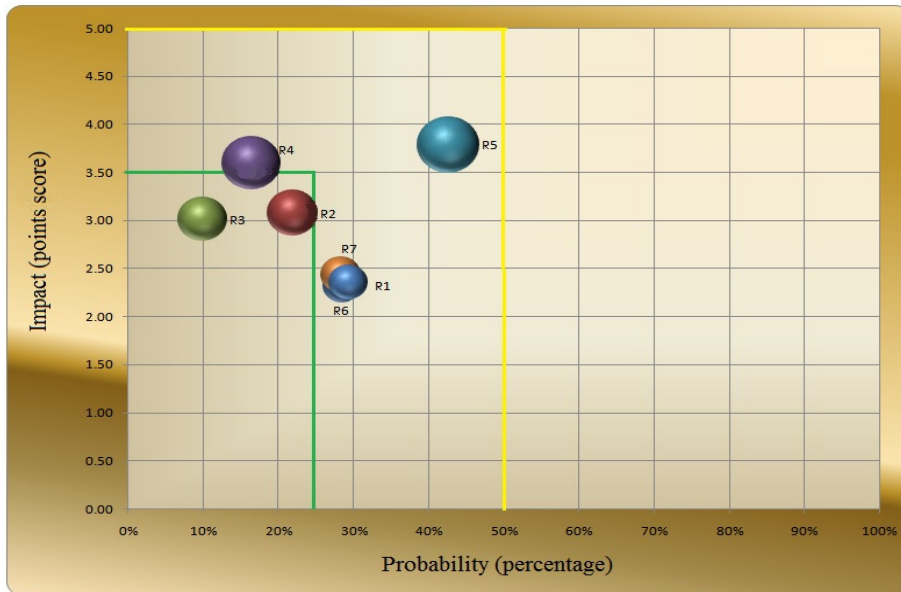
Figure 1. The risk map for university innovation implementation

Table 3. Risks sensitivity analysis results

Risks	Basic version (from Table 2)		Version 1		Version 2	
	Probability	Influence	Probability	Influence	Probability	Influence
R 1	0.28	2.33	0.33	2.57	0.35	2.81
R 2	0.22	3.08	0.26	3.35	0.28	3.62
R 3	0.10	3.01	0.14	3.28	0.15	3.54
R 4	0.16	3.60	0.21	3.87	0.24	4.14
P5	0.43	3.78	0.49	4.07	0.52	4.35
R 6	0.28	2.43	0.33	2.69	0.35	2.95
R 7	0.29	2.35	0.34	2.70	0.36	3.05

Developing the study further we proved the sensitivity analysis to be important. The analysis necessity may be explained by the following idea. As mentioned above, risk assessment and the attitude to its relevance (in terms of possible negative consequences) typically are subjective. It is well known from the theory of risk management that the risk attitudes of all subjects can be attributed to two categories: risk- neutral persons (with indifferent attitude toward risk), i.e. never exaggerating the hazardous consequences; and those persons who exaggerate negative consequences of risks.

In this regard, the authors consider it to be interesting and helpful to test the quantitative characteristics of risks, by changing the boundaries of "high," "medium" and "low" concepts depending on the attitudes to risk consequences. We have calculated two versions for risk probability change, or variation, and its influence degree.

Table 3 presents the results of sensitivity analysis for risk assessment indices when the version for the risk map is called the basis one and the alternatives are numbered as versions 1 and 2.

According to the results obtained we build the *Risk Wheel*; graphs for the three options (basic version and two additional) are presented separately for each index. The distribution of probability indices is shown in **Figure 2**.

According to **Figure 2** the most sensitive to boundary variations for option (version) 2 are:

R3 - the risk of deterioration of the reputation and prestige of the university in specific areas of study (coefficient of variation is 1.51); and

R 4 - the risk of decrease teaching staff interest regarding the quality of rendered educational services (average of 1.47), though initially the probability of these risks was the lowest.
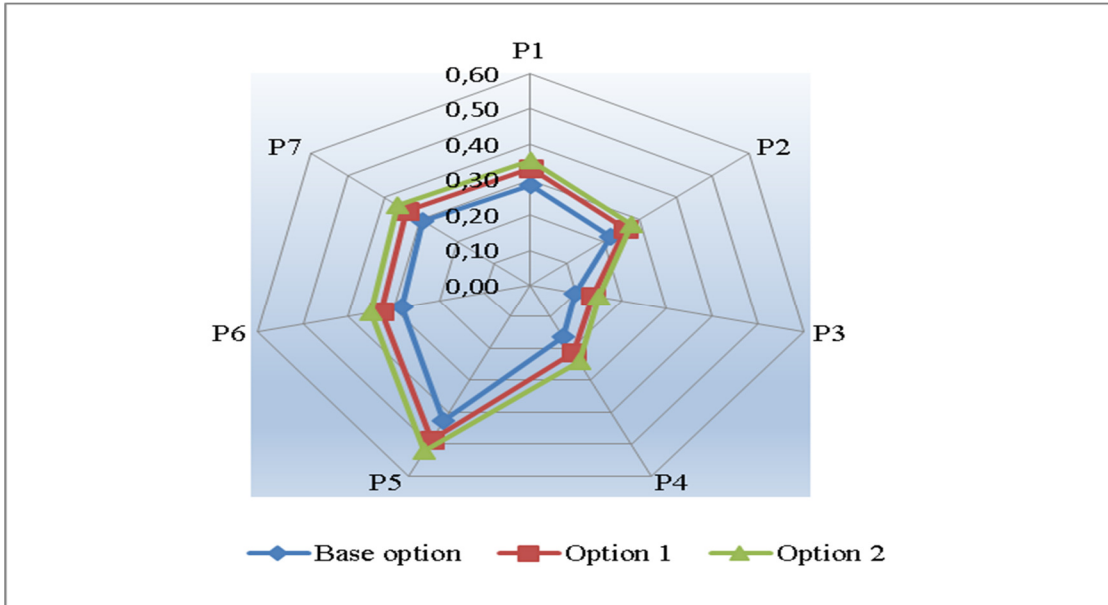
Figure 2. Risk Wheel for risk occurrence probability
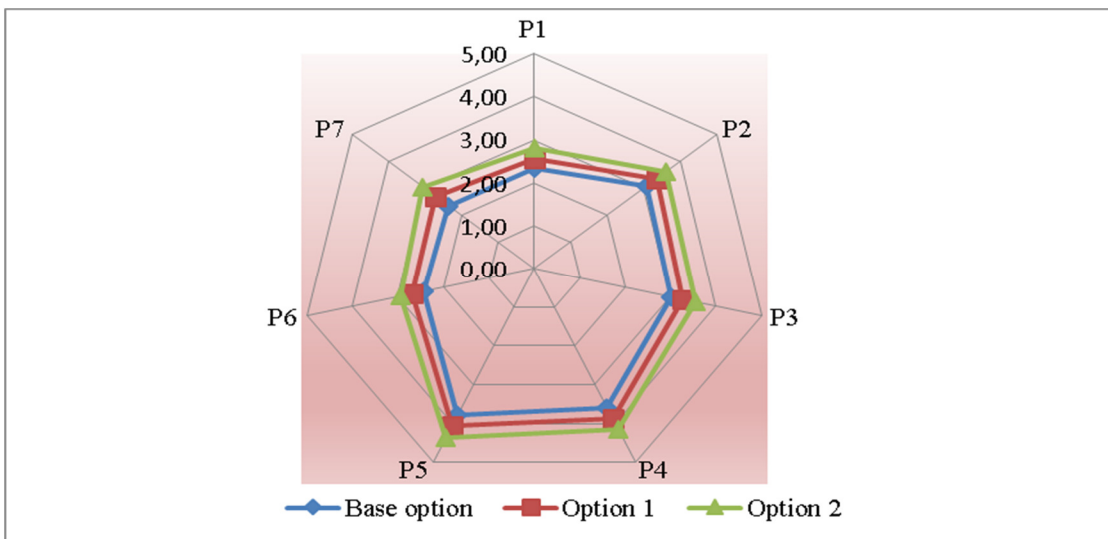
Figure 3. Risk Wheel for estimating the degree of risk influence

Similarly is the *Risk Wheel* for considering the degree of risk influence was also designed (**Figure 3**).

The sensitivity of this indicator is much lower. Most sensitive to changes is Risk 7 - subjective assessment of risks related to their discrepancy in volumes and complexity, coefficient of variation is 1.3.

As for the risks, the most critical appeared to be Risk 5 (the risk of education cost rising).

Other risks demonstrated different pictures: for example, Risks 2, 3 and 4 are lower in their occurrence indicator compared to the rest risks, but the extent of their exposure is higher.

On the whole, the risks associated with electronic technology introduction discussed here cannot cause substantial harm to the educational process.

DISCUSSIONS

Consideration of the issues of *implementing* and evaluating *educational* technology initiatives is a very significant aspect in transforming economic system. So, under modern conditions it is particularly important to examine the main risks arising in the process of implementation, as well as distinguish and highlight problematic aspects that researchers and education process participants are facing. It is a common knowledge that close connection between theory and practice is the specific feature and requirement of educational process in practice.

This relationship remains relevant for a long time; it has always been of interest and recognized by certain representatives of the scientific community. In the early 20th century the issue was discussed by Weber (2016). In the process of theoretical comprehension of social processes of their time the authors believe it necessary to pay attention to education as the basis of society and determine its specific characteristics. That is why the authors faced challenges in their study, *encountered* certain difficulties in the course of conducting the experiment.

The research methodology development and calculation of indices (indicators) boundaries made the authors think over some difficulties and challenges. One of them was caused by the fact that when studying other researchers' papers we encountered controversial opinions. This phenomenon included numerous positive views concerning information technology introduction into education, or learning process. This aspect was looked upon as not very desirable; there were many viewpoints stating that it might increase negative consequences in effectiveness of education. In this regard, the authors have had problems in comparing their experiment values with those received by other researchers. The authors are absolutely sure that implementation of information technologies for successful higher education is imperative, though should be based on true understanding, analysis and evaluation of the risks that may emerge in the process.

Our future work on the issue will involve consideration of security management issues that have not been discussed in this paper. Risk for information security involves considering the types of loss (risk category) and how that loss might occur (risk factor). Data trespass is another issue. IT security involves protecting information stored electronically and the industry needs to come up with solutions to avoid any problems with information management and security. This paper have dealt with students' opinions on technology innovations implementation not considering the above mentioned aspects as they were not our aims in this research.

Difficulties in Transition to a New Paradigm

We'd like to add that experiment results might have different values because of the lack of complete fairness and credibility on the part of students. It was observed that some of the students when completing the survey questionnaire adjusted their responses in accordance with their ideas about the expectations of its authors. For these reasons, we think of Masters as suitable responsible actors to be involved in carrying out the questionnaire interview but not teachers.

We also believe it is appropriate under conditions of our country to consider the issues of developing anti-risk measures to provide success in quality professional training on the basis of integrated approach, combining market and public authorities' requirements, as well as taking into account personal attitudes and demands of direct participants of the educational process, i.e. students and teachers.

CONCLUSION

Economic changes and new innovative facilities put forward the necessity to think over new requirements to university graduates' skills and competencies. We can't have a strong economy without a strong university sector. A competitive economist training is impossible without the use of modern teaching facilities in the process of training. In this regard, e-learning in the field of education to control learning outcomes in online and offline modes, obtain analytical reports on achieving the goals, and analyze students' performance is of great importance.

In the course of writing the paper the objectives set have been solved. The first objective was to conduct a survey with students majoring in Economics, full-time 3-d and 4-th- year students, elaborate and process the results obtained. The study attempted to assess students' perceiving level of risks arising in the course of their educational activities under the conditions of electronic support tools implementation in university training.

As the second objective the authors suggested risks encountered under special conditions of higher education; they had to be identified, assessed in terms of their probability and impact. The study proved the positive effect of a virtual learning environment and Blackboard Learn course management system on the entire educational process in the university. Currently, Blackboard Learn helps optimize Kazan National Research Technical University learning management systems i.e. improve implementation services and training to create new learning experiences.

The third problem discussion showed that when Kazan university students gave their appraisal of LMS Blackboard Learn use they confirmed its importance and usability in the educational process, and that was later evidenced by results of questionnaires survey. Risk mapping to reflect the peculiarities of using modern learning technologies at higher education institutions in the long run brought to the visualization stage of all cumulative results. With the aim of expanding the boundaries of the study a sensitivity analysis was conducted; the sufficiency of made it possible to design the *Risk Wheel* and determine the degree of final response result variations for each risk.

Innovation is always fraught with difficulties; however, the implementation of programs for innovative development with the aim of improving the Russian higher educational system is able to ensure the appropriate quality of human capital, the ability to bring the Russian education system to the global level. Despite the fact that the need for innovative technologies in the modern educational process is not questioned, the issue of full transition of educational process to online learning is controversial because of certain possible risks and dangers.

Summing up, we would like to conclude that state-of-the art innovative tools being intensively introduced in Russian educational process enables the universities with effective support in learning, leads to increase in students' learning incentives and activity, improves their independence, contributes to successful formation of their skills and competencies required to participate in the knowledge economy. Despite the fact that the process contains certain risks it provides practitioners with a smart tool, supporting them in the *innovation* policy-making *process*.

ACKNOWLEDGEMENT

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An Adaptive e-Learning System for Enhancing Learning Performance: Based on Dynamic Scaffolding Theory

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ABSTRACT

Adaptive learning for individual learners has recently become popular in education. This study aims to fill the void in the existing literature by building an adaptive e-learning system with self-assessment rubrics based on the dynamic scaffolding theory in response to different student needs. Meanwhile, the purpose of this study is to explore the effectiveness of using adaptive e-learning with dynamic scaffoldings and rubrics in fostering students' learning outcomes. An experimental design was conducted to evaluate learning effectiveness and learning satisfaction in the Excel (spreadsheet) of the course for using the developed adaptive e-learning system. Sixty undergraduate students from a technology university in central Taiwan participated in this experimental study and executed a pretest and a posttest. Research results revealed that the developed adaptive e-learning system can effectively support students with personalized learning materials and successfully helps students acquired knowledge and develop cognitive abilities. The results recommend that teachers could employ rubrics as a self-assessment tool for supporting students with dynamic scaffoldings to conduct a learner-centered e-learning environment. Additionally, the lack of generalizability is clearly a limitation of the present data due to a few participants. Finally, future research direction of this study was also discussed.

Keywords: adaptive learning, e-learning, dynamic scaffoldings, rubric

INTRODUCTION

Individual differences among students have significant effects on their learning outcomes (Rukanuddin, Hafiz, & Asfia, 2016). Previous studies examined these effects and indicated that providing the same learning materials and delivering the same instructional conditions to all students may lead to a reduction in learning performance without considering their different background characteristics, prior knowledge, experiences, and learning aptitudes (Smith-Jentsch et al., 1996; Ford & Chen, 2000). For ensuring effective learning for all students, adapting teaching strategies and content to meet individual student needs has long been regarded as a central and persistent issue in education.

Many researchers have conducted studies adapting instruction procedures to individual student variables. Until the 1990s, when the field of adaptive learning systems arose (Mödritscher, 2008); and radical development in the field was observed in the last decade (Popescu, 2010). In contrast to the difficulties of individual difference diagnosis in traditional classroom settings, adaptation to student differences are easier in e-learning environments because the development of educational technology has provided a powerful tool for conducting and implementing sophisticated instructional systems from diagnosing a student's specific learning needs during the learning process. Therefore, more and more e-learning systems were developed to accommodate a certain level of adaptability to suit individual student needs better. Stoyanov and Kirschner (2004) proposed the concept of an adaptive e-learning system "that personalizes and adapts e-learning content, pedagogical models, and interactions between participants in the environment to meet the individual needs and preferences of users if and when they arise" (p. 41).

Contribution of this paper to the literature

- This study provides a theoretical framework for building an adaptive learning system.
- The developed system in this study employs Rubrics as a self-assessment tool assisting a better understanding of students' cognitive abilities.
- The study makes a significant contribution to the literature with empirically examine the learning effectiveness and satisfaction towards the adaptive e-learning system.

Over the past decade, various adaptive e-learning systems have become popular in education because of modern advances in information communication technology that allow for the delivery of individually tailored instruction to mass audiences simultaneously (De Bra et al., 2004; Park & Lee, 2004; Wang & Liao, 2011). Meanwhile, there are numerous studies focusing on the issues of adaptive e-learning systems. Researchers began to integrate various pedagogical theories/approaches in adaptive e-leaning systems such as scaffolding theory, learner-centered theory, and assessment methods for learners. Although previous studies have developed adaptive e-learning systems with scaffolding theory to facilitate student learning (Brusilovsky et al., 1996; Shi et al., 2002; Murray, 2003; Azevedo, Johnson, Chauncey, & Burkett, 2010; Molenaar, van Boxtel, & Sleegers, 2011), study related to developing rigorous student self-assessment to underpin adaptive e-learning systems remain limited. In fact, most adaptive e-learning systems assess/diagnosis individual student differences during the initial learning period and provide tailored learning instruction; and the scaffoldings/supports are not adjusted in accordance with concerning students' learning progress (Molenaar, Roda, van Boxtel, & Sleegers, 2012). In this regard, conducting an adaptive e-learning system that is dynamic and adapts specific instructional procedures and strategies for specific student characteristics has received considerable attention in pedagogical research. This study aims to fill a void in the existing literature by building an adaptive e-learning system with self-assessment rubrics based on dynamic scaffolding theory in response to different student needs.

The core objectives of the current study, scheduled to run for one semester, were to investigate the outcomes of using adaptive e-learning with dynamic scaffoldings upon learning Excel (a spreadsheet). Based on the research purposes, the research questions addressed in this study are as follows: 1) What are the effects of the adaptive e-learning system with dynamic scaffoldings on students' learning? And 2) What extent students satisfy adaptive e-learning systems with dynamic scaffoldings?

In the following sections, the theoretical framework of the study and related theories are introduced, followed by the research methodology. The results of the study are reported next. Finally, the discussion and conclusions are reported.

LITERATURE REVIEW

E-Learning System

Electronic learning (e-learning) integrates related ICT applications in the teaching and learning process. E-learning has a dramatic change on the modes of teaching and learning and provides a great way to remove drawbacks that are inherent in traditional classroom learning, especially its lack of flexibility in time and space (Rosenlund & Damark-Bembenek, 1999). There are numerous and different definitions for e-learning in the literature. Rosenberg (2001) proposed a broad definition of e-learning as "the use of Internet technologies to deliver a variety of solutions that enhance knowledge and performance" (p.28). Rosenberg also addressed three essential characteristics of all e-learning environment: 1) e-learning is networked, making it capable of instant updating, storage/retrieval, distribution and sharing of instruction or information; 2) it must be accessible to learners via a computer; and 3) it goes beyond the traditional paradigms of training.

In comparison with traditional classroom education that centers on instructors who have control over class content and learning process, e-learning systems offer a learner-centered, self-paced learning environment that enables learners to access learning resources at any time and from any place via web technologies. A learner-centered instruction means that learners take the initiative and responsibilities to determine their learning needs at their own schedule and pace (Zhang, 2004).

No doubt, implementing e-learning strategy has become a common practice for delivering training and education in corporations and educational institutions. However, most e-learning courses still follow a traditional homogenous model, i.e. a "one size fits all" approach that delivers the same static learning materials to all learners, although they have different prior knowledge, experience, cognitive abilities, and learning goals (Stewart et. al., 2005; Dominic & Francis, 2015). Supporting this, Chiu (2008) indicated that identifying learner requirements dynamically is an important and missing part for most conventional e-learning systems. Additionally, Premlatha, Dharani, and Geetha (2016) pointed out that numerous existing e-learning systems have problems with offering
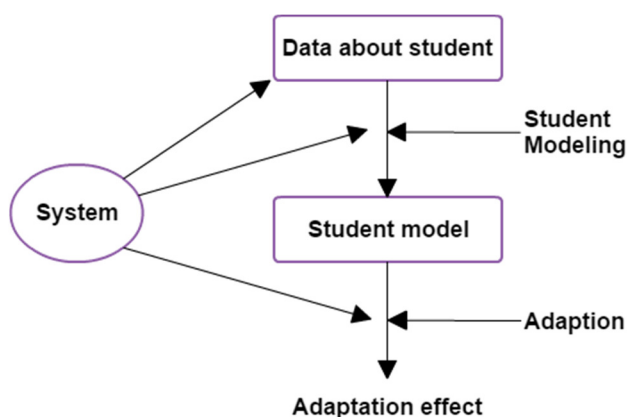
Figure 1. The architecture of an adaptive e-learning system. Adapted from "From adaptive hypermedia to the adaptive web", by P. Brusilovsky and M. T. Maybury, 2002, *Communications of the ACM, 45*(5), p. 32.

reusable, personalized, and learner-centric content. This weakness of the existing e-learning systems become obvious, particularly when implemented in educational environments where the student characteristic is varied. Ignoring this weakness leads to an unchanging static profile construction, which may, in turn, keep students from achieving their own learning goals. Thus, the concept of adaptation has become a major issue in e-learning.

Adaptive E-Learning System

In consideration of the weakness of conventional e-learning, a number of online learning systems try to bring individualization into the learning process by providing learner-centered instruction, but the adaptive learning system is viewed as one of the most popular models (Surjono, 2011). An adaptive learning system can tailor its reaction to various circumstances. To be specific, this system in education aims to develop and implement a solution framework for individualized instruction in accordance with real-time individual differences (Brusilovsky, 2001; De Bra et. al., 2004). In other words, an adaptive learning system focuses on delivering learning contents in a customized and adaptive manner.

Adaptive e-learning, a variant of e-learning, endeavors to satisfy the demand of individualization in learning. Adaptive e-learning systems refers to a set of information techniques oriented to offer all students appropriate learning materials in response to their requirements and characteristics (Brusilovsky, 2001). In the same line, the adaptive e-learning system, according to Stoyanov and Kirschner (2004), is "an interactive system that personalizes and adapts e-learning content, pedagogical models, and interactions between participants in the environment to meet the individual needs and preferences of users if and when they arise." In summary, the adaptive e-learning system aims to give the best support to students on their learning path with the final goal of maximizing their learning performance.

As a developing new teaching method, the field of adaptive e-learning has received much attention since 1990 (Mödritscher, 2008), and recent research statistics demonstrated that there is a significant growth of applying adaptive e-learning for delivering various courses in the last decade (Popescu, 2010). A growing interest in building adaptive e-learning systems has led to the development of a wide range of adaptive processes and models. For example, Brusilovsky and Maybury (2002) proposed the architecture of an e-learning adaptive system (see **Figure 1**). The system intervenes at three stages during the process of adaptation and controls the process of collecting data about the student, the process of building up the student model, and during the adaptation process. Brusilovsky and Maybury also indicated that this system collects data for the user model from various sources that can include implicitly observing student interaction and explicitly requesting direct input from the student.

Compared with e-learning, adaptive e-learning systems are more personalized and stress the adaptation of learning content and the presentation of that content (Froschl, 2005). Thus, the implementation of adaptive e-learning systems asks for appropriately assessing individual difference of all students. In other words, these systems are capable of measuring learner difference and account for this while creating the learning path. Continuous assessments (i.e. collecting data) for student modeling incorporated into adaptive learning systems during the learning process helps deliver suitable learning instruction to each student.

Scaffolding and Dynamic Scaffolding

The concept of scaffolding refers to providing additional support or scaffolding by a "master" teacher (e.g. a teacher, an expert, or a more capable peer) in a learning setting for assisting students' cognitive development
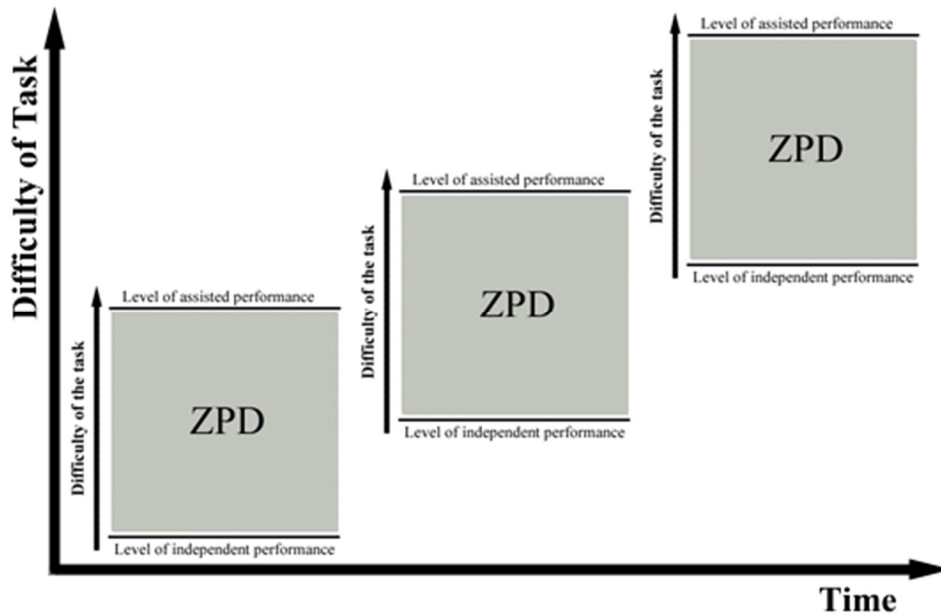
Figure 2. Changes in a learner's ZPD over time. Reprinted from: "Scaffolding emergent writing in the zone of proximal development," by E. Bodrova and D. J. Leong, 1998, *Literacy, Teaching and Learning*, *3*(2), p. 3.

(Wood, Bruner, and Ross, 1976). The supports that teachers use to assist students engage in a learning process are called "scaffolding". Scaffolding activities will take many forms, depending on the needs of the students such as models, cues, prompts, hints, partial solutions, think-aloud modeling, and direct instruction (Hartman, 2002). These scaffolds help the learner eventually solve a problem, carry out a task, master a concept, or achieve a goal (Wood, et al., 1976; Vygotsky, 1978). As students become capable of independent activity, scaffoldings/supports will be gradually removed.

Scaffolding is widely considered an essential component of effective instruction; therefore, the scaffolding strategy has been wildly employed to include several tools such as multimedia and hypermedia software to provide learners with supports (Kim & Hannafin, 2011). Most studies applying scaffolding theory provided static scaffolds in their learning contexts without considering students' changes during the learning process. However, learning styles may be influenced by students' experiences, so they are not unchanged traits that can be measured through explicit questionnaires once and ignored until the end of the implementation.

Scaffolding can be either static or dynamic, static scaffolding is constant over time and the same for all students; whereas, dynamic scaffolding continually assesses the students' ability after selecting one scaffold. Then an appropriate scaffold is provided to students according to the assessment. In other words, static scaffolding does not adjust to individual students' progress in the learning process, but dynamic scaffolding does. According to Vygotsky's Zone of Proximal Development (ZPD), learners develop new skills/knowledge at a high level of mastery (Vygotsky, 1978), both their actual level and potential level increase. That is to say, with mastery the entire zone moves along the developmental course. **Figure 2** shows the ZPD itself is not static but progresses as students attain a higher level (Leong & Bodrova, 1995), because learner development involves a sequence of constantly changing zones. Since the zone is dynamic and never static, dynamic scaffolds are required for learners for analyzing learner behavior after an appropriate scaffold being selected.

RESEARCH METHODS

The Experimental Design

A pretest-posttest designed experiment with two equivalent groups was conducted in this study. The independent variables were the different learning modes; the experimental group took part in an adaptive e-learning system with dynamic scaffoldings and rubrics, while the control group participated in a traditional e-learning system. The total duration of the experiment was one semester. The dependent variables were the learning effectiveness and learning satisfaction consisting of learner interface, learning content, and personalization.
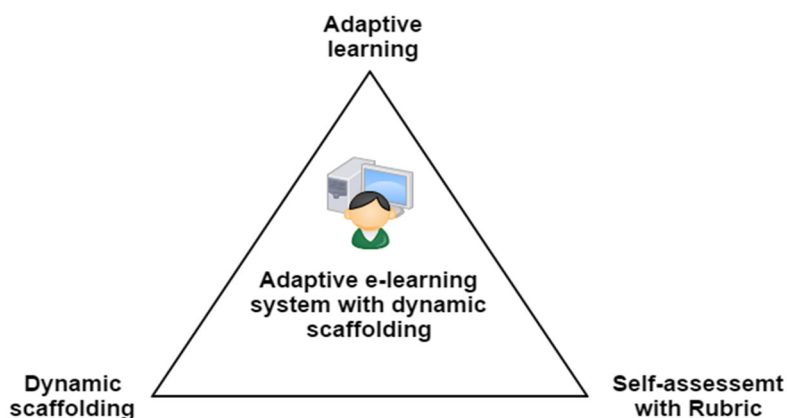
Figure 3. The theoretical foundation for adaptive e-learning system with dynamic scaffolding
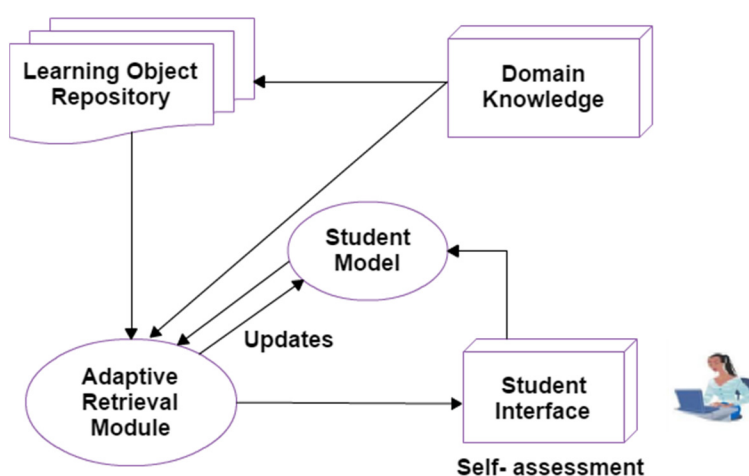
Figure 4. The architecture of an adaptive e-learning system

Participants

A total of 60 undergraduate students with an average age of 21 from a technology university in central Taiwan volunteered to participate in this experimental study. Each student was randomly assigned using SPSS software to either the experimental or the control group, each of which had 30 students. Students in each group were independent of those in the other, meaning that no students in either group could influence students in the other group and no group could influence the other group in this experiment.

To avoid the Hawthorne effect and the John Henry effect, students in both groups were not informed of the experiment. Both groups were taught by the same instructor who used the same curriculum materials for learning Excel.

System Description

This study developed an adaptive e-learning system with dynamic scaffolding for learning Excel by integrating online rubrics to assess students' capabilities and then provide suitable learning materials to them. The theoretical underpinning of the developed system includes dynamic scaffolding, adaptive learning, and self-assessment with rubrics (**Figure 3**).

In detail, based on Roy and Roy's (2011) study, this adaptive e-learning system presents an architecture consisting of five major components: domain knowledge, student model, learning object repository, adaptive retrieval module, and student interface (**Figure 4**). The lines in **Figure 4** represent a logical connection among the linked models.

Compared with e-learning, adaptive e-learning systems are more personalized and stress the adaptation of learning content and the presentation of this content (Froschl, 2005). Thus, the implementation of adaptive e-learning systems asks for appropriately assessing individual differences for all students. In other words, these

systems are capable of measuring learner difference and account for this while creating the learning path. Continuous assessments (i.e. collecting students' data) incorporated into adaptive learning systems during the learning process helps deliver suitable learning instruction to each student. These five components in the developed system are described as follows.

1) Domain knowledge: Storing learning content that is to be taught in specific academic courses.

2) Student model: Storing information and data about students. This component determines the student's skill/competence level.

3) Learning object repository: Storage of learning objects. It allows students to retrieve learning materials based on their own objectives.

4) Adaptive retrieval module: The adaption technique allows students select suitable required materials in accordance with their own learning goal and individual learning capabilities.

5) Student interface: Providing learning materials and information. In addition, a self-assessment test using rubrics is conducted during the learning process.

According to Andrade (2008), rubrics can be a powerful self-assessment tool. Under the right conditions, student self-assessment can offer accurate, useful information to improve learning. In this study, the developed system uses feedback from students' self-assessments to guide revision.

Research Hypotheses

The potential payoffs of designing, developing, and employing good e-learning solutions are great and include improved effectiveness and satisfaction of the learning experience. Therefore, this study addressed the following research hypotheses.

H1. There is a significant difference in individual learning outcomes between students who receive dynamic scaffoldings and who do not receive dynamic scaffoldings.

H2. There is a significant difference in learning satisfaction towards the e-learning system between students who receive dynamic scaffoldings and who do not receive dynamic scaffoldings.

H2a. There is a significant difference towards learning interface of the e-learning system between students learning with dynamic scaffoldings and students learning without dynamic scaffoldings.

H2b. There is a significant difference towards learning content of the e-learning system between students learning with dynamic scaffoldings and students learning without dynamic scaffoldings.

H2c. There is a significant difference towards personalization of the e-learning system between students learning with dynamic scaffoldings and students learning without dynamic scaffoldings.

Experimental Procedure

All participants first joined a 30-min training session to become familiar with both systems (adaptive e-learning system and traditional e-learning system). Following that, both experimental and control groups underwent a pretest that was distributed at the beginning of the course, which enabled us to determine that there was no statistically significant difference between two groups concerning their pre-existing Excel knowledge. **Figure 5** shows the experimental procedure used in this study.
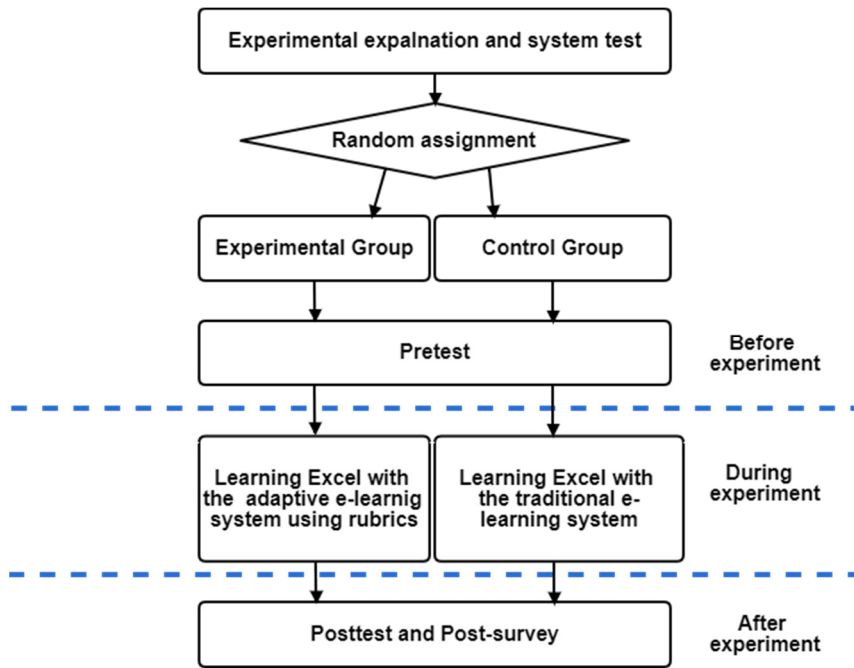
Figure 5. The experimental procedure of this study

Figure 6. A snapshot of the adaptive e-learning system

Participants in both groups received the same content except for using a different e-learning system. Students in the experimental group use an adaptive learning system with dynamic scaffolding and rubrics (**Figure 6**), whereas students in control group adopt a traditional e-learning system without dynamic scaffolding and rubrics. The experiment lasted for one semester.

Measuring Instruments

Learning effectiveness and satisfaction were used broadly to assess learning performance in previous studies (Hung et al., 2009). Learning effectiveness is to understand whether learners obtain domain knowledge and understand major issues of courses. Moreover, the most common way to measure learning effectiveness is

Table 1. Comparison between experimental and control group in pretest scores

Group	N	Mean	SD	*t*-statistics	*p*-value
Experimental group	30	77.1	17.899	0.148	.883
Control group	30	76.6	4.553		

Table 2. Comparison between experimental and control group in posttest scores

	N	Mean	SD	*t*-statistics	*p*-value
Experimental group	30	89.0	10.73	2.882	.006 **
Control group	30	77.3	19.48		

Note: ** *p* < .01

quantitatively with pre and posttests. In addition, satisfaction was adopted to evaluate learning performance in numerous educational studies. Therefore, this study measured students' learning performance at two different levels: learning effectiveness and learning satisfaction. Further, there were three aspects for learning satisfaction: learner interface, learning content, and personalization.

A pretest and a posttest were conducted to evaluate learning effectiveness. The pretest was designed to evaluate the students' pre-existing knowledge of Excel course content, while the posttest was designed to evaluate students' Excel skills. Both the tests were developed by two experienced teachers.

The learning satisfaction measuring instrument, consisting of a total of 12 items, was adopted from Wang (2003). It consisted of three constructs, including learner interface (4-items), learning content (4-items), and personalization (4-items). All items were measured by a five-point Likert scale in which 1 represented strongly disagree, 3 was the neutral point, and 5 represented strongly agree.

In this study, we attempted to use valid and reliable measures. First, items were adopted from previously validated instruments. Second, content validity was established through both academics during the phase of questionnaire development. Third, the reliability of the measures were reassessed with the current sample.

DATA ANALYSIS AND RESULTS

This study collected quantitative data to answer the research questions including 1) pretest/posttest scores of the experimental group and the control group, and 2) a learning satisfaction survey towards the use of e-learning systems.

Analysis of Learning Effectiveness

Quantitative data were collected from pre and posttests for students in the experimental group and in the control group.

Research collected data were analyzed with independent *t*-test using the SPSS version 20 to assess whether the means of two groups are statistically different from each other. **Table 1** shows there are no significant difference between the mean pretests of two groups (*t*=0.148, *p*=.883 > .05), so it is assumed that participants in both groups had equivalent prior knowledge.

The mean score of the experimental group is also compared with that of the control group in the mean score of the posttest. The mean is found to be 89.0 for the experimental group and 77.3 for the control group. The independent-sample *t*-test procedure was adopted to examine differences of learning outcomes between two groups. **Table 2** shows the *t*-test results revealed that a significant difference was found between the experimental and the control groups (*t*=2.882, *p*= *.006* < .01) and indicated that the research hypothesis H1 was supported. From *t*-test analytical results of **Table 2**, it was found that participants in the experimental group perform better learning than the control group. In other words, the adaptive e-learning system with dynamic scaffolding strategy proposed by this study was verified to be able to successfully help students enhance student learning outcomes. **Figure 7** presents an overview of the pretest and posttest scores of participants in deferent groups. The experimental group demonstrated significant higher learning effectiveness gains than the control group.
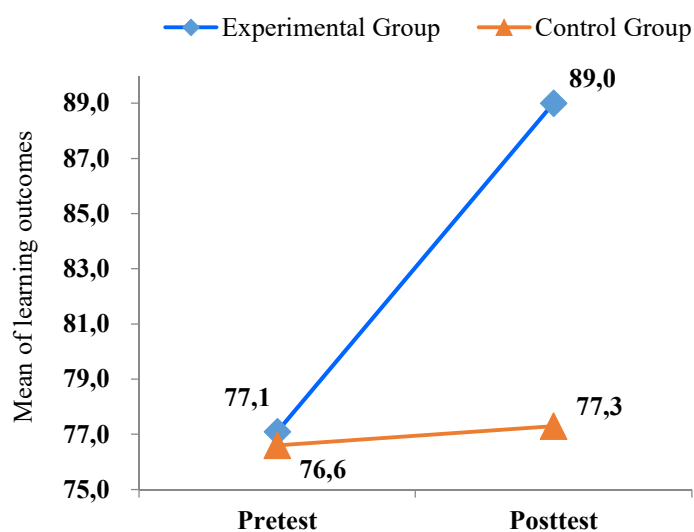
Figure 7. Differences in pretest and posttest of learning outcomes

Table 3. Reliability coefficients for all constructs of learning satisfaction

Constructs	Item description	Cronbach's *α*
Learning satisfaction		.951
Learner interface	The e-learning system is easy to use	.852
	The e-learning system is user-friendly	
	The operation of the e-learning system is stable	
	The e-learning system makes it easy for you to find the content you need	
Learning content	The e-learning system provides up-to-date content	.884
	The e-learning system provides content that exactly fits your needs	
	The e-learning system provides sufficient content	
	The e-learning system provides useful content	
Personalization	The e-learning system enables you to learn the content you need	.915
	The e-learning system enables you to choose what you want to learn	
	The e-learning system enables you to control your learning progress	
	The e-learning system records your learning progress and performance	

Table 4. Descriptive statistics and *t*-test for all constructs of learning satisfaction

Constructs	Experimental group		Control group		*t*-statistics	*p*-value
	Mean	SD	Mean	SD		
Overall satisfaction	4.20	0.44	3.91	0.62	2.036	.047*
Learner interface	4.15	0.48	3.96	0.63	1.229	.224
Learning content	4.21	0.55	3.99	0.60	1.506	.137
Personalization	4.24	0.58	3.79	0.79	2.468	.016*

Note: * *p* < .05

Analysis of Learning Satisfaction

Cronbach's *a* (Cronbach, 1951) was used as a test for the internal consistency reliability of each scale. Cronbach's *a* ≥ .70 are judged to be high in internal consistency (Nunnally, 1978). In this study, **Table 3** shows the reliability coefficients of learner interface, learning content, and personalization were ranging from .852 to .915, which exceeds the recommended cut-off level of 0.70. Furthermore, the Cronbach's *a* test suggested good reliability for overall learning satisfaction questionnaire (Cronbach's *a*=.951); thereby, implying an adequate level of internal consistency.

Table 4 presents the descriptive statistics and independent *t*-tests for all constructs of learning satisfaction questionnaire. It was found that students in the experimental group have higher overall satisfaction and personalization towards the used e-learning system than the control group, which means H2 and H2c can be considered to have empirical support from the data at hand. However, there is no significant difference between two groups towards learner interface and learning content of the used e-learning system, which means H2a and H2b are not supported.

DISCUSSION AND CONCLUSIONS

E-learning systems are considered adaptive when they can dynamically change in response to individual student differences. Major challenges faced by researchers and instructors are to optimally integrate learning theories and instruction strategies with system functions and to empirically examine the effects and value of these systems in real-world environments (Park & Lee, 2004). To enhance learning effectiveness for all students, this study developed an e-learning system based on an integrated theoretical framework that consists of adaptive instruction strategy, dynamic scaffolding theory, and self-assessment mechanism. The developed adaptive e-learning system can take the dynamic student ability into account and deliver suitable learning materials to all students.

The experimental results revealed that there is a significant difference in student learning effectiveness and learning satisfaction between the experimental and control groups. When comparing learning effectiveness, the experimental group's score was significantly higher than the control group's scores. With the capabilities adapting to the needs of individual students, the adaptive e-learning system with dynamic scaffolding and rubric was confirmed to successfully foster students' learning effectiveness. From the students' perceived learning satisfaction, this developed adaptive e-learning system enabled students to learn the content they need, to choose what they want to learn, to control their learning progress, and to record their learning progress and performance. In summary, the developed adaptive e-learning system in our study can effectively support students with personalized learning materials and to successfully help students acquire knowledge and develop cognitive abilities.

The research results are consistent with previous studies. For instance, Mampadi et al. (2011) developed dynamic scaffoldings tailored to students' cognitive style in an adaptive hypermedia learning system and examined the effect compared with an ordinary hypermedia learning system that does not exhibit any adaptation. The findings indicated students who used the adaptive hypermedia learning system obtained better learning outcomes for learning eXtensible Markup Language (XML) than those with an ordinary hypermedia learning system that did not support any adaptation. Likewise, Molenaar et al. (2012) measured the effects of dynamic scaffolding supported by an attention management system on middle school students' learning in small groups with the experimental method. Their findings indicated that the dyads with dynamic scaffolding were more positive about their teachers and collaborators than students without dynamic scaffolding.

The results of this study can be of the reference for system developers, programmers, platform operators, teachers, and relevant personnel in education in the hope to conduct a successful adaptive e-learning environment. Particularly, the results suggest that teachers can employ rubrics as a self-assessment tool to support students with dynamic scaffoldings to conduct a learner-centered e-learning environment.

This study, like much of the empirical research, has limitations that should be addressed. First, the lack of generalizability is clearly a limitation of the present data due to a few participants. The findings for this study cannot be generalized across a large population because participants in this study were selected from the same university. This study still retains considerable space for growth. Future research could consider the other individual learner variables and provide dynamic scaffoldings for them.

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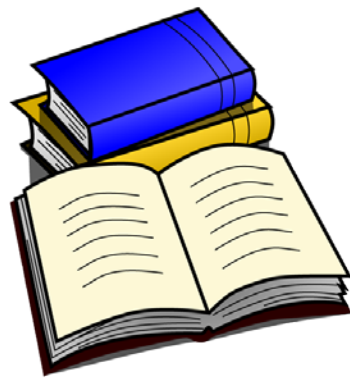
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Effects of Corporate Governance on Accounting Education and Enterprise Value in High-Tech Industry

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ABSTRACT

Corporate governance, an important study on enterprise operation and management, aims to have an enterprise effectively supervise organizational activity and operation through favorable management and supervision systems or mechanisms. When a company presents sound corporate governance, the managers would maximize corporate value and shareholders' equity to enhance the business performance and corporate value.

Listed high-tech industries in Shanghai are sampled for this study. The data are acquired from China Economic and Financial Research Database. The research results conclude 1.significantly positive correlations between corporate governance and Accounting Education, 2.remarkably positive correlations between Accounting Education and enterprise value, 3.notably positive correlations between corporate governance and enterprise value, and 4.mediation effects of Accounting Education between corporate governance and enterprise value. The results could provide reference for managers in domestic high-tech industries making investment decisions and governmental authorities formulating relevant regulations. Good match with corporate governance allows a company thoroughly developing the benefit of capital expenditure to further create higher corporate value.

Keywords: high-tech industries, corporate governance, accounting education, enterprise value

INTRODUCTION

In the past decade, the so-called "corporate governance" has become an important study on enterprise operation and management. After the series of malpractice, e.g. Enron event and WorldCom, enterprises have gradually stressed on corporate governance systems. "Corporate governance" aims to have an enterprise effectively supervise organizational activity and operation, prevent from malfeasance and malpractice, and guarantee the rights and interests of all stakeholders (shareholders, creditors, employees, and other stakeholders) through favorable management and supervision systems or mechanisms to realize corporate social responsibilities. Under the trend of trade liberalization and market internationalization, product innovation is fast and diversified, product lifecycle is shortened, and market change becomes rapid with fierce competition. For this reason, when a company presents sound corporate governance mechanisms, the managers would maximize corporate value and shareholders' equity to enhance the business performance and corporate value.

Since business performance is mainly presented with financial statement information, the evaluation value of accounting information of earnings and book value are important for investors. Under the assumption of the sustained-yield management of a company, stock value reflects the future profitability and definitely reflects the capability of dividend payout, cash generation, or making excess earnings (abnormal earnings) of a company in the future. As earnings information could not reflect the earnings quality, the accounting information in the financial statement is the business performance of a company as well as the important information source for investors understanding the operating condition. The forecast relevance and persistence of current excess earnings and next-period excess earnings information of a company are closely related to the factors in corporate governance and the

Contribution of this paper to the literature

- Sales High-tech industry investors should actively participate in corporate governance systems. In addition to promoting the corporate governance quality of high-tech industries, they could reduce the investment risks.
- High-tech industries are therefore suggested to include versatile business ethics courses in accounting education, covering the topics of information ethics, environmental ethics, consumer ethics, labor ethics, competitor-in-business ethics, government ethics, shareholder ethics, decision-making ethics internal control (supervision) ethics, international society ethics, and corporate social responsibility.
- Investors should take corporate governance into account when selecting stocks.

persistence of future excess earnings. Corporate governance towards accounting education and enterprise value in high-tech industries is therefore discussed in this study.

LITERATURE REVIEW

Corporate Governance

From social points of view and general aspects, Fama & French (2015) pointed out corporate governance as guiding, controlling, and regulating various activities among members with power under the social organization with social legal systems as well as formulating internal systems and relationship to maximally enhance the common interests of the group (Mao & Renneboog, 2015). The core value of an effective corporate governance system lied in standardizing board of shareholders and board of directors. With the division of authority and responsibility between shareholders and directors, board of shareholders controlled the appointment and removal of directors and the final approval of systems as well as supervised directors. Board of directors, on the other hand, was responsible for the benefits of shareholders and the company as well as supervised management echelon by grasping the power of financial policies and personnel management to ensure the sustained-yield management of the company (Beaudoin et al., 2015). Reed (2015) explained corporate governance as to ensure capital providers being able to acquire deserved rewards. Syriopoulos & Tsatsaronis (2012) defined corporate governance as the system to instruct and control a company that the corporate governance structure should enhance transparent and efficient markets, establish consistent law, and clearly explain the division of responsibilities among supervision, control, and authority and responsibility execution units.

Referring to Huang & Ni (2017), the following dimensions are utilized for measuring corporate governance in this study.

(1) Manager holdings: Van der Colff (2015) indicated that managers, on whom the company concentrated the holdings more, inclined to maximizing shareholders' wealth in the decision-making.

(2) External shareholders: Khan et al. (2013) proposed two opinions. One was "efficiency supervision assumption" which considered that institutional investors presented more professional knowledge and technology on supervising managers than on small shareholders, and the supervision cost was lower. Increasing institutional investors therefore could effectively reduce agency problems, enhance the operation performance of an enterprise, and appear positive intention to the beneficial acquisition for the enterprise

(3) Board size: Schnatterly & Johnson (2014) considered that the smaller board size could more effectively supervise CEO's action.

Accounting Education

The quality characteristics of accounting education refer to the provided information being able to help users make economic decisions (Hwang et al., 2013). Kouwenberg et al. (2014) classified accounting education into accrual quality, predictability, stationarity, persistence, value relevance, timeliness, and robustness. The robustness of accounting information, from the viewpoint of income statement, could be rapidly measured from good and bad news of earnings response to further extend to the capital market. Zagorchev & Gao (2015) considered that accounting robustness could be promoted through accounting education, and the robustness was the multiple of bad news coefficient of earnings response in good news coefficient of earnings response. When the value was higher than 1, the earnings conformed to the robustness principle. Positive accounting operation has become a tactic for a company with the intention of fraud that a healthy corporate governance system should avoided the situation through accounting education. Company accountants (and firm's CPA) often encounters moral dilemma as they are responsible for the company management (firm's clients) and the public that they present dual identity. Under the pressure of dual identity, the decisions are not made with accounting profession, but take socio-psychological

into account, when encountering moral dilemma. Both current situation and organizations are the factors in the moral decision making (Filbeck et al., 2013). Abernathy et al. (2014) pointed out the high complexity of current commercial environment that listed ethics or codes of conduct could not provide complete behavior directions for corporate accountants. For this reason, a school should provide professional morality courses to train students and cultivate the moral judgment ability (Charles et al., 2016).

Referring to Ni et al. (2017), professional ethics, ethical value, and professionalism are applied to measure accounting education in this study.

Enterprise Value

Lew & Wu (2013) indicated that the real value of a company could not be determined with traditional accounting standards, where tangible asset-centered and amount-emphasized enterprise evaluation model could not completely estimate the true value of high-technology and high value-added industries. Dhaliwal et al. (2012) regarded enterprise value as the process of an enterprise creating wealth for the shareholders through the enhancement of stock value and the distribution of dividend. Otsubo (2017) also mentioned that tangible asset-centered enterprise evaluation model could not completely measure the true value of an enterprise. Kim et al. (2014) considered that the key in creating enterprise value focused on the viewpoints of shareholders and customers and the application of correct strategies as course of action and guidelines to achieve the final objective of enterprise value. Baber et al. (2012) divided enterprise value into 1. the value of tangible assets, 2. the value of intangible assets, and 3. the synergy value operated by effectively integrating tangible assets and intangible assets.

Habib et al. (2013) measured enterprise value with financial indicators and non-financial indicators. The common financial indicators contained price per book value, Tobin's Q, and economic profits, which presented clear definitions and definite calculation, that they were not difficult to measure. Non-financial indicators included customer satisfaction, product quality, and organizational stability, which were more difficult and not easily identified. As a result, financial indicators were used in most studies for measuring enterprise value. The idea of Tobin's Q has been proposed for more than four decades. Tobin's Q, proposed by James Durbin, a Nobel laureate in economics, in 1969, aims to assist in predicting the investment decision of an enterprise beyond economic factors. The equation is the ratio of the market value of an asset and the replacement cost. Tobin's Q larger than 1 stands for high growth of the company, while Tobin's Q smaller than 1 represents the low growth. The Tobin's Q approximate equation proposed by Shieh et al. (2016) is utilized in this study. By multiplying the stock value of a company by the market value of outstanding shares and outstanding preferred stocks, adding the book value of long-term liabilities as well as the market value of short-term liabilities, and then being divided by the book value of total assets, the result is similar to Tobin's Q.

Research Hypothesis

Fama & French (2012) indicated that the basis of the external environment of corporate governance was to establish the regulation and law enforcement system to effectively regulate a company. Without proper accounting standards, shareholders or the external could not know the situation when controlling shareholders or the managerial level did not take the responsibilities or appear non-arm's length. Besides, when illegal things appear in administering authorities, appropriate legal punishments are necessary to stop such behaviors. Accountant education is therefore necessary in corporate governance for promoting the ability and literacy of accounting profession. Tan (2012) indicated that different governance mechanisms in various countries would affect accounting education and the relationship between information and stock value changes as well as the liquidity of capital market, as investors would be willing to invest in a company when they, to some degree, confirmed the invested capitals not being infringed by the management. Vintila & Gherghina (2012) mentioned that controlling shareholders might not provide accounting education for reflecting real transactions but consider self-interest when agency problems existed in between controlling shareholders and external shareholders. In this case, controlling shareholders might manipulate earnings to cover the effect of wealth encroachment on earnings or report the earnings with total amount, but ignore the details. Such behaviors could result in accounting education losing the reliability. When external investors did not trust financial accounting information, the correlation between earnings information and stock value reward would be reduced (Zagorchev & Gao, 2015). For this reason, the following hypothesis is proposed in this study.

H1: Corporate governance presents significantly positive correlations with accounting education.

Huang & Ni (2017) discovered that company accountants could promote the professional skills through accounting education to create financial earnings of the company and enhance enterprise value. Syriopoulos & Tsatsaronis (2012) compared the suitability between accounting earnings and cash flow for measuring company performance. As the shorter performance measuring period and longer company operating cycle would increase the importance of accrued receivables, in which the figures of earnings were included, it was considered that

earnings could better measure company performance than cash flow. Besides, the accounting measuring ability relied on an enterprise practicing accounting education to effectively measure enterprise value (Tone & Tsutsui, 2014). Corporate accounting supervisors or firm's accountants should provide effective and correct information based on good faith principle. Accounting profession was therefore responsible for unspecific statement users, and reliability and ethics were emphasized characters beyond professional skills. Furthermore, accounting environment allowed flexible accountant selection that business managers would engage in legal or illegal enterprise value management due to self-interest or other factors (Hung et al., 2014). Accounting professionals often encountered moral judgment. At the time, perceived professional ethics would determine the accounting processing method. Accounting education therefore was necessary for promoting accountants' professionalism and professional ethics perception so as to enhance the reliability of enterprise value information (Zahra, 2014). The following hypothesis is therefore proposed in this study.

H2: Accounting education shows remarkably positive correlations with enterprise value.

Different holding structures would determine distinct organization structures of enterprises to further determine various governance structures and eventually determine the behavior and value of such enterprises. Internal governance arrangement of a company, e.g. board of directors structure and managers' shareholding incentive, is the internal power allocation of the company; and, holding structure is the direct reaction of the internal power allocation of the company (Qian & Yeung, 2015). Based on board of directors' selection for proper goals and propose suggestions, Walls & Hoffman (2013) indicated that, when time permitted, board of directors should proposed suggested goals by matching company requirement and considering directors and potential directors' capabilities. Large board of directors was not as efficient as small board of directors (Hwang et al., 2013). Relevant research discovered the smaller board size, the better business performance (Mao & Renneboog, 2015). Van der Colff (2015) indicated that independent directors, compared to general directors, did not present self-serving motivation but presented higher independence that they could objectively play the role of a supervisor. Besides, most seats of board of directors should be left for external directors in order to enhance the supervision function. Huang & Ni (2017) also proved that the establishment of two seats for independent directors and one seat for independent supervisor showed positive correlations with corporate performance, revealing that the system could actually enhance company performance. The independent directors and supervisor mechanism could benefit the sound operation of board of directors and promote enterprise value. Accordingly, the following hypotheses are proposed in this study.

H3: Corporate governance reveals notably positive correlations with enterprise value.

H4: Accounting Education appears mediation effects between corporate governance and enterprise value.

RESEARCH DIMENSION AND METHOD DESIGN

Definition of Research Dimension

(1) Corporate governance

Huang & Ni (2017), manager holding, external shareholders, and board size are used in this study for measuring corporate governance.

(2) Accounting Education

Referring to Ni et al. (2017), professional ethics, ethical value, and professionalism are applied in this study to measure Accounting Education.

(3) Enterprise value

In order to overcome the problem of an enterprise's replacement cost data being hard to acquire, Shieh et al. (2016) proposed a Tobin's Q approximate equation. By multiplying the stock value of a company by the market value of outstanding shares and outstanding preferred stock, adding the book value of long-term liabilities and the market value of short-term liabilities, and then being divided by the book value of total assets, the result is similar to Tobin's Q.

Research Object

Listed high-tech industries in Shanghai are selected as the research samples. The data are acquired from China Economic and Financial Research Database. To complete the data of the research samples, a company with missing data would be deleted when collecting corporate governance, Accounting Education, enterprise value, and financial ratio related variables.

Table 1. Regression Analysis of corporate governance and Accounting Education

Dependent variable	Accounting Education					
Independent variable	professional ethics		ethical value		professionalism	
corporate governance	β	ρ	β	ρ	β	ρ
manager holding	2.127***	0.000	2.224***	0.000	2.476***	0.000
external shareholders	2.244***	0.000	2.371***	0.000	2.253***	0.000
board size	2.044**	0.002	2.446***	0.000	2.325***	0.000
F	26.552		31.438		37.263	
P	0.000***		0.000***		0.000***	
R2	0.221		0.277		0.324	
Regulated R2	0.203		0.251		0.311	

Note: * stands for p<0.05, ** for p<0.01, *** for p<0.001

Analysis

Regression Analysis is utilized for understanding the relations among corporate governance, Accounting Education, and enterprise value.

ANALYSIS AND DISCUSSION

Correlation Analysis of Corporate Governance and Accounting Education

Regression Analysis is used for testing the hypotheses and theoretical structure in this study. The analysis of the first regression is shown in **Table 1**, where the regression equation achieves the significance (F=26.552, p< 0.001). "Manager holding", "external shareholders", and "board size" in corporate governance show notably positive effects on professional ethics, reaching the significance (β=2.127, p<0.001; β=2.244, p<0.001; β=2.044, p<0.01). The analysis of the second regression is displayed in **Table 1**, where the regression equation reaches the significance (F=31.438, p<0.001). "Manager holding", "external shareholders", and "board size" in corporate governance present remarkably positive effects on ethical value, achieving the significance (β=2.224, p<0.001; β =2.371, p<0.001; β=2.446, p<0.001). The analysis of the third regression is showed in **Table 1**, where the regression equation reaches the significance (F=37.263, p<0.001). "Manager holding", "external shareholders", and "board size" in corporate governance reveal notably positive effects on professionalism, achieving the significance (β=2.476, p<0.001; β=2.253, p<0.001; β=2.325, p<0.001). Accordingly, H1 is supported.

Correlation Analysis between Corporate Governance, Accounting Education and Enterprise Value

Regression Analysis is applied to test the hypotheses and the theoretical structure in this study. The analysis of the first regression is listed in **Table 2**, where the regression equation reaches the significance (F=33.275, p<0.001). "Manager holding", "external shareholders", and "board size" in corporate governance appear notably positive effects on enterprise value, achieving the significance (β=2.433, p<0.001; β=2.382, p<0.001; β=2.516, p<0.001). H3 is therefore supported.

The analysis of the second regression is shown in **Table 2**, where the regression equation reaches the significance (F=36.834, p<0.001). "Professional ethics", "ethical value", and "professionalism" present remarkably positive effects on enterprise value, achieving the significance (β=2.188, p<0.001; β=2.297, p<0.001; β=2.622, p<0.001). In this case, H2 is supported.

Table 2. Regression Analysis between corporate governance, Accounting Education and enterprise value

Dependent variable→	Enterprise value			
Independent variable↓				
corporate governance	β	ρ	β	ρ
manager holding	2.433***	0.000		
external shareholders	2.382***	0.000		
board size	2.516***	0.000		
Accounting Education				
professional ethics			2.188***	0.000
ethical value			2.297***	0.000
professionalism			2.622***	0.000
F	33.275		36.834	
P	0.000***		0.000***	
R2	0.377		0.412	
Regulated R2	0.349		0.386	

Note: * stands for p<0.05, ** for p<0.01, *** for p<0.001

Table 3. Hierarchical Regression between corporate governance, Accounting Education and enterprise value

Dependent variable→	Enterprise value			
Independent variable↓	Model 1		Model 2	
corporate governance	β	ρ	β	ρ
manager holding	2.433***	0.000	2.172***	0.000
external shareholders	2.382***	0.000	2.069***	0.000
board size	2.516***	0.000	2.243***	0.000
Accounting Education				
professional ethics			2.667***	0.000
ethical value			2.546***	0.000
professionalism			2.618***	0.000
F	33.275		42.169	
P	0.000***		0.000***	
R2	0.377		0.453	
Regulated R2	0.349		0.421	

Note: * stands for p<0.05, ** for p<0.01, *** for p<0.001

Mediation Effect Analysis between Corporate Governance, Accounting Education and Enterprise Value

The mediation effect of Accounting Education is shown as the Hierarchical Regression Analysis in **Table 3**. Corporate governance reveals significant explanation on enterprise value (F=33.275, p<0.001). According to Model 2, where the effects of corporate governance and Accounting Education on enterprise value are taken into account to discuss the mediation effect of Accounting Education, it is discovered that β of manager holding remarkably drops from 2.433 (p<.001) down to 2.172 (p<.001), revealing that Accounting Education would reduce the direct effect of manager holding on enterprise value. Furthermore, β of external shareholders notably drops from 2.382 (p<.001) to 2.069 (p<.001), showing that Accounting Education would reduce the direct effect of external shareholders on enterprise value. Moreover, β of board size significantly drops from 2.516(p<.001) to 2.243(p<.001), presenting that Accounting Education would reduce the direct effect of board size on enterprise value. According to the research results, Accounting Education appears partial mediation on corporate governance and enterprise value that H4 could be supported.

CONCLUSION

Corporate governance is a management issue commonly concerned in academia and business circles. After Asian Financial Crisis, landmine stock event, and a series of false financial statements of US large enterprises, governments in various countries adopted several measures to reinforce the corporate governance mechanism, expecting to enhance the overall governance standard of listed companies through the basic norms and effective practice of legal institution. Good corporate governance is the commitment to investors investing in capitals for acquiring reasonable rewards as well as the efficient operation of investment. Corporate governance therefore would affect the funding ability of high-tech industries in the capital market. Besides, corporate governance is

closely related to national economic performance as high-tech industries play an important role in the production and allocation with rare economic resources. Corporate governance in high-tech industries could supervise the managerial level of a company and guarantee investors' basic equity through accounting education, but the final objective is to increase company value to thicken the long-term development of high-tech industries. When the capital market presents certain efficiency, stock value is the specific reflection of company value and shareholder wealth in high-tech industries. Consequently, the key in driving high-tech industries to apply higher-level governance mechanisms lies in the relationship between corporate governance and company value. That is, governance quality would affect stock value of a company in high-tech industries, and the adoption of good accounting education could have investors trust the accounting information and further be willing to invest. The funding capability and enterprise value in the capital market would be promoted.

SUGGESTION

Aiming at the research results of corporate governance, Accounting Education, and enterprise value in high-tech industries, the following suggestions are proposed in this study.

I. High-tech industry investors should actively participate in corporate governance systems. In addition to promoting the corporate governance quality of high-tech industries, they could reduce the investment risks. Institutional investors with long-term funds present social moral responsibility on investors' capitals that institutional investors, by thoroughly developing the market influence, could lead the sound corporate governance of high-tech industries as well as ensure the risks and the rights & interests of the mass investors.

II. Pure cultivation of business operation ability is lack of ethical care about the world and active function to develop commercial behaviors for human wellbeing. High-tech industries are therefore suggested to include versatile business ethics courses in accounting education, covering the topics of information ethics, environmental ethics, consumer ethics, labor ethics, competitor-in-business ethics, government ethics, shareholder ethics, decision-making ethics internal control (supervision) ethics, international society ethics, and corporate social responsibility. Multiple teaching approaches of discussion questions for moral development, case method, value clarification, and role-playing method could be used for achieving the goal.

III. Investors should take corporate governance into account when selecting stocks. In addition to the profitability of listed companies in high-tech industries, institutional investors' shareholding ratio, employment of external directors, frequent information openness and disclosure, and future business risks hid in too many holdings of insiders should be pay attention to. Such variables related to corporate governance in high-tech industries should be concerned.

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Important Factors Affecting Student Information System Quality and Satisfaction

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ABSTRACT

Student Information System is one of the key systems for facilitating the management and development of Higher Education Institutions. Its use for academic decision-making purposes as well as other academic tasks is crucial. Therefore, this paper aims to understand the impact of System Quality, Information Quality and Information Presentation on Student Information System satisfaction of academic and administrative staff. In this study, System satisfaction survey is carried out and factor analysis and regression tests are applied to interpret the collected data. The results show that only Information Quality has direct effect on satisfaction. Then the impact of decision-making as a mediator factor on system satisfaction is measured and the results reveal that System Quality and Information Quality has indirect significant effect whereas Information Presentation does not have direct nor indirect effect on system satisfaction.

Keywords: system satisfaction, student information system, higher education institution, information quality, system quality, information presentation

INTRODUCTION

"Producing meaningful, accessible, and timely management information has long been the holy grail of higher education administrative technology" (Goldstain & Katz, 2005, p.1). Significant and timely information management is important for the decision-making process. Higher Education Institutions (HEIs) collect and organize all student data with the help of the Student Information Systems (SIS) to provide meaningful information that affects the decision-making process. However, is the collected data sufficient to prepare a report for decision-makers and do HEIs obtain the information they require?

New decision support systems are being developed and researched with the rapid development of information and communication technologies. The work of Negash (2004) aimed to improve the timing and quality of input in the decision-making process and to facilitate management work. For this reason, author developed a framework and identified a potential research area that emphasized the significance of data to support informed actions of decision-makers.

Today, there is an increasing pressure from organizations to supply information for managerial decisions. According to Abubakar et al. (2017) information integration and exchange encourage the creativity and learning within the organization, which has significant impact on organizational performance. Most HEIs are greatly pressured to maximize student retention and reduce the time of completion of the program. HEIs are increasingly gaining insights about their students through the data they collect, and this is done for the benefit of international accreditation bodies, national accreditation bodies and government bodies which are continuously seeking for more information in order to measure and assess the effectiveness of HEIs. Each one increases the demand for information. For this reason, the quality of the provision of successful information and the relevance of such information to measurements and evaluations by international and national accreditation bodies become critical (Goldstein & Katz, 2005).

Bharati and Chaudhury (2004) investigated the factors which affect decision-making satisfaction in web-based decision support systems through the hypothesis that "system quality, quality of information and the way it is

Contribution of this paper to the literature

- Impact of System Quality, Information Quality and Information Presentation on Student Information System (SIS) measures the satisfaction levels of academics and administrative staff.
- This system is significant because information gathered in this way, can be used to make decisions about strategies of institution up to departments and programs' needs and helps to develop statistical information for accreditation purposes.
- Course advisors use the SIS to decide courses that the students will get based on their performance. And finally, students use SIS to make online course registration, to check their time table, exam schedules, exam results and transcript.

presented affect decision-making satisfaction". According to the results of the research, even though the way information is presented has no importance on the decision-making process, the quality of the system and the quality of the information positively influences the user's decision-making.

The decisions taken by the universities are very important and these decisions directly affect many different parties; such as students, administrators and faculty members. The majority of organizational decisions involve some degree of conflict or dissatisfaction. SISs are commonly often used to support decisions by university administrators. Administrators in universities believe that the collection of diverse data on student performance and enrollment should be included in the SIS.

This study considers the development of HEI with the SIS to assist academic and administrative staff in generating reports. Faculty coordinators generate reports on the number of students in each department and determine the number of sections (groups) for each course, the Rector's office uses these reports to determine the number of students from each faculty/department in order to see the increase or decrease in the number of students. This information is then used to decide on whether to consider closing the program or improving the department's needs. Faculties use statistical information for accreditation issues. Course advisors use the SIS to decide courses that the students will get based on their performance. And finally, students use SIS to make online course registration, to check their time table, exam schedules, exam results and transcript. Given the importance of the SIS to HEIs, this study examines the level of satisfaction of academic and administrative staff using SIS generated reports.

Since SIS is a vital system for HEIs, it is important to understand the factors that affect user satisfaction. The structure of this article is as follows: Section II is a literature review of the use of SIS in higher education institutions and previous work on system satisfaction. Section III is the research methodology that describes the model used in the research and provides information about the questionnaire, hypothesis, data collection and analysis. According to the results of the analysis, the article describes the experimental findings and discussions in Section IV.

LITERATURE REVIEW

Use of SIS in HEIs

The effectiveness of organizational decision-making and daily tasks is critical for every organization (Begam, 2015). Likewise, decision-making and productivity in HEIs is important, not only for their present position, but also for their future development. For this reason, universities should consider the use of technology for decision-making. In universities, SIS plays an important role as a system because it is used to store information that is used to generate reports for decision-making about students, lecturers, departments, faculties and curriculum (Bayangan-Cosidon, 2016). There are many factors (i.e. quality of information system, information presentation, etc.) that affect the use and dissemination of such systems in organizations.

According to Wang & Strong (1996) poor data quality can have significant social and economic impacts. While companies improve data quality with practical approaches and tools; efforts to improve focus are tightly intensive on accuracy. They also talk about the fact that data consumers have a greater concept of data quality that IS professionals recognize. Entries in the organization's information system can contain hundreds of data items. As the use of organizational information systems increases; the cost, complexity and quality of the data on which decisions are based become critical (Huang et al., 1998; Laudon, 1986).

Price and Shanks (2004) stated that quality information and its management within an organization is compulsory for adequate transactions and decision-making. According to the same study, decision makers can be kept very far from original data sources or information about data conditions or associations. Having the necessary rigorous and generic skills to understand the quality of data will be essential to understand how the data collection decision affects the decision-making process and to create strategies that are used to improve the quality of data (Price & Shanks, 2004). Data collection and quality of knowledge are important for organizations, as strategic and

tactical decision-making depends on the quality of the data used in decision-making. Increasing use of data warehouses in order to collect and join various sources of data to improve decision-making to its highest level points out the vulnerability of an organization regarding the poor data quality (Bharati & Chaudhury, 2004).

The information system quality and success have been recently studied with different methodologies. However, the studies like Bayangan-Cosidon (2016) and Alzahrani et.al. (2017) consider students' evaluations of SIS. Bayangan & Cosidon (2016) aims to improve the efficiency of the existing SIS of Kalinga State University Rizal Campus. To obtain this objective, an evaluation of the current system was done through investigation and interview methods from the perspective of acting registrar, faculty members, campus secretary and students. The survey questionnaire was developed based on the characteristics and sub-characteristics of ISO Software Quality Model 9126. The results show that the current SIS met the five requirements: security, reusability, usefulness, maintainability, and functionality. The information system quality and success model has been studied on a digital library system by Alzahrani (2017) and it has been found that "behavioural intentions are greatly influenced by system quality, information quality and service quality".

Information System Satisfaction

Gelderman (1998) explore the effectiveness of two frequently used measures for the success of information systems: usage and user satisfaction. The results indicate that user satisfaction is significantly related to performance. In the study mentioned, the information system satisfaction is cognitive evolution of gratified level of end-users who directly interact with the IS. The end-users are non-technical users.

Au et al. (2002) defines the information system satisfaction of end users as "the IS end-user's overall affective and cognitive evaluation of the pleasurable level of consumption-related fulfilment experienced with the IS. IS end users refer to non-technical personnel who use or interact with the system directly, as opposed to technical personnel who design the IS". DeLone and McLean (1992) describe the success model as an IS influence at the organizational and individual level. As a result, six basic dimensions of IS success model have been revealed; system quality, information quality, usage, user satisfaction, individual impact and organizational impact (DeLone & McLean, 1992). The model has been updated with the new variables in 2003 as: Information Quality, System Quality, Service Quality, Intention to Use, Use, User Satisfaction, and Net Benefits after ten years (Delone & McLean, 2003).

Abubakar et al. (2017, p.4) opined that "to increase the success of knowledge management projects and applications, investing in information technology is unavoidable". Rezaei et al. (2016) studied effect of cloud computing systems on the service quality of knowledge management systems. The uploading result of a knowledge management system using the cloud computing technology is also investigated aiming to answer the main question "whether this new knowledge management system can cause a proper result on the quality of services or not?" According to their findings the users observed significant differences after the implementation of the service. Alzahrani (2017) evaluated the success of a digital library system based on DeLone & McLean's IS Success Model and it has been reported that digital library systems have a strong influence on the quality factors, satisfaction, behavioral intent and deviation of actual use. Padayache et al. (2010) used ISO 9126 model to analyze the external systems quality characteristics, sub-characteristics and domain specific criteria for evaluating e-Learning systems. "Educators, educational administrators, and higher education institutions adopting Course Management Systems (CMS) to implement e-learning have a vested interest in evaluating 'quality in use' as they inform the decision-making process with regards to the choice of CMS" (Padayachee et al., 2010). Moreover, Mir and Mehmood (2016) examined the success factor of online student support system of Allama Iqbal Open University by using the DeLone and McLean IS Success Model with the sampling of 173 students. According to their findings, most of the students were satisfied with this online support system in terms of technical standards and functionality. However, they were not satisfied with the information or responses. Another case study from Epoka University by Sherifi (2015) investigated the impact of information systems in satisfying students of the university. The dimensions of the student satisfaction were assurance, responsiveness, tangibility (the physical evidence of the service), empathy and reliability. According to the same study, students are satisfied by the Student Affairs Information System services.

The Bharati and Chaudhury (2004) model (**Figure 1**) was established on the basis of structure along with information quality and their impact on user satisfaction, since it was in a way a part of the IS success model. According to their study, independent variables, System Quality, Information Quality and Information Presentation are affected. A successful model is given in **Table I**, "decision-making". "Deciding on a system's problem solving and decision-making skills indicate that these variables are in position to determine if the system helps the individual in identifying problematic areas, structuring system problems and making decisions regarding the aim of managing a business cycle" (Bharati & Chaudhury, 2004). This model uses decision-making confidence and decision-making effectiveness for the decision-making structure.

Many studies in literature have evaluated the satisfaction and success of information systems at universities from students' perspective with different methodologies like ISO 9126, Serwqual, and DeLone & McLean IS Success Model. However, this paper contributes to the literature by evaluating student information system satisfaction and success from the administrative and academic staff perspective who are the main users of such systems for better decision-making.

METHOD

Considering the purpose of this study, main data is collected through the questionnaire which is inspired from Bharati and Chaudhury (2004) and adopted from various sources such as Chervany et al. (1972), Belardo et al. (1982), Mahmood (1987), Zmud et al. (1983), Bailey and Pearson (1983), Srinivasan (1985), Miller and Doyle (1987), King and Epstein (1983), Vessey (1994), Swanson (1985), Goslar et al. (1986), as displayed in **Table 1**. This study uses the conceptual model of Bharati and Chaudhury (2004) displayed in **Figure 1** as a basis. The questionnaire is applied to the academic and administrative staff of a HEI.
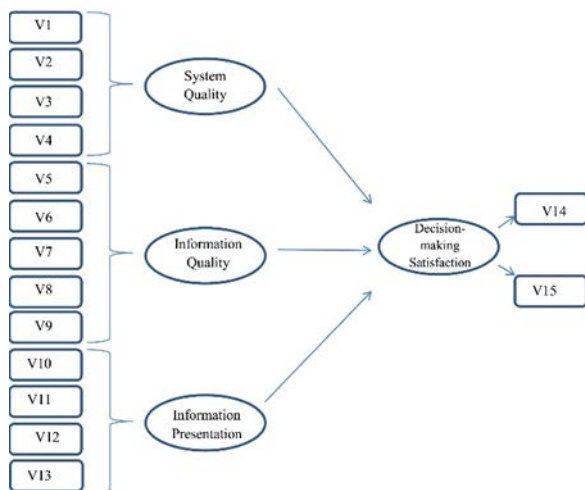
Figure 1. Base Conceptual Model

The questionnaire had two main sections, first section included demographic variables and second section grouped into 5 groups like system quality, information quality, information presentation, decision-making, and satisfaction. The questionnaire had 59 questions using 1 to 5 Likert type scale. Cronbach's Alpha reliability statistics was used to test the reliability of the instrument. Results confirmed that the instrument is reliable (system quality: %79, information quality: %95, information presentation: %88, satisfaction: %77). The overall reliability result was %96.

In total 120 questionnaires were distributed to the faculties and 96 were returned within 30 days which shows 80% response rate. The collected data was analyzed with SPSS to accept or reject the hypothesis. The demographic questions were included the administrative positions of the responders such as Rector/Vice Rector, Rector's Advisor, General Secretary, Dean/Vice Dean/Head of a School, Head of Department/Vice Head of Department, Faculty Coordinator and student advisors. Also, the overall performance of the SIS was asked to be evaluated on a 7 Likert scale.

Table 1. List of Utilized Instruments

Variables Type	Variable's name	Item no.	Item measured	Reference
Independent	System Quality	1	System reliability	(Srinivasan, 1985)
		2	Convenient to access	(Bailey & Pearson, 1983)
		3	System ease of use	(Belardo, Karwan & Wallace, 1982)
		4	System flexibility	(Srinivasan, 1985)
Independent	Information Quality	5	Information accuracy	(Bailey & Pearson, 1983), (Mahmood, 1987), (Miller & Doyle, 1987), (Srinivasan, 1985), (Ge & Helfert, December 2015)
		6	Information completeness	(Bailey & Pearson, 1983), (Miller & Doyle, 1987)
		7	Information relevance	(Bailey & Pearson, 1983), (King & Epstein, 1983), (Miller & Doyle, 1987), (Srinivasan, 1985)
		8	Information content needs	(Doll & Torkzadeh, 1988)
		9	Information timeliness	(Bailey & Pearson, 1983), (King & Epstein, 1983), (Mahmood, 1987), (Miller & Doyle, 1987), (Srinivasan, 1985)
Independent	Information Presentation	10	Presentation graphics	(Swanson, 1985), (Vessey, 1994)
		11	Presentation color	(Swanson, 1985), (Vessey, 1994)
		12	Presentation style	(Swanson, 1985), (Vessey, 1994)
		13	Navigationally efficiency	(Swanson, 1985), (Vessey, 1994)
Mediator	Decision-Making	14	Decision confidence	(Goslar, Green & Hughes, 1986), (Gueutal, Surprenant & Bubeck,, 1984), (Zmud, Blocher & Moffle, 1983)
Dependent	Satisfaction	15	Decision effectiveness	(Chervany, Dickson & Kozar, 1972)

Hypotheses

System Quality (SQ) is one of the measurements for the information processing system itself Petter et al. (2013) and it's a manifestation of system software and hardware (Bharati & Chaudhury, 2004). Sensitive measures such as ease of access Bailey & Pearson (1983); user friendliness, system reliability and flexibility Srinivasan (1985) and Belardo et al. (1982) have been utilized in previously assessed survey instruments in order to obtain system quality measurement. According to Gürkut and Nat (2016) the System Quality has positive effect on decision-making satisfaction. Considering this, four measures mentioned above have been taken into account and the following hypotheses are stated:

Hypothesis 1: *System Quality has significant direct effect on satisfaction.*

The quality of the information (IQ) is a measure of the value of the information offered to the user. The user perception of the value of Gallagher's (1974) information system was used to determine the quality of information of the system. The measures that have been employed for information quality are information accuracy, information completeness, information relevance, information content needs, and information timeliness (Bailey & Pearson, 1983; Doll & Torkzadeh, 1988; Ge & Helfert, 2015; Iivari, 1987; King & Epstein, 1983; Mahmood, 1987; Miller & Doyle, 1987; Srinivasan, 1985). These five dimensions are used for the quality of information structure. According to Gürkut and Nat (2016) the Information Quality has positive effect on decision-making satisfaction. Considering this, measures mentioned above have been taken into account and the following hypothesis is stated:

Hypothesis 2: *Information Quality has significant direct effect on satisfaction.*

Information presentation (IP) is a research area that examines how information is displayed. "Many studies have focused on factors such as image formats, colors and graphics in contrast to tables, and how these factors help to decide" (Vessey, 1994). Interfaces and improperly designed screens can adversely affect users and cause unnecessary work in decision-making environments. Dimensions of informative presentation; graphics, colors, introductory style and navigational efficiency. According to Gürkut & Nat (2016) the Information Presentation has positive effect on decision-making satisfaction. Considering this, four measures mentioned above have been taken into account and the following hypothesis is stated:

Hypothesis 3: *Information Presentation has significant direct effect on satisfaction.*

Therefore, in order to identify the significant direct effect of System Quality, Information Quality, and Information Presentation on satisfaction, the conceptual model in **Figure 1** has been modified and Model-1 in **Figure 2** is created.
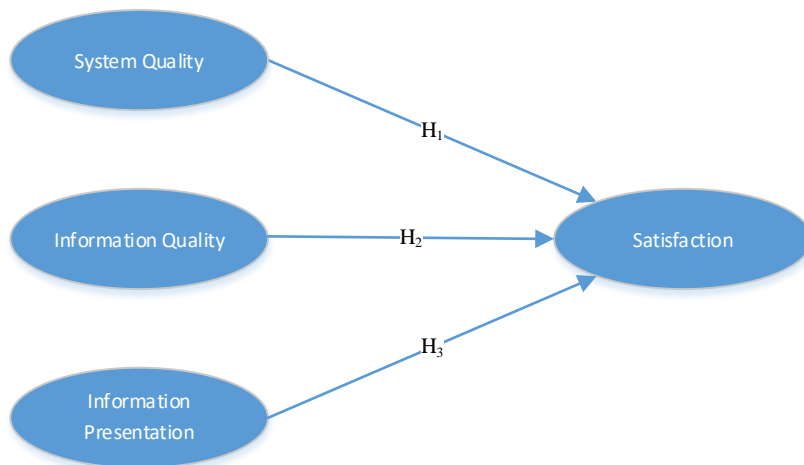
Figure 2. Model-1

Data Analysis

In this study, the factor analysis is applied to examine if all the variables are representing their corresponded variable to test our Model-1. Kaiser-Meyer-Olkin (KMO) and Bartlett's test is applied to the System Quality variables, Aprox.Chi-Square is obtained as 646.231 with the significance of 0.000 and the results show that KMO is 0.790 for the system quality. These results indicate that the data were suitable for factor analysis. Bartlett's test is also applied to the variables of the Information Quality and Information Presentation. Aprox.Chi-Square is obtained as 1313.032 with the significance of 0.000 and the results show that KMO is 0.945 for information quality variables. Aprox.Chi-Square is obtained as 436.852 with the significance of 0.000 and the results show that KMO is 0.881 for information presentation. These results show that the data is suitable for factor analysis of information quality (Bharati & Chaudhury, 2004) and information presentation group of questions. Finally, KMO and Bartlett's test is applied for variables of the decision-making and satisfaction, Aprox.Chi-Square is obtained as 0.592 with the significance of 0.000 and the results show that KMO is 0.597 for decision-making. Aprox.Chi-Square is obtained as 154.032 with the significance of 0.000 and KMO is 0.730 for the satisfaction. These results show that the data were sufficient for factor analysis of satisfaction separately.

According to factor analysis results which can be seen in **Table 2**, all variables are suitable to test our Model-1. The loaded value of factors is more than 0.50 and factor analysis table shows that the determinant is more than 0.00001 which signifies the absence of multicollinearity.

Table 2. Factor Analysis of Variables

Variables	Reliability Cronbach's Alpha	KMO	Bartlett's Test	
			Aprox. Chi-Square	Sig
System Quality	0.799	0.790	646.231	0.000
Information Quality	0.950	0.880	1313.032	0.000
Information Presentation	0.881	0.848	436.852	0.000
Decision-Making	0.600	0.592	228.147	0.000
Satisfaction	0.766	0.730	154.030	0.000

Nevertheless, to test the direct significance of model in overall (all variables together) regression test is applied and coefficients results in **Table 3** show that only Information Quality is significant at 5% level with an impact of 0.292. System quality and information presentation are not significantly significant which means Information Quality has direct effect on satisfaction, but System Quality and Information Presentation does not have significant direct effect on satisfaction.

In light of this, researchers developed the following hypothesis to capture the full view.

Hypothesis 4: *System quality has significant indirect effect on satisfaction*

Hypothesis 5: *Information quality has significant indirect effect on satisfaction.*

Hypothesis 6: *Information presentation has significant indirect effect on satisfaction.*

Model-2 has been created by using decision-making as mediator variable to identify the significant indirect effect of variables to satisfaction. Effectiveness of this model on satisfaction has been analyzed by regression test and results are shown in **Table 3**.
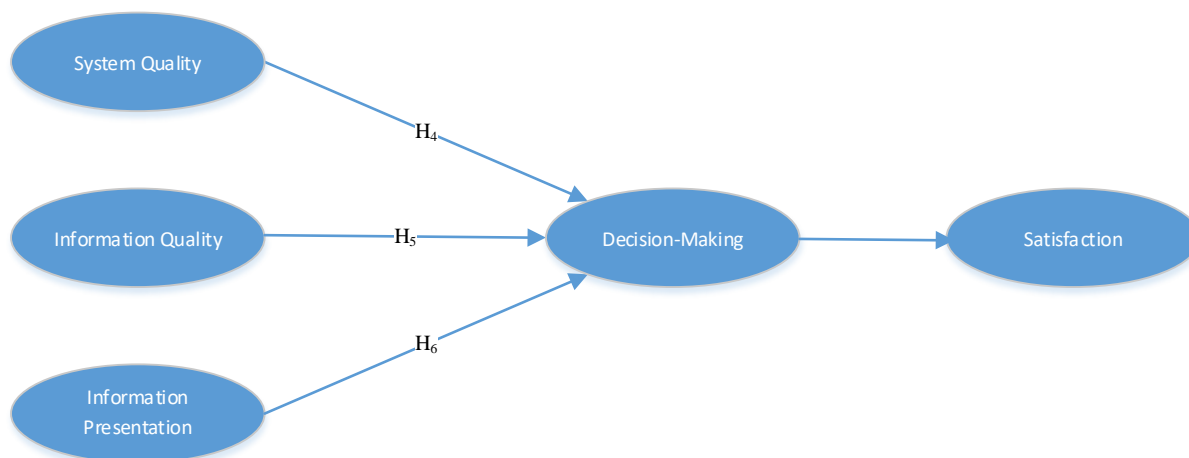
Figure 3. Model-2

In view of the hypothesis H4, H5 and H6 the Model-2 in **Figure 3** was created, and decision-making is considered as a mediator variable. Regression test results in **Table 3**, show that, with decision-making, system quality become significant at 5% level with an impact of 0.315, information quality still significant at 5% level with an impact of 0.254, and information presentation is not significant.

Table 3. Repost Regression Model

	Dependent Variable: Satisfaction			
	Model-1	**VIF**	**Model-2**	**VIF**
Variable	B		B	
Constant	1.254		-0.212	
System Quality	0.306 (0.179)	2.346	0.315 (0.158)**	2.346
Information Quality	0.292 (0.125)**	2.346	0.254 (0.110)**	2.346
Information Presentation	0.86 (0.108)	2.045	-0.018 (0.97)	2.134
Decision-Making	-	-	0,561 (0.107)*	1.130
R Square	0.323		0.479	
Adj. R Square	0.301		0.456	
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*, and **, denotes significant level at %5 and %1 respectively. The standard error values are referral in parenthesis.

EMPIRICAL FINDINGS AND DISCUSSIONS

Results of this study show that the System Quality has a significant direct effect on satisfaction (Hypothesis 1 is accepted), so increase in the System Quality guide to increase in satisfaction. Information Quality has a significant direct effect on satisfaction (Hypothesis 2 is accepted), so increase in the Information Quality guide to increase in satisfaction. These findings are in line with Tian and Xu (2017), where their results also show that system quality and information quality has significant impact on satisfaction. Information Presentation has significant direct effect on satisfaction (Hypothesis 3 is accepted), so increase in the Information Presentation guide to increase in satisfaction. These findings are in line with Gürkut and Nat's (2016) study which reports that System Quality, Information Quality and Information Presentation all together have positive effect on decision-making satisfaction. Nevertheless, it is assumed that the complete implementation of system (Model-1) makes academic and administrative staff satisfied, if all variables are working together. However, when the significant direct effect of variables tested results show that only Information Quality is significant at 5% level with an impact of 0.292, and System Quality and Information Presentation are not significant. These findings show that Information Quality has

direct impact on satisfaction, but System Quality and Information Presentation does not have direct impact on satisfaction. Information Quality includes information accuracy, information completeness, information relevance, information content needs and information timeliness which are also considered by Bharati and Chaudhury (2004) for the decision-making satisfaction on a web-based decision support system. Therefore, SIS should provide relevant, complete, timely and accurate information in order to increase user satisfaction. In hypothesis H4, H5 and H6 decision-making is considered as the mediator variable for satisfaction and Model-2 is created. And when this model is tested; the Information Quality becomes statistically significant at 5% level with an impact of 0.254, the System Quality becomes significant at 5% level with an impact of 0.315 and the Information Presentation is identified as not significant. This might show that people ask for information based on their needs and the way of their understanding. Furthermore, according to Carnoy (2004), the lack of training, lack of data analysis skills of administrators, and lack of user-friendly software for analysing test results at the school level are some of the important barriers for ICT-based management tools used in educational management. The statistical results also show that all variables support our research models. Model-1 shows that only System Quality has significant direct effect on satisfaction when there is no mediator variable. However, in Model-2 with the mediator variable decision-making; System Quality becomes significant, which shows it has indirect effectiveness between System Quality and satisfaction. With the mediator variable, Information Quality significance increases by 15% which means System Quality has effectiveness on Information Quality as well. Results for Information Presentation, which is in line with Bharati and Chaudhury (2004 and 2006) show that it is not significant on both Model-1 and Model-2, can be interpreted as the way of information is presented is not important as long as their needs are satisfied.

CONCLUSION

It is widely known that HEIs use SIS to collect, organize, and manage all student data to provide meaningful information that affect the decision-making process and day-to-day activities. Reports derived from SIS are used to support decisions of academics and administrative staff. According to the results of this study, decision-making is the most mediator variable in terms of satisfaction. Also, from findings it can be observed that the System Quality and the Information Quality affect the overall satisfaction of the SIS users. Previous research (Bharati & Chaudhury, 2004) show that Information Presentation is not important in the decision-making process. However, as Nyhan and Reifler (2015) advocates graphical representation of information reduces misperception. Today's technological advancements and people's mindsets make it possible to make decisions on the basis of visual (a clear and pictorial) presentation. Users are interested in finding up-to-date and detailed information to make an effective decision. This study demonstrates that the users' preferences may differ on the visualization and presentation of data from their preference of information, depending on the satisfaction they have, either directly or indirectly.

This paper is expected to guide a large frame of research which is required to improve SIS for futuristic uses. Also, it will help SIS developers to design a system in light of users' needs. As a future work, this study will be extended by considering different HEIs and various administrative and academic staff who use SIS for various reasons.

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Exploring the Influence of Using Collaborative Tools on the Community of Inquiry in an Interdisciplinary Project-Based Learning Context

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ABSTRACT

This study aims to explore the relationships among three presences, namely cognitive presence, social presence and teaching presence in a Community of Inquiry (CoI) framework in the context of interdisciplinary project-based learning (IPBL) through the collaborative technology Google Applications. The survey data was collected from 138 students with mixed subject specialism participated in a cultural creativity project. All participants were randomly assigned into one of two groups. The control group used online discussion boards, while the treatment group used the Google Applications as a collaborative technology to support the project learning. The results of the study showed that the students' cognitive presence was positively influenced by the teaching and social presence, which supported the theoretical CoI framework. Moreover, in an IPBL context with the support of the Google Applications, social presence had more predictive power in explaining students' cognitive presence than the support provided by the online discussion boards.

Keywords: Community of inquiry, Google Applications, Collaborative technology, Interdisciplinary project-based learning

INTRODUCTION

A central challenge of interdisciplinary integration in professional education is the radical restructuring of the whole learning process, and the introduction of modern pedagogical methodologies, techniques and information technologies (Chu et al., 2010; Di Blas et al., 2014; Sampson et al., 2014), as well as the need to spark communication and collaboration that clearly crosses traditional disciplinary boundaries. Interdisciplinary project-based learning (IPBL) is regarded as crucial pedagogy that can provide sufficient training in teamwork by developing multidiscipline teams similar to those that operate in industry. In responding to this need in higher education, a number of scholars have conducted the studies that involve complex technical, engineering, educational and social projects based on cross-disciplinary domain knowledge for students with different subject specialisms, so that they can contribute their individual efforts and resources to promote learning (Carpenter et al. 2007; Johansen et al., 2009; Maxim, 2006; Stozhko et al., 2015; Whitney, 2014). Such works suggest that this kind of IPBL can help students to further develop creativity and overcome the barriers framed by disciplinary egocentrism. Empirical studies have proved that IPBL can help students to develop knowledge management processes, arouse their interest and motivation in the subject course, foster their involvement in the learning process, and increase the level of cognition and satisfaction with learning outcomes (Bisasutti, & El-Deghaidy, 2012, 2015; Dekhane & Tsoi, 2010; Yueh et al., 2015), demonstrating the need, relevance and importance of interdisciplinary integration through IPBL in current pedagogical methodologies.

Nowadays, different discipline areas employ various information applications, which encourage teachers and students to collaborate in learning, using open-source electronic platforms to enhance the interdisciplinary technology-mediated training of students (Urban, 2014). As a creative pedagogic approach, IPBL could further integrate and work more effectively through the use of online collaborative technologies. Learners could be well

Contribution of this paper to the literature

- The study confirms CoI model as a valid theoretical framework in describing and explaining the relationships among three presences, cognitive, social and teaching, in the context of IPBL.
- By employing collaborative tools, namely Google Applications, to facilitate the learners' community of inquiry, this study sheds light on the importance of collaborative technology being incorporated into IPBL for promoting the development of learners' perceptions of cognitive presence.
- With the support of collaborative technologies, such as Google Applications in an IPBL context, instructional designers and faculty could focus more attention on the most significant component in the model, namely social presence, which can foster cognitive presence in guiding the course development of the IPBL, with the aid of these technologies.

prepared to collaborate in the IPBL learning environment in which complex tasks can be accomplished with an abundance of available collaborative tools through the internet, which has made the tracing of collaborative activities and interactions easier than ever before. Numerous online collaborative applications allow learners with a common learning goal to share, discuss, and edit their project work online synchronously, such as Google Applications (Cheung & Vogel, 2013). With the support of such online collaborative tools, students with different domain knowledge are able to co-construct knowledge and make connections with other learners and professionals, and thus develop a deeper sense of learning community and collaborative inquiry.

Communities of learning and collaborative inquiry are crucial within such an IPBL learning context, as the areas of teaching and learning are expanding as new interactive technologies support innovative forms of pedagogy in higher education. Among numerous efforts that have been dedicated to systematically explore the integration of new pedagogical ideals and new communication technologies, one promising theoretical perspective, based on the collaborative constructivist principle, is the Community of Inquiry (CoI) framework (Garrison et al., 2000). Conceptually useful in describing, explaining, and enhancing students learning in purely online environment, the CoI model has proved to be more productive that other approaches as it focuses more directly on teaching and learning in a completely technology-mediated environment (Shea & Bidjerano, 2009). Scholars contend that the CoI model can provide online faculty and instructional designers with a mechanism for the integration of technology and pedagogy in ways that impact online learning across many disciplines (Shea & Bidjerano, 2009). The CoI framework identifies three core elements, namely the teaching, social and cognitive presences, which are required to create and sustain purposeful inquiry and meaningful collaboration. The overlapping relationships of these presences provide the structure to understand the dynamics of deep and meaningful online learning experiences (Garrison et al., 2010).

As scholars (Garrison et al., 2010) have pointed out, unique patterns of relationships among these three presences are formulated within different disciplines, thus producing the interactive and inquiry-based focus of online communities of inquiry. They conducted an empirical study to test the relationships among the three presences using a sample of students enrolled in programs of interdisciplinary study and distance education in courses across multiple subject areas in the social science domain. An online conferencing platform was provided to further assess student engagement and group interaction. The results verified the theoretical assumptions of the CoI framework, showing that students' perceptions of teaching presence and social presence predicted the significant effects on the perception of cognitive presence. Moreover, a significant direct effect of the focal programs on cognitive presence was found, particularly in the program of interdisciplinary study. This provides empirical evidence of the need for further research to explore the dynamic relationships among the three presences across disciplines and online learning settings.

As the integration of Google Applications to support project-based collaborative learning has become an important issue in higher educational institutes, it is thus of interest to explore the influence of these applications on learners' perceptions of teaching, social, and cognitive presences in IPBL to verify the CoI model in this context. To date, a growing body of conceptual and empirical literature has been dedicated to articulating and expanding the explanatory power of the CoI framework. However, little has been done to investigate the relationships among the three presences, or comparing different online learning environments in terms of IPBL. To verify the utility of the CoI framework in describing, explaining, and ultimately improving learning in different online educational environments, it is crucial to depict and test the constructs within different online learning settings, as is done in the current work.

LITERATURE REVIEW

Interdisciplinary Project-Based Learning (IPBL)

In current pedagogy, interdisciplinarity is seen as "the hallmark of contemporary knowledge production and professional life" (Boix Mansilla & Dawes Dursising, 2007:215), and there have thus been many debates and discussions dedicated to its definition, and the approaches employed to achieve it are often very significantly different, thus resulting in divergent philosophies, contexts of practice and views of the function of particular educational systems (Klein, 2013). As a long-term theorist of interdisciplinary teaching and learning, Klein (2013) argues for the need to shift away from a focus on discrete disciplines of knowledge to more holistic thinking that looks at the productive relationships that can arise among disciplines, and she particularly emphasizes the use of participation and collaboration. Resonating with project-based learning outcomes, interdisciplinary project-based learning (IPBL) can be defined as when the learners are actively involved in a learning process by developing projects for which insights from various disciplines are integrated in response to solving a particular problem or issue.

The ability of individuals to work together productively and creatively is highly desirable by the employers, and is regarded as a pre-condition for employment. In the higher education training, interdisciplinary group projects are seen as important tools for students to be equipped with such professional world environments to which they aspire. Interdisciplinary group projects emphasis teamwork and collaborative learning, which foster the development of effective communication skills, problem solving skills as well as the community involvement they need in the real world experience (Johansen et al., 2009).

There is number of researches that investigate the students collaborate together in the group projects which the course design and development are based on cross-disciplinary domain knowledge (Biasutti & El-Deghaidy, 2012; Carpenter et al., 2007; Goff et al., 2006; Gorev & Masalimova, 2017; Marchioro et al., 2014; Maxim, 2006; Whitney, 2014; Zhu & Qiu, 2017), suggesting that interdisciplinary integration is important as the restructured learning process enable learners to synchronize team efforts, contributing their individual strengths, so as to develop their creativity and to balance their independent learning. Within such interdisciplinary collaboration environment, learning becomes a comparable process of shared creation, where individual with various academic disciplines can bring different sets of knowledges and skills to the partnership (Miles & Rainbird, 2015).

IPBL can provide a sufficient way of enhancing learners' cognition and learning, helping leaners to develop knowledge management processes and raising their satisfaction while collaborating in designing interdisciplinary projects, in particular, with the facilitation of technology support. Stozhko et al. (2015) employed a computer-assisted learning system (CALS) in an analytical chemistry course with students from different academic specialisms, and find that IPBL can significantly enhance learning and positively impact students' cognitive level. The literature shows that online collaborative tools can play an important role in facilitating the IPBL environment. Bisasutti and El-Deghaidy (2012) examine the use of wikis as an online didactic tool to develop learners' knowledge management processes, which are essential professional skills in higher education. The results reveal that wikis can be used as a facilitating tool for IPBL and help learners to develop their knowledge management processes, as well as raise student satisfaction when collaborating in designing interdisciplinary projects.

Collaborative Technologies Facilitate Online Learning

Collaborative technologies, as one of the most important applications of e-learning, have triggered a new wave of free online wikis, word processors, spreadsheets, presentation and discussion forum software packages since they were first introduced in 2005 (Rienzo & Han, 2009). Collaborative technologies have attracted much attention from educational scholars, as they can provide students with a context/platform on which they can discuss, exchange, and share their opinions and ideas, as well as construct their own knowledge collaboratively. Cheung and Vogel (2013) define collaborative learning technologies as "a set of tools for task-specific collaborations, and are associated with goal and work-oriented activities" (pp.161).

As part of the growing new wave of free web-based collaborative learning technologies, Google Applications can help learning communities to create, edit, and share content online. Cheung and Vogel (2013) investigate the adoption behaviors of e-collaboration technologies in the web 2.0 environment for the information sharing, learning activities, communication, and interactions within group-based project work, which are trackable and monitored through a computer-supported collaborative platform. By employing the social learning approach in a web-based collaborative platform, individual and group perspectives are all involved in the learning through participation in joint activities and the social practice mediated by the collaborative tools.

With the support of effective collaborative technologies, knowledge can be transferred not only from the teacher to students, but also the students can effectively construct knowledge through collaboration in the learning process.

Due to the rapid development of online collaborative technologies, more educational institutions are now working to prepare students to learn in a collaborative environment in which learning tasks can be accomplished with online (Cheung and Vogel, 2013). Such synchronous collaborative technologies can promote "meaningful discourse" with regard to the learning activities where knowledge is constructed through learners' social communication with their peers and communities in the learning process, just as it is in the physical, face-to-face classrooms.

Collaborative technologies also provide an effective way to integrate technology into the curriculum in the project-based learning (PBL) context. PBL is intended to engage students in authentic tasks to enhance learning, and is thus a dynamic instructional strategy in which students explore real-world problems and challenges, simultaneously developing cross-curriculum skills while working in small collaborative groups. Asan and Haliloglu (2005) indicate that PBL is also a model for computer classroom activities that moves away from short, isolated, teacher-centered lessons. Instead, it emphasizes learning activities that are long-term, interdisciplinary, student-centered, and integrated with real world issues and practices. PBL, in which students work in teams to explore a question or create a project, also helps maximize the students' abilities to develop computer skills. Prokofieva (2013) employs wikis as the focal collaborative technology to facilitate an online project learning, and find that student-content interaction was dominant in this process. Moreover, the results also show that the instructor's attitude is particularly important for encouraging student-student interactions.

A recent study by Lee and Lee (2016) investigates college students' interaction and collaborative learning in the Google Drive facilitated computer supported communication learning (CSCL) setting of performing team-based project design tasks. They found that learners' interaction pattern and team's achievement are significant different between two achievement groups (high v.s. low), showing that for learners in CSCL, social interaction plays an important role in building shared knowledge and academic achievement in collaborative project learning activities. In particular, when learners perceive their project goal and task are highly rely on their team members, the greater extent to which they interact with their team members will be achieved in online collaborative learning across different knowledge domains. Thus, such kind of knowledge boundary spinning will be more effective in the interdisciplinary e-collaboration project learning environment, which in turn will influence their project quality and performance (Zhu & Qiu, 2017).

Community of Inquiry Model

Garrison et al. (2000) develop the concept of the Community of Inquiry (CoI) as a comprehensive theoretical framework to better understand the order and structural elements needed in the process of online learning and the practice of online instruction. Rooted in the philosophical foundation of collaborative constructivism, the CoI model emerged in a computer-supported context in higher education, providing the ideas and beliefs that are consistent with the ideals and values of higher education in our post-Internet society (Garrison et al., 2010).

Within a collaborative constructivist learning environment, the CoI framework consists of three core dimensions, namely cognitive presence, teaching presence, and social presence, and the dynamic relationships among these need to be understood in order to construct the deep and meaningful online learning environments needed to support purposeful inquiry and meaningful collaboration. Cognitive presence reflects the learning and inquiry process, which can be divided into four phases of activation, exploration, integration, and resolution (Garrison et al., 2010). Within this context, cognitive presence represents the purposeful nature of collaborative knowledge construction inherent in educational experience among constructivists (Arbaugh et al, 2008). Garrison et al. (2000, 2001) define cognitive presence as the extent to which learners are able to construct meaning through sustained communication, in which group work with valued personal contributions and a secure learning environment is encouraged to foster exchanges (Matheson et al., 2012).

Teaching presence has been shown to be crucial in establishing and sustaining the success of a formal educational community of inquiry (Garrison & Arbaugh, 2007), and is defined as "the design, facilitation and direction of cognitive and social processes for the purpose of realizing personally meaningful and educational worthwhile outcomes" (Anderson et al., 2001, p.5). A growing body of literature confirms the importance of teaching presence for successful online learning (Garrison & Cleveland-Innes, 2005; Garrison et al., 2010; Murphy, 2004; Swan, 2002; Wu & Hiltz, 2004), as well as noting that it is a significant determinant of perceived learning, student satisfaction, and sense of community (Arbaugh et al., 2008; Shea et al., 2005).

Theoretically, the CoI model posits that teaching presence has direct influences on the creation and sustainability of social and cognitive presences. Teachers are responsible for designing, organizing, facilitating discourse, and directing instruction to obtain desirable outcomes based on their students' need and capabilities. However, in an IPBL context the teachers play the role of facilitator, setting project goals and providing guidelines and resources, moving from group to group while providing suggestions and support for student learning activities. With the aid of collaborative technology to support communication with others, students can actively make choices about how to generate, obtain, manipulate, or display information. Moreover, when technology is

used as a tool to support students in performing authentic tasks, the students are in the position of defining their goals, making design decisions, and evaluating their progress. Social presence is critical within such a learning context, as the utilization of technology can increase the level of collaboration, as well as students' regulation of their own learning. Technology use allows many more students to be actively thinking about information, making choices, and executing skills than is typical in teacher-led lessons.

Social presence is essential in online learning environments (Swan et al., 2009), and is defined as "the ability of participants to identify with the community (e.g., course of study), communicate purposefully in a trusting environment, and develop inter-personal relationships by way of projecting their individual personalities" (Garrison, 2009, pp. 352). In the CoI model, social presence is regarded as a mediating variable between perceived teaching presence and cognitive presence, reflecting online discourse promotes positive affect, cohesion, and interaction (Rourke et al. 1999), as well as supports a collegial, collaborative environment (Shea & Bidjerano, 2012). Furthermore, social presence is foundational for online interaction, a powerful activity supporting joint knowledge construction to foster cognitive learning, because it represents learners' ability to get to know others, form distinct impressions of classmates, participate in web-based communication and interact comfortable and feel acknowledged by others through those interaction (Shea & Bidjerano, 2012).

Previous studies find a causal relation between teaching presence and social presence with regard to the cognitive presence (Garrison, et al., 2010; Archibald, 2010), as well as a significant correlation between social and cognitive presence (Shea & Bedjerano, 2009; 2012). Although collaborative research efforts have validated the structure of the CoI framework, there are still some limitations with regard to explaining the interaction effects of the presences within the contextual dynamics of an online learning environment with the support of various technologies. Gutierrez-Santiuste et al. (2015) investigate students' perceptions of synchronous and asynchronous virtual learning in various text-based communication formats, namely chats, forums, and emails, and find that cognitive presence is predicted more strongly by social presence than by teaching presence, which implies the importance of social presence in achieving the focal learning objectives.

When carrying out IPBL with the use of collaborative tools, group activities can be facilitated by enabling ease of communication and coordination among group members. There is growing evidence of a variety of benefits from the use of collaborative tools. Lou et al. (2001) found that the use of such tools for the group learning has more positive impacts on cognitive processes when compared to their use in individual learning. Moreover, the quality of the social interactions between students and students, and between students and teachers, is also improved through the use of collaborative tools, as these make the interactions among users more visible, thus improving their understanding of each other (Ma, 2009). Within a collaborative-technology supported interactive process, learners are better able to construct meaningful knowledge at a social level (Kreijns et al., 2003). The atmosphere and relationships among student peers might thus have more weight than the act of teaching (Gutiérrez-Santiuste et al., 2015).

Cheung and Vogel (2013) conduct a study addressing the need for implementation of a web 2.0 environment, using the communications and activities of project groups working with Google Applications as collaborative tasks within a social networking environment. The findings show that the 26 peer groups with strong social ties were associated with strong investments of time, reciprocity and sharing, whereas the instructor should be considered as a "weak social tie" when moving toward a student-centered learning environment. They conclude that the influence of peers is more powerful with regard to the adoption of collaborative technology than with other e-learning applications (Cheung & Vogel, 2013).

In summary, it is important to create and sustain a collaborative community of inquiry, and a growing body of literature uses the CoI model to investigate various aspects of online and blended learning environments. However, there is a need to turn from descriptive to more predictive quantitative studies that can verify the dynamic effects of the social and teaching presences on cognitive presence in different online learning settings (Garrison, et al. 2010; Gutiérrez-Santiuste et al., 2015). Earlier works suggest that future research should explore the relationships among the three presences in different online learning settings, as research shows that cognitive presence is predicted more strongly by social presence than by teaching presence, which implies the importance of social presence in achieving the stated learning objectives.

METHODOLOGY

Based on the theoretical model of the CoI, the following research questions were addressed in this study:

1. Do students' perceptions of teaching and social presence have significantly positive effects on cognitive presence in the interdisciplinary project-based learning (IPBL) environment?
2. Do students' perceptions of teaching presence have significantly positive effects on social presence in the interdisciplinary project-based learning (IPBL) environment?

3. Compared with the students using the discussion board supported by the Wisdom Master Pro online learning platform, is students' cognitive presence better explained by social presence than by teaching presence in the IPBL environment with the utilization of collaborative tools?

Measurement

A valid and reliable CoI survey instrument, the Community of Inquiry framework developed collaboratively by previous scholars (Garrison et al., 2010; Arbaugh et al., 2008), was employed in this study with modifications to incorporate and adapt to the Google Applications context. The CoI survey consists of three dimensions of presence, a total of 34 items (see Appendix, i.e., items 1-13 for Teaching Presence, items 14-22 for Social Presence, and items 23-34 for Cognitive Presence) with a Cronbach's alpha reliability of .84 (Arbaugh et al., 2008). A five-point Likert type scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*) was provided to students so that they could make their responses. The factorial validity of the scale has been established in previous research (Garrison et al., 2010; Shea & Bidjerano, 2009), and thus the CoI model is a reliable measure of the theoretical constructs of the three presences. Details of the students' demographic backgrounds were also obtained, including age, gender and major, with the data then subjected to descriptive analysis.

Participants

The subjects were 142 undergraduate students who enrolled in a "Digital Content Marketing" course conducted at a university of technical and vocational education in Tainan, Taiwan. The participating students came from several academic disciplines, within business, informatics, and design knowledge domains. The structured questionnaire was developed with two sections: demographics and the CoI framework survey instrument, and was distributed to the students enrolled in the course. The total number of valid respondents was 138, and their answer were used in the data analysis. The distribution by sex was 43% male to 57% female. The average age of the respondents was 20.6 years old. Approximately 37% were majoring in business-related disciplines, 30% in informatics disciplines, and 33% in design discipline.

Utilization of Google Applications as Collaborative Tools

Google Applications, such as Google Docs, Google Group Forums and Google Drive, are used to support the online collaborative learning for the project examined in this study. As researchers (Cheung & Vogel, 2013) point out, online collaborative technologies offer a more "authentic learning experience," as learning activities, communications, interactions and collaborations are visible and trackable simultaneously throughout the learning process. Moreover, students are able to exercise the ubiquitous possibilities for content creation, editing and sharing, and so gain a deeper sense of discipline knowledge through social communications with their learning partners and communities, as in real-world workplaces.

Procedure

The data was collected from the students enrolled in a 16-week "Digital Content Marketing" course, which required the students to work collaboratively for an interdisciplinary integration project. Before the course started, a face-to-face session was held to explain the purpose and procedure of the study. A total of 142 students were randomly divided into 24 groups, each with five to six members. To fulfill the goals of the interdisciplinary project learning, each group required students from three different subject areas for the specific cross-disciplinary project tasks. The project tasks consist of product design, 3D printer modeling, market research, planning and promotion, which relied on design, informatics, and marketing domain knowledge. During the course, students were required to work collaboratively in groups to complete a cross-disciplinary integration project for specific brands, particularly in the cultural creativity industry. By having students work together on the same project in the so-called "industrial-academic cooperation" model, the instructors in these different disciplines made attempts to challenge students with varied domain knowledges by engaging them in tasks that reached across disciplinary boundaries. The goal was to create a "real world" context for the students equipped with specific knowledge and skills, in recognition of the applied nature of their disciplines.

In particular, among the 24 groups of participants, 12 groups (72 participants) were randomly selected as the experimental group who used Google Applications to facilitate collaborations and interactions in the online learning community, including Google Docs, Google's share space, and discussion forums. In contrast, the other 12 groups (70 participants) were treated as the control group, using online discussion boards supported by Wisdom Master Pro, the most commonly used e-learning platform among higher educational institutes in Taiwan. The experiment sessions were developed over ten weeks.
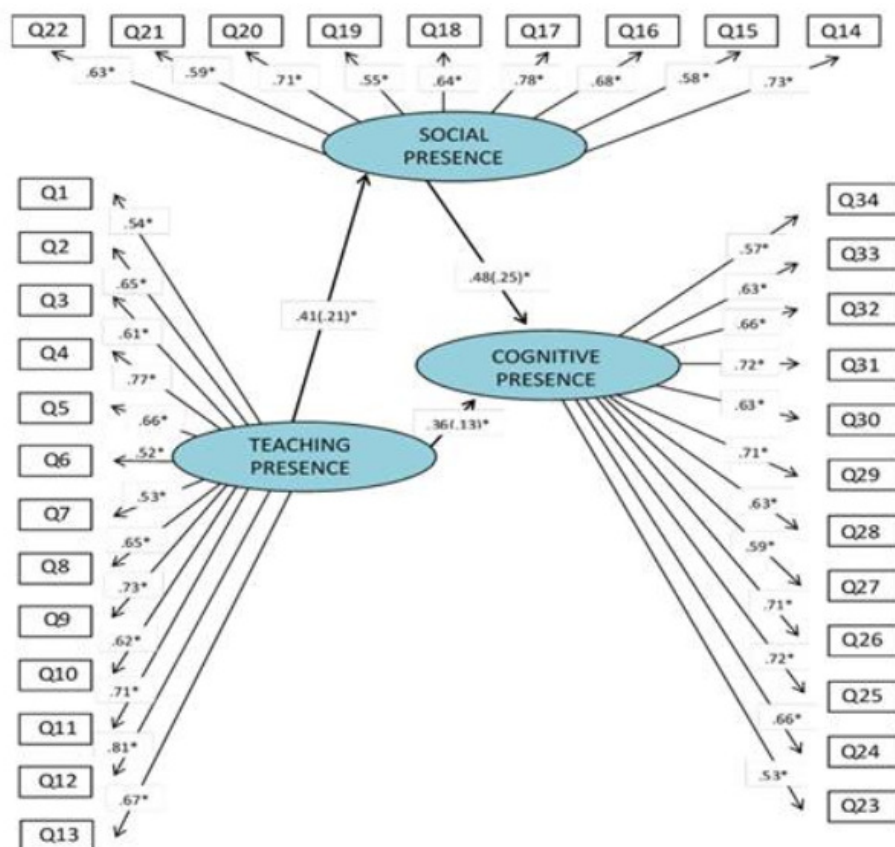
Figure 1. Model of the relationships among the factors in the community of inquiry

All the participants were assigned the same tasks, course schedule, and same instructors during the experiment, only using different communication tools to support their online project learning activities. After a 70-minute lecture session, the experimental group stayed in a computer lab for further discussion of the project tasks they had been assigned, with this lasting for 30 minutes. The students in the control groups used the online discussion boards as a communication tool for project discussion and summarizing ideas.

The students in the experimental group were required to utilize various collaborative tools supported by the Google Applications for discussing, sharing, editing their project work. Different from the e-learning discussion board, Google collaborative tools allow students to modify the project work and monitor the modifications made by other group members simultaneously, which makes their collaboration more effective in the IPBL environment. After the 10-week experiment session, the CoI survey was administered to the142 students who participated in this course, and a total of 138 valid questionnaires were collected and used for the data analysis.

RESULTS

Factor Analysis

Principle axis factor analysis using an oblimin rotation was used to extract three factors. A three-factor solution provided clean loadings and interpretability in terms of the theoretical framework (see **Figure 1**). The loadings of all the CoI items were higher than 0.40, as expected, across the three presences. The first extracted factor was consistent with the items included in the teaching presence subscale, with 13 items with a reliability of .91. The second and third extracted factors were associated with social presence and cognitive presence, respectively. The factor of social presence had nine items with a reliability of 0.89. The last extracted factor, cognitive presence, consisted of 12 items with a reliability of 0.93.

Structural Equation Model

This study aims to explore the relationships among teaching, social and cognitive presences for students involved in an interdisciplinary project-based learning environment with the utilization of Google Applications.
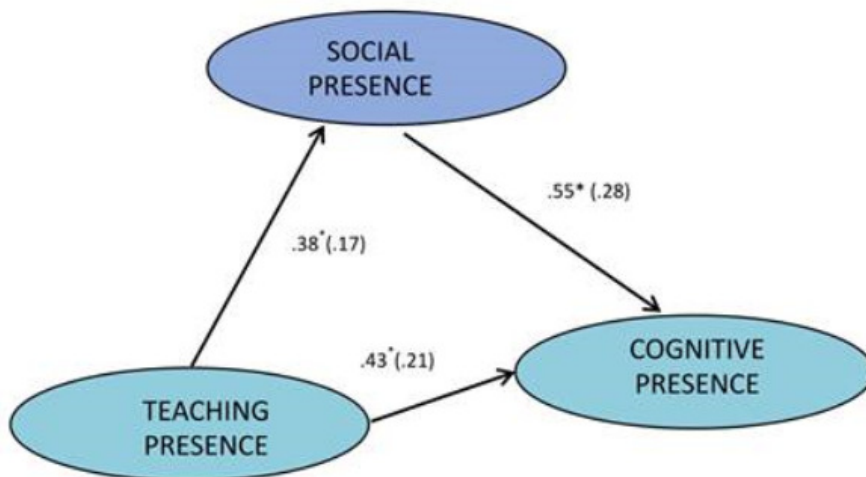
Note: Marker coefficients (*) are significant at p<0.05
Figure 2. The structural model for the collaborative tools

Note: Marker coefficients (*) are significant at p<0.05
Figure 3. The structural model for the online discussion boards

Consistent with the previous literature, the structural equation model confirmed that the model can be used to verify the predictive relationship of cognitive presence with regard to the social and teaching presences in an IPBL environment (see **Figure 1**). The students' perceptions of teaching presence predicted a significant direct effect on their perceptions of cognitive presence. In addition, the perceptions of teaching presence were signi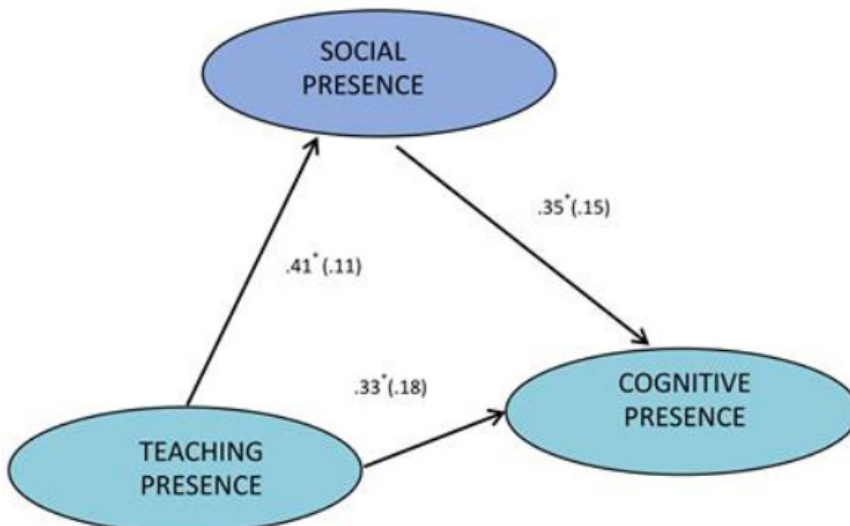ficant associated with social presence. The indirect effect of social influence on cognitive presence was also confirmed.

Analysis of Collaborative Tools and Online Discussion Boards

Further analysis was carried out to investigate whether the factors which affected students' cognitive presence with regard to the collaborative tools were similar to those related to the online discussion boards, as shown in **Figures 2** and **3**. Two points should be observed in these. First, cognitive presence was mainly influenced by social presence, followed by teaching presence, in the collaborative tool supported learning environment (see **Figure 2**). Second, cognitive presence was mainly influenced by teaching presence, followed by social presence, with the online discussion boards (see **Figure 3**). Therefore, it can be concluded that social presence significantly encouraged students to use the collaborative tools, while teaching presence significantly encouraged students to use the online discussion boards.

DISCUSSION

This study made an attempt to investigate the theoretical framework of the three presences embodied in the Community of Inquiry (CoI) framework with regard to describing, explaining, and improving the interdisciplinary project-based learning environment through online collaborative technologies. Consistent with the previous research (Arbaugh et al., 2008; Shea & Bidjerano, 2009, 2012; Archibald, 2010), the findings of this study verified the theoretical assumptions of the CoI framework, showing that the students' perceptions of teaching and social presences have direct, positive effects on cognitive presence. Our study shows that the CoI model can be applied to collaborative technologies for IPBL. In light of this verification it is thus suggested that the CoI framework and three constructs of teaching, social, and cognitive presences represent a valid model for delineating and explaining students' online collaborative learning communities in cross-disciplinary knowledge domains.

In addition to verifying the CoI model in IPBL context, this study also examined the differences in students' perceptions of three presences in different online learning settings (Google Applications v. s. online discussion board). While other studies made attempts to explore the relationships among the three presences when using different communication tools (Gutierrez-Santiuste et al., 2015) or in different online delivery formats (Shea & Bidjerano, 2010; 2012), this work, in particular, investigated the impact of synchronized online collaborative tools, and found that social presence has greater predictive power in the online learning environment with the facilitation of Google's collaborative tools, confirming the findings from Gutierrez-Santiuste et al. (2015), showing that cognitive presence is predicted to a greater extent by social presence than by teaching presence. This important finding suggests that the collaborative technologies may contribute to the salience of prompt communication and high interaction among group members in IPBL, creating a more effective community of inquiry. As argued by Cheung & Vogel (2013), peer influence is particular important in a collaborative technologies learning context because of the highly interactive nature of the collaborative platform. Such collaborative-interactive mechanism may further create the social interdependence among members with different professions, which in turn facilitate the effective understanding and applying the practical knowledge across professional boundaries (Zhu & Qiu, 2015).

Compared with the other e-learning applications, collaborative technologies may better help to create sufficient online interactions IPBL needs for collaboration across professional boundaries. Chi (2009) contends that the online interaction has constructive in nature, involving learners' to co-construction knowledge, enhance understandings through building upon each other's contributions. Such online interaction, as a powerful activity supporting joint knowledge construction, can benefit learners' cognitive learning from partner's contributions to additional information, new perspectives, corrective feedback, a new line of reasoning (Shea & Bidjerano, 2012), which in turn scaffold the integrated knowledge in IPBL context. Since social presence construct is crucial for such constructive online interaction, it is not surprising that learners' social presence has more predictive power on the cognitive presence in the IPBL with Google applications compared to their counterparts with online discussion boards.

In addition, this investigation may further reinforce the previous scholars' assertions that learners' perceived level of social presence could be affected by the characteristics of the tools they used (Horzum, 2015), and the usage of online interactive tools can positively increase social presence (Weinel et al., 2009). This might be explained by the fact that students can get instant feedback, trace the editing, and interact with their group members through using synchronized communication tools when working collaboratively on a cross-disciplinary project. This could overcome the problem of implementing and monitoring the collaborative activities in group-based project work on a regular basis. Google Applications, which enables synchronous discussing, sharing, editing, and interacting among users, have a degree of social presence due to their capability of communicating authentic messages and providing a more immersive experience for users. The virtual learning communities that can be supported by collaborative tools can orient communication to high level of critical thinking, which is associated with the notion of cognitive presence (Garrison et al., 2007). Within such a learning context, social presence thus plays a crucial role in enabling communication oriented to the learning objectives.

Implications for IT Practitioners

As numerous researchers have worked to apply web 2.0 technologies to facilitate online learning communities for different modes of collaborative project-based learning, the associated constructs of teaching, social, and cognitive presences delineated in the CoI framework represent an alternative theoretical model for describing and explaining the new learning experiences that take place within such an online environment. Given that the students' social presence has demonstrated greater predictive power with regard to cognitive rather than teaching presence, future educators should thus consider the utilization of web 2.0 collaborative communication tools in order to foster learner perceptions of social presence to guide the development of online collaborative and interdisciplinary learning communities in higher education. Cheung and Vogel (2013) suggest that the communications and activities of project groups that use Google Applications can be regarded as collaborative tasks within a social network

environment, and thus instructional designers can serve as "weak social ties" and formulate activities and strategies to foster the "strong social ties" which were associated with strong investments of time, reciprocity, and sharing among group members (Wellman, 1997). Moreover, the intensity level of social network tie may represent different quality of social presence for learners to communicate comfortably via the online medium and feel connected, as well as socially supported by their peers and instructors. As Shea and Bidjerano (2012) assured the importance of learning presence as represented as self-regulated learning (SRL) on cognitive presence which is likely to depend on the characteristics the leaner (i.g. SRL) bring to the learning environment when quality of teaching or the quality of social interaction are low or inadequate, selection criteria for enrolled in such IPBL program may extended to assess learners' different level of SRL to better fit the various types and functions of online interaction supported by different collaborative learning technologies.

Limitations and Future Research

As this study examined the responses from a relative small sample size, the results should be interpreted with a degree of caution. Furthermore, while various online collaborative tools provide different functions for collaborative learning, this study was limited to the features of Google Applications with regard to Forms, Docs, and share space. As these applications have been widely employed as collaborative tools, more research is needed to provide reliable findings that can be generalized to other technologies for use in IPBL environments. Finally, the individual difference characteristics were not considered in the present study, which may provide the opportunities for the prospective researchers. As scholars (Shea & Bidjerano, 2012) pointed out that the individual-level determinants can play equally important role in students' perceptions of cognitive engagement and gains, future work should address whether individual-level determinants (i.e. SRL, psychological needs of motivation) have significantly mediating effects on the three presences in the development of community of inquiry in IPBL, a task specific learning context supported by online collaborative tools.

In conclusion, the results of this study support the explaining power of the CoI model and filled the gaps in the literature by testing the most significant elements in the model that foster cognitive presence in an IPBL environment with the facilitation of web 2.0 collaborative tools. This investigation has demonstrated that social presence plays a more important role in predicting cognitive presence for students employing collaborative communication tools in an IPBL environment. Future research can further test the influence of the social network ties between the teacher and students on student perceptions of cognitive presence, which in turn can enhance their learning. As IPBL is of growing importance with regard to interdisciplinary integration in professional education, more research should be devoted to verifying the influences of teaching and social presences on cognitive presence for students involved in the cross-disciplinary collaborative learning in various online learning settings.

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APPENDIX

Questionnaire Items for the Constructs Used in This Study

1. The instructor clearly communicate important course topics.
2. The instructor clearly communicate important course goals.
3. The instructor provided clear instructions on how to participate in course learning activities.
4. The instructor clearly communicated important due/dates/time frames for learning activities.
5. The instructor was helpful in identifying areas of agreement and disagreement on course topics that helped me to learn.
6. The instructor was helpful in guiding the class towards understanding course topics in a way that helped me clarify my thinking.
7. The instructor helped to keep course participants engaged and participating in productive dialogue.
8. The instructor helped keep the course participants on task in a way that helped me to learn.
9. The instructor encouraged course participants to explore new concepts in this course.
10. Instructor actions reinforced the development of a sense of community among course participants.
11. The instructor helped to focus discussion on relevant issues in a way that helped me to learn.
12. The instructor provide feedback that helped me understand my strengths and weaknesses relative to the course's goals and objectives.
13. The instructor provided feedback in a timely fashion.
14. Getting to know other course participants gave me a sense of belonging in the course.
15. I was able to form distinct impressions of some course participants.
16. Online discussion board/Google Applications is an excellent medium for social interaction.
17. I felt comfortable conversing through the Online discussion board/Google Applications medium.
18. I felt comfortable participating in the course discussions.
19. I felt comfortable interacting with other course participants.
20. I felt comfortable disagreeing with other course participants while still maintaining a sense of trust.
21. I felt that my point of view was acknowledged by other course participants.
22. Online discussions help me to develop a sense of collaboration.
23. Problems posed increased my interest in course issues.
24. Course activities piqued my curiosity.
25. I felt motivated to explore content related questions.
26. I utilized a variety of information sources to explore problems posed in this course.
27. Brainstorming and finding relevant information helped me resolve content related questions.
28. Online discussions were valuable in helping me appreciate different perspectives.
29. Combing new information helped me answer questions raised in course activities.
30. Interdisciplinary project-based learning (IPBL) activities helped me construct explanations/solutions.
31. Reflection on course content and discussions helped me understand fundamental concepts in this class.
32. I can describe ways to test and apply the knowledge created in this course.
33. I have developed solutions to course problems that can be applied in practice.
34. I can apply the knowledge created in this course to my work or other non-class related activities.

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Graphic Design Applications for Spatial Imagery and Examples from a Nursery School

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ABSTRACT

In this study, from the point of the significance of "spatial imagery" in spaces, the contributions of graphic design to space were explored. Also, the importance and effect of illustrative, photographic, typographic and pictographic studies on the spatial imagery have been evaluated on the basis of examples. The observations obtained during the research showed that illustrations, photographs, typographies and pictograms, which have highly expressive language, have turned the space into a conceptual medium while presenting design solutions in accordance with the function and identity of the space in the creation of the spatial image and also positively influenced and directed the human behavior in the space. Graphic design solutions were shown with examples of architectural elements that create awareness of the space, perceive it and create permanent images in mind. The issue was supported by comparing the images before and after graphic analysis of sample spaces in this research. As a result, it was understood that the spatial images created by illustrative, photographic, typographic and pictographic analyses, which are the subdisciplines of graphic design, were transformed into an environment where they can communicate with the users of the space that is an architectural product, and express themselves correctly.

Keywords: space, graphic design, environmental graphics, spatial imagery, interior graphics

INTRODUCTION

In recent years, the concept of "spatial image" has frequently been mentioned. The image, in its most general definition is, "the impression and influence that an entity has on the human mind" (Gemlik & Sigri, 2007). The spatial image is the person's perception of the environment which becomes meaningful in the mind. While Rapoport (1974) describes spatial image as perceiving the environment based on experiences, Baud-Bovy and Lawson have defined it as a scheme formed in mind as a result of the perception of the environment with the goal, prejudice, imagination, and the influence of the senses (Baud-Bovy et al., 1998) Man perceives, interprets, and makes sense in many of the fixed and moving visual elements in the space by selecting those that are remarkable or reasonably suitable. Perception depends on many factors, such as human's cultural and social characteristics, past experiences, and the spatial image may not be the same for everyone. The perception based on the place and the acquired images are important because they will directly affect the behaviour on the spot. The issue that is being discussed in the all today's studies is that a well-designed spatial image facilitates the perception of the environment and thus positively affects the human behaviour.

Lynch (1960) lists the senses as consisting meaning, serving senses, rhythmic, harmonious, encouraging, invigorating and privileged respectively. Accordingly, when we think of specific spatial image components in interior space as colour, light, material, texture and form, the remarkable appearance of one of them will provide a faster and more effective perception of the space which will distinguish them from each other and leave a more permanent place in minds. A feature that distinguishes itself from others is recognised first and is accepted as the spot. If the place is attractive and logical, it will increase interest, it will boost the desire of the person to stay in the

Contribution of this paper to the literature

- This study will be an additional point of view for the studies in literature and increase the regard to spatial imagery with an inclusion of different graphic designs to assist other studies. It will also be a novel contribution to the limited perceptions of spatial imagery in North Cyprus graphic design studies. Graphic design has begun to be accepted all over the world that it is necessary to strengthen the language of expression of the space, and even a new concept "environmental graphic design" has been developed.

place, and if the time elapses, the sense of the space will deepen and more details will be noticed. Powerful images are helpful as they have convenience in finding good impression and direction about the place. The user who finds the direction comfortably is feeling safe, the work efficiency increases and it is possible to save time.

The design of the spatial image began to develop, especially in the second half of the 20th century. Along with the developing technology and global market, the day-to-day information, media and money flow, developing and changing society structure, and time consuming socialization cities have become crowded, complex and difficult to live in. People in big urban buildings, besides the architectural elements of the space, are surrounded by the system of continuous symbols and communication, and the skill of understanding the language of these spaces is also the struggle for survival of the human. Multifunctional, complex and crowded structures such as hospitals, airports, shopping malls, university buildings are becoming increasingly difficult to perceive, learn, navigate and meet needs. A strong spatial image study, which everyone can understand in these structures, which form a mosaic in terms of user diversity, will help a better understanding of the relationships between spaces and what spaces tell. For this purpose, architects, designers, academics and administrators agree about the same common thought; to reduce the increasingly complicated modern urban spaces to human dimensions by surrounding them with images that everyone can understand. In this process, graphic design has become more and more involved with definitions such as architectural graphics, signage or sign-systems, environmental graphic design and way-finding design.

Today, spatial image is the study that can be done not only by architecture but also graphic design. For the spatial image to be read well, the language used first must be clear, simple and universal. This is the visual language of graphic design. In addition to typography on the surface of the places, graphic designs are made with universal elements such as photographs, illustrations, pictograms. These graphics are not only aesthetic elements that support spatial image, but also spatial analysis that defines space, informs, translates, enhances direction and directs.

METHODOLOGY

Documentation analysis and observation techniques which forms of qualitative methods, were used in the study. Documentation was conducted in order to explore the contributions of graphic design to spaces from the point of spatial imagery. The analysis of documentation was divided into headings which are typographic, illustrative, photographic, and pictographic solutions on the spatial imagery and each has been evaluated and analysed by giving examples from all over the world. Therefore, this study insights not only a descriptive character but also uses observation method to gather information, explore spatial imagery and to be able to examine the other related works. Near East University Nursery School in North Cyprus was accepted as the main example as the case study. The graphic images in the school were analysed and their contribution to the school - student interaction were discussed.

TYPOGRAPHIC SOLUTIONS

One of the most important design elements in structured communication is typography. It establishes a visual structure that produces continuous dialogue, associates not only visual but also typographical features with typographic items, the area of the place, and the basic data of the period, associating it with its surroundings. It has begun to be used with the aim of getting beyond the use of typography, information and orientation, and to give an image to the place like an artistic element, with the development of technology, Giant dimensions have become an important part of typography design with many application methods such as digital prints, three-dimensional applications, digital panes, projections and light games.

For typographic applications, it is necessary to know and to apply the basic properties of typography such as writing character, writing family, font, size, colour, alignment as well as other graphic design applications.

One of the best used examples of typography is the central building of the Adidas Research and Design Centre (SEGD, 2015a). A nickname for this new business building of Adidas is "laces". The "laces" nickname and -in particular the athletes- movement spirit have been inspiration in the design of space graphics. High-voltage and

Figure 1. Typographic Spatial Image Studies of the Centre of Research and Design Centre (https://segd.org/)

super-scale typography walks the entire building, bounces on the walls and floors of the rooms, and connects spaces such as shoelaces, and reflects the brand's institutional 3-dimension. The "infopoint" inscribed in three dimensions in the entrance is the statue form. In Bistro the word "TIMEOUT" is a kind of curtain. In Adidas, it is possible to see typography as not only an artistic element but also a surface that limits the space, and informational qualities (**Figure 1**).

ILLUSTRATIVE SOLUTIONS

According to the definition of Becer (1999, 2015) and Workshop (2016), "All elements that visually describe and interpret verbal elements such as title, slogan, and text are generally regarded as Illustration". As can be understood from the description, illustrations are the art of conveying a thought or a message to the audience through universal language of art; painting. It is usually drawn as support for advertising, education and fantasy narratives, or it is designed as an artistic work itself. The diversity of unlimited and rich image world of painting art and application techniques have always been an indispensable element for graphic design applications.

Photographs or illustrations which have meanings by themselves, how and what size images that can communicate with the user should be used, the way it is related with what is intended to create in the space should be considered together with the architectural design. Thanks to the possibilities provided by the huge printing technology, photographs and digital illustrations can be used on the surfaces of large rooms. In this way, environments can be created in many different themes such as legendary, unreal, romantic, science fiction (Stelling & Mason, 2000).

If illustration is preferred, digital designs as well as painting techniques in different techniques can be applied directly to the surface of the room. Hand drawn illustrations, graffiti, stencil printing, manual foil cutting (vinyl), pistol (airbrush) and anamorphic techniques can be applied to all fixed or variable surfaces (Ergün, 2012).

Especially in the places of institutions targeting children and families with children, colourful pictures are preferred more. In order to increase happier and willing participation of children to places like libraries, schools, hospitals, and space surfaces are painted in such a way to appeal to their imagination, or they are covered with digitally prepared images.

Sometimes illustrations are supported by three-dimensional studies. In Seattle, the graphic identity of the Randall Children's Hospital, which consists of 9 storeys, was rewarded in 2013 by the SEGD organization (SEGD, 2015b). The purpose of design by using art and space graphics is to make patients and their relatives make unexpected discoveries and thus to disperse their minds. Guidance and informational graphics were designed with colours of nature; animal motifs, signs and labels were also used. People wandering through these living and inspiring spaces are guided unwittingly and informed. This is the power of space graphics design (**Figure 2**).

Figure 2. Illustrative Spatial Image Studies of Randall Paediatric Hospital (https://segd.org/)

PHOTOGRAPHIC SOLUTIONS

Along with the invention of camera, photography began to replace painting. Photography, which shoots and archives a moment of reality, allows us to get countless and diverse visuals in a very fast and easy way with the technology of our age. Photographs have been preferred for many years instead of paintings, especially in news publications, product advertisements, travel promotions, when a feeling is wanted to express in the most direct way. Today, with the advance technology, the start of illustration and photography in digital media has caused both disciplines to intertwine and the differences between them disappear. No photographs taken are added to the design without processing on the computer. Illustrations can also be produced on a computer in photographic reality, or collage techniques are applied along with photographs. In recent years, the more important thing than the question of photography or illustration, which visual is more effective, striking and original?

Hand photographs placed in the interior design and decoration fair at the city centre of Madrid and at the Expo Hogarbienal in Barcelona are a good example of the orientation use of the installation art introduced with the title "Hand-to-hand" (SEGD, 2015c). It is a work designed from the point of view that there is no more universal language than the pointing hand photographs. The large figures were printed on polyester and placed on aluminium-framed panels in the joint designs of Maria de Ros's architectural team and photographer Daniel Loewe. Along with the orientation, the hand photo makes visitors stop and read the information (**Figure 3**).

Figure 3. Photographic work at Madrid's city centre and Barcelona's Expo Hogarbienal (https://segd.org/)

PICTOGRAPHIC SOLUTIONS

The universal forms and visual expressions that have gained a common meaning throughout the world that are used to express, describe and imitate all kinds of concepts and items are called signs and symbols. There are common signs and symbols like letters, numbers, music signs, religious symbols, and colours in traffic lights. These shapes and expressions have become universal over time and have created a common language for graphic design. The viewer, whichever culture and language s/he has, will have the same perception when they see these symbols. That is why graphic designers refer to this common language when they need a universal definition and message creation.

Signs and symbols are used extensively in the space graphic, especially for orientation graphics. It facilitates the easy understanding of people from different languages, as well as providing a quick and simple perception. The words are applied places where the signs are not enough. But words have different meanings in every language and translations in various languages are needed.

Graphic systems designed by the University of Technology in Sydney, Brand Culture Communications, make it easier for students to participate in workspaces and production studios, while demonstrating occupational health and safety requirements for spaces (SEGD, 2015d). The company that set out with the theme of "find and discover" triggered the sensation of discovery feeling of young people and make them learn the sign systems (**Figure 4**).

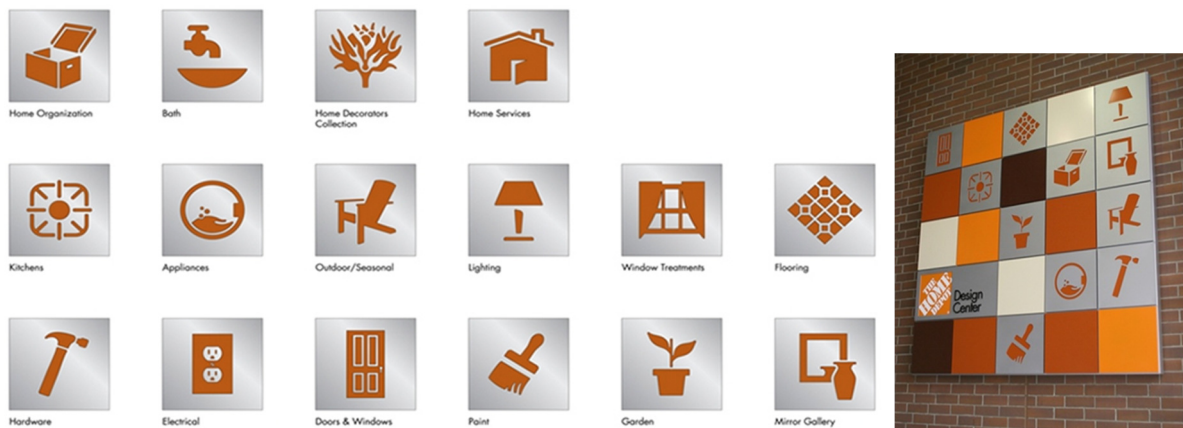**Figure 4.** Orientation Graphics of Technology University in Sydney (https://segd.org/)

Figure 5. Home Graphics Made with Pictograms for Home Depart Store (https://segd.org/)

The "pictograms" are designed by using a number of symbols and signs with pictorial meaning to facilitate written expressions. When looking at the origin of the word, it is seen that it is derived from "pictus" and "gram" which mean it is a picture without writing. One of the most important considerations when designing a sign, symbol and pictogram or when using it in a design, colours, forms and values, which may lead to other meanings, should be avoided. It must be original and simple, express the meaning to be given directly, should not lose its clarity when it is reduced and enlarged, it should not change its formal features and expression even when it is used without any colour.

Home Depart Store, which changed the concept of product sales and renewed, renewed its corporate identity accordingly by making its name Home Depot Design Centre (SEGD, 2015e). The pictograms defining the product classes were designed in accordance with the identity of the institution and used on the space graphics (**Figure 5**).

CASE STUDY OF NEAR EAST NURSERY SCHOOL AND ITS SPATIAL ANALYSIS

A visual work was requested by the administration for the playground of the Near East Nursery School building, which has just started to serve in Northern Cyprus. The aim here is both to attract the young children's interest and to make them perceive and distinguish easily the four doors that open to the corridors and are identical in visual qualities. Erdoğan Ergün's own illustrations were applied to the around of the doors with stencil method. In the study, it was understood that the young children perceived the stylized figures more easily and found the animal figures closer to them. It was also explored that the vivid and soft tones of the main colours accelerated the

Figure 6. Stencil Works for Near East Nursery Playground Doors

Figure 7. Near East School playground doors; before and after graphic work

perception (Porada, 2013). From this point, coloured stylized simple animal images were chosen for graphic analysis (**Figure 6**).

As can be seen in the photographs, the place does not have enough communication with children with its own architectural language. With only four illustrations, the interior playground has been revitalized, appealing to the children, and facilitating the use of doors (**Figure 7**). This is also the case with the feedback from the teachers and the staff after the study conducted. The intended goal has been achieved.

DISCUSSION

Spaces have been recognized as living things in environment and surroundings where people have their leisure time throughout the history and try to understand their feelings and perceptions of their emotions and senses. As a matter of fact, Ching saw the space as a living object and stated: "The space is constantly wrapping our existence, moving along the spatial volume, seeing shapes and objects, hearing voices, feeling the breeze and getting the smell of the flowers that open in the gardens. The place is a material essence like wood and stone. But it is deformed by nature. Its visual form, its light qualities, its dimensions and its scale depend entirely on the boundaries defined by

the elements of the total form. As space is comprehended and surrounded, and a mould is inserted and organized by formal elements, architecture gains wealth" (Ching, 2016).

Başkaya et al. (2003) again described places in a variety of meanings and imagined them as living beings. The venues are almost a choreographer for the dynamic relationship of the moving people. Architects can manipulate the movement, behaviour and shape of the user of the space by controlling the places we move and use in their designs and this cause happiness or unhappiness in socio-psychological terms. The spaces that a designer creates often give us hints about how to use them. Their space organizations encourage certain uses, while others prevent them. For example, behind the scenes in a theatre, if there is a court case in a courtroom, the design is placed in a defined area and guarantees the existence of the law. It is inevitable that if we do not give a correct message about the direction to which we are going, we will have uneasy and mixed feelings.

The most significant part of the urban environment is the people so the environment and the space are created in accordance with their needs. There is an interaction with the surroundings of the person by observing, interpreting and perceiving it. The individual acquires through the sensory organs and decides how to behave accordingly. Thus, there is a constant interaction between the individual and the space. Individuals are self-absorbed and adhered as long as they can perceive the places they live in and it makes sense (Özdemir, 2016; Marshall, 2005).

This impressive analysis of visual gain suggests an examination and description of visual culture. If we take into consideration our sensory organs the most effective one at first is visual by which we gain experience and collect information and data about the space by looking, seeing and observing our surroundings like newspapers, road signs, books, social media or television. We judge and make decisions about the space by analysing our visual experience. (Barnard, 2002).

Graphic design and space and its relation have been studied in many studies. These were analysed in many different dimensions since Graphic Design is a phenomenon that has existed for a very long time in the communities even before they understand it (Frascara, 1988). Graphic design illustrates a great variety of areas to create spatial image. It is possible to see different designs of different buildings from religious sites to schools, from street to street shop windows to stadiums to basement floors (Trolliet et al., 2014). As some examples were given above graphic design can be seen all around of our living spaces.

Gestalt principles and the concepts showed a dramatic development due to advanced visual technology and the perception of human beings were analysed and the principles were assessed by using a range of examples. In its study Rasmussen explored a series of illustrations which are buildings for religious activities. He used some Early and classical mosques, Muslim related old schools and big graves as examples. Consequently, these places were observes and examined from the point of graphic design and it was explored that there was a use of guttal theory. The significance of applying graphic design concepts, which are gestalt principles in buildings, has been highlighted. (Rasmussen, 2010)

Similarly, there have been, nevertheless, a lot of fascinating places that facilitate the discussion of 'graphic affect'. This evaluation of the concept is a significant process in order to express the relation art and design and their closeness (Barber et al., 2016). For example, "the Bauhaus movement, which was the first to combine art and technology to obtain clarity and functionality rather than aesthetics, still has a crucial effect on modern design, graphic arts and visual communication in Greece" (Kyriakopoulos, 2016).

Symbolic structures in the context of public space and cultural image interaction play an important role in the physical and socio-cultural transformation of the place they are located. One of the most striking examples, the Pompidou Centre, was designed by the Italian architect Renzo Piano in 1971, in the Beaubourg region of France, and opened in 1977. According to Baudrillard (1982), the centre which aims at cultural division and political deterrence has made a difference in terms of size, architectural structure and material details within the environment and became an important focal point (Kürkçüoğlu, 2014; Güç, 2013).

Renovating buildings and innovation has had its place for a long time. While remodelling places and spaces rereading has been used as a formal testament for the renovation. These renovations were always done with the thought of using it again but not with taking into consideration art or graphic design. In media, we have seen so much emphasis on the renovation of so many places like Tate Modern in London, the Baltic Art Factory in Gateshead, the Grand Louvre pyramid and courtyard, and the Reichstag in Berlin. While remodelling graphic design took its place and added a great taste to the architectural design and made places more perceivable and living places for people. As Brooker stated "Illustrated throughout with a rich international portfolio of case studies, it explains the theory behind the way that architects and designers interpret and adapt buildings" (Brooker, 2004).

Another example of the work of adding taste to spaces is seen in the tourism sector. Besides the fact that the facilities of the tourism buildings built in the Mediterranean Region of Turkey, the possibilities offered by the buildings and the surroundings of the various styles, forms and quests in the planning-designing process can be physically based on image, identity, meaning which can be done by graphic design such as. For this reason, during

the planning and design stages of tourism buildings and surroundings, image, identity and meaning must be emphasized by a professional graphic designer (Kancıoğlu, 2006).

Compared to the functional associations, it is seen that there are mostly shops, which have displays, and eating and drinking places. These functions are more useful that generate stimuli (colour, sound, smell, diversity, mobility, etc.) that affect the perception of the individual and appeal to different senses, as well as the cause of conscious preference of spaces. In this context, it is an important parameter for explaining movements, which are included in especially busy routes or cafes and the extent to which stimuli are perceived (Kürkçüoğlu & Ocakçı, 2015),

The New Basics Designers at the Bauhaus had a belief in both a common description of visual formation and its importance. Thus the importance of visual arts in spatial imagery comes to the front one more time in another study. (Lupton & Phillips, 2008)

Spatial image and graphic design applications have also taken place in the re-modelling work (Ching, 2014). It is possible to see the effects of spatial image designs in the studies mentioned above.

Spatial design has added meanings to the spaces, and studies have been carried out throughout the history as in many of the examples listed above to facilitate the interaction of graphic design with living beings. Almost all of the attempts to provide space for interior decoration with graphic design have been successful (Wolfe & Horowitz, 2004).

In these examples, it was tried to evaluate the effects of graphic design from the point of spatial imagery mainly in nursery playground but also with many other examples indoors and outdoors. There are many studies in the literature for spatial images. Therefore, a number of designs were analysed and their scattered results, observations, and examples from the results of the studied like Hinckley et al. were evaluated. In their study, they attempted to determine free-space 3D interaction areas in their work. This framework guides researchers or system developers who know design issues as spatial inputs. As Hinckley et al. stated, "A set of strategies, which may help users to better perceive a 3D virtual environment, include spatial references, relative gesture, two-handed interaction, multisensory feedback, physical constraints, and head tracking" (Hinckley et al., 1994). These strategies are handled in so many works.

The positive perception created by the sustainability of space designs and architectural images has reached a point of great importance today. With the help of spatial imagery, NEU Nursery School was chosen as for the space design. This work also included 3D interactions, which led the design of this framework. In addition, these realities were applied with graphs that were formed by the extended reality application such as graphic, sound, video (Gökçearslan, 2016; Şenyapılı, 1996) and differences and effects were analysed with observations before and after implementation. Because sustainability is very important in architectural fields as well (Kayıhan & Tönük, 2008; Kalınkara, 2006) and creating environmentally sustainable places gives much more successful results with environmental graphic design models and shows the importance of spatial imagery and graphic design.

CONCLUSION

The purpose of this study is to demonstrate the role and importance of graphic design solutions that support architectural design so that spaces can easily be distinguished within today's complex architectural complexes so as to increase the directional skills create a better impression of the place's identity and transfer the necessary information accurately and effectively. The way in which the spatial images created by illustrative, photographic, typographic and pictographic analyses, which are the sub disciplines of graphic design, transformed the space of an architectural product into a conceptual medium was explained through examples.

Graphic design has begun to be accepted all over the world that it is necessary to strengthen the language of expression of the space, and even a new concept "environmental graphic design" has been developed. With the help of these graphic elements, which are accepted as architectural graphics, "storytelling" spaces are getting widespread. The day-to-day necessity of coordination of all disciplines for a single objective, while all sub disciplines branching that require specialization, can also be considered for environmental graphic design and requires collaboration with other disciplines such as architecture, interior architecture, landscape, and furniture.
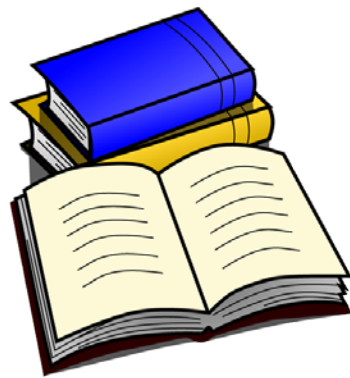
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Formation of Academic Mobility of Future Foreign Language Teachers by Means of Media Education Technologies

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ABSTRACT

The relevance of research: Modern transformations in society and education pay special attention to the increase of the quality of teaching staff training, making new requests for competitive specialists in the world labor-market. According to the demands of educational laws and regulations, modern teacher is meant to be competent in his own sphere of work, have a number of professional skills, be flexible and mobile, be capable to work efficiently in compliance with international standards, be prepared for professional and personal growth. At the same time, an increased competition at the world labor-market requires new approaches to training future teachers with regard to increased demands for the specialists who are capable to adapt to modern world standards. *The purpose of the research:* The purpose of this research is to identify efficient forms and means of academic mobility of future foreign language teachers. *Research methods:* The leading research method that tests hypothesis is pedagogical experiment (ascertaining, forming and control stages of experiment) and also the method of processing of quantitative results of the research. 270 future foreign language teachers took part in the experimental research where 138 respondents belonged to an experimental group and 132 future teachers belonged to a control group. *Results of the research:* the model of formation of academic mobility of future foreign language teachers was designed and scientifically grounded. Formation of academic mobility is implemented by means of media-education technologies, methodological principles which include systemic, competency-based, synergetic, student-oriented approach and the following principles such as humanization, viability, self-education, succession, continuity, dialogism. The proposed model was realized in three stages (motivational-cognitive, organizational- action-based, professional-communicative) and provided for gradual acquisition by future educators the motivation for academic migration and their ability to master their foreign language communicative competence. The purpose of the above mentioned model is to develop such personal qualities which will contribute to students' readiness to get education in foreign educational environment. The result of the realization of the model is the formation of the academic mobility of foreign language teachers on a creative level. *Relevance of the research:* The efficiency of the proposed model of formation of academic mobility of future foreign language teachers by means of media education technologies has been proved and confirmed by the statistics of the experiment. Materials of the article can be useful for students, teachers of educational institutions of higher education, foreign language teachers who write projects, course works, qualifying projects and other types of scientific works.

Contribution of this paper to the literature

- A set of diagnostic tests has been created to reveal the initial levels of formation of academic mobility of future foreign language teachers; The methodology of formation of academic mobility of foreign language teachers by means of media education technologies is proposed;

- Pedagogical conditions facilitating the formation of academic mobility of future foreign language teachers have been defined. These conditions are the following: to create common information-education space which abounds in foreign information; facilitate the development of communication skills by means of intercourse and communication technologies which allow to develop creativity, ability to interact efficiently and to adapt to foreign language education space. Besides, the article attempts to introduce the systemic approach to develop professional knowledge, abilities and other skills to adjust to foreign language environment, as well as to stimulate a sustainable interest of future foreign language teachers in acquiring knowledge of country studies, history and culture of the host country they are studying;

- Content methodology section highlights the formation of academic mobility of future foreign language teachers by means of media education technology comprising teaching aids, forms, methods of formation of academic mobility of future foreign language teachers.

INTRODUCTION

Relevance of the Problem

Russian society has moved into the stage of international integration which influences all the life spheres, and first of all, economic viability of the state. Global transformation of manufacture and labor markets has made actual the need for competent specialists who are ready for continuous and constant professional self-perfection. Consequently, academic mobility as the quality of a person who can easily adapt to conditions of technological progress, competition at the international labor market and who shows readiness for matched cooperation with representatives of foreign companies acquire special significance (Tersek, 2017). Formation of the above mentioned quality becomes a top-priority task during the process of training of a contemporary specialist.

Modern transformations in society and education pay special attention to the increase of quality of teaching staff training, making demands for competitive specialists of the world labor market. Professional education in Russia at present is switching to new educational standards which predetermine the formation of mobile competitive specialists. The leading role in their training is assigned to formation of competencies which must ensure students the acquirement of vocationally-oriented foreign language communication skills as an efficient mean which can enhance the professional potential of future foreign language teachers and their performance. Meanwhile, organization and content details of the modern educational process restrict the formation of academic mobility which must ensure strategic involvement into multinational economic cooperation. But at present the formation of the above mentioned mobility is restrained because of poor language proficiency (Devyatova, 2012; Porshneva & Abdulmianova, 2017).

It is also obvious that in the process of training a modern specialist there is no integration of psychological-pedagogical sciences and foreign language which should be taken into account for its specific opportunities in formation of academic mobility and professional education of a person. The formation of information responsiveness, goal setting skills and collective interaction of the future foreign language teacher is never connected with subject-oriented and vocational training of foreign language acquisition in higher educational institution. Within this framework there is an urgent need for searching efficient conditions which will facilitate the formation of academic mobility of future foreign language teachers by means of media education technologies (Malach & Chmura, 2017).

One of the leading theorists of contemporary media education, British scientist and educator justified seven reasons why media education is a burning issue in the modern world (Bondarenko & Zhurin, 2002, Fateeva, 2007, Grigorova, 2006, Tsygankov, 2004, Vartanova & Zasursky, 2003). They are the following:

1. High level of media consumption and saturation of modern societies with modern means of communication.

2. Ideological importance of the media and its influence on audience consciousness.

3. Rapid growth of the amount of media information, need for enhanced monitoring of its broadcast.

4. Intensive media penetration into main democratic processes.
5. Mainstreaming of visual communication and information in all the spheres.
6. Necessity for education of students in accordance with future requirements.
7. Growth of national and international processes of privatization of information.

One more reason can be added to the above mentioned list: popularity of yellow press and degradation of mass production which in its turn creates a demand for education technologies in mass media.

Purposes and Objectives of the Research

The purpose of the article was to develop a model of formation of academic mobility of future foreign language teachers by means of media education technologies. The main objectives were the following:

to identify the core of the model, to develop and apply the model of formation of academic mobility in practice which is one of the conditions of integration of future specialists into the world labor market; to determine and test pedagogical conditions which will enhance the efficiency of formation of academic mobility of future foreign language teachers; to improve competitiveness of foreign language teachers.

LITERATURE REVIEW

Analysis of Russian Scientific and Pedagogical Literature

Problems of the formation of academic mobility of students of higher educational institutions abroad in the context of Common European educational space (adapted from research report of the foreign experience research laboratory of professional education) are represented in works of (Tregubova et al, 2009). Author's categorical conception of formation of academic mobility is represented in the research both in a general sense and specific for specialists of social, technical and economic fiels; scientific-pedagogical aspects of formation of foreign language teacher academic mobility have been examined, which were characterized by its ability to be reproduced, diversified and adapted; the model of formation of academic mobility, which allows to predict and ensure its efficiency was developed and approved; systematization and classification of conditions and factors of formation of academic mobility of students, which promote the enhance of quality of education and the reputation of higher educational institution, was carried out (Tregubova et al, 2009); general and special features in the use of foreign and domestic approaches, principles and criteria of formation of academic mobility of students have been established; principal directions and conditions of use of "portfolio" as a means of formation of academic mobility of students were determined; the algorithm of implementation of foreign experience in formation of academic mobility in domestic higher education institutions has been developed and successfully approved. Scientists mark that fundamentality of Russian education, scientific and intellectual potential of the teaching staff, high quality and price affordability, wide variety of educational services proposed is the process of integration of our country into the European educational space (Power et al, 2017; Valiulis, 2013). Academic mobility, which can be considered as a key factor of modernization and realization of systematic changes is an essential component and a mechanism of stimulation of Russian Federation higher education institutions to be included into the Bologna process.

Derzaev and Ahmadiev (2013) in their article "The model of formation of academic mobility of students" on the basis of analysis of standard and legal, psychological and pedagogical, sociological scientific literature and participation in a number of roundtable discussions, which were conducted by the Ministry of education and science of the Republic of Tatarstan, developed a model of formation of academic mobility of students of higher educational institutions. They also described the elements of the model and showed the results of experimental work on formation of academic mobility of students.

The article of Buzukov (2015) underlines that the Bologna Declaration, which was signed by the ministers of 29 countries on the 19.06.1999, highlights the role of universities in the development of European culture, strengthening intellectual, cultural, social, scientific-research potential, the "European knowledge" acquisition. The declaration stressed the necessity of creation of the European sphere of higher education which would promote the mobility and employment of citizens and also the development of the continent in general. Fundamental foundations of the Bologna process are: 1. mobility (academic and professional); mobility of students as well as teachers; 2. competitiveness; 3. credit system – ECTS (European Credit Transfer System).

The article of Sakharova (2011) presents the pedagogical essence of the academic mobility of students of the university in the context of the foreign language competency development. Top priorities in the development of contemporary higher professional education are highlighted. The most advanced educational priorities at present are the following: multilevel education (Bachelor degree programme, Master's Degree programme, Doctoral programme); additional vocational training in the system of higher professional education; lifelong learning; cross-

disciplinary integration of higher professional education. Academic mobility of university students is a multifaceted phenomenon and can be interpreted from the positions of students' readiness to use European and domestic resource in the sphere of future professional engagement, taking into account the right of students to choose educational institution. From the point of view of personal development academic mobility presents a system of student personal qualities, oriented at achieving social and vocationally meaningful goals. It is supposed that these qualities provide and optimize the process of learning in terms of international educational programmes.

Yurasova (2014) examines the methods how to develop common cultural and professional competencies of the graduate of a non-linguistic higher education institution by means of analysis of the literary text. Analysis of the literary text is one of the major forms of work in terms of professional training of students-philologists and translators. Along with the development of specific language skills and abilities, analysis of the literary text promotes the general personal development of a young person. Work with fiction text helps to reveal additional competencies: ability for emotion analysis, emotional intellect. Emotional intellect is the basic managerial competence which allows a specialist to become a successful leader in the sphere of business, politics, state and municipal management. Thus, under current conditions philological education becomes the most universal way of development of basic and special managerial competencies.

Ryabova (2014) in her work proved the actuality of use of integrative approach as a methodological base in the system of translator training. The new essence of the translating process and a new role of the translator have been revealed.

Socio-cultural mobility of the translator is provided by integrative knowledge. Integrative processes in translator education are aimed at training of such a specialist, whose translator decision is based on self-criticism, objectivity and striving for development of professional qualities.

Examination of international education measurement is usually reduced to the comparative analysis of features of education in different countries. The situation started to change at the end of 20 – at the beginning of 21 century because of rapid development of globalization processes (formation of transparency of national borders) and integration (deepening of cooperation between countries on the basis of intergovernmental agreements). The above mentioned processes influenced the education sphere, which internationalized intensively (to get a wide international aspect). In spite of possible failures, the process of internationalization of education, general vector of development, reside in the fact that this process will enhance. The purpose of the article is to analyze what new challenges and possibilities become available due to the internationalization of education (in particular, Russian education). Materials and methods: the research was based on the principles according to which education on the one hand depends on the transformation of global political organization and on the other hand promotes this transformation. Materials for the research are based on international agreements which are in particular accepted in terms of the Bologna process and also the results of scientific works of Russian and foreign scientists. Descriptive and comparative methods of analysis are widely used. Results: analysis of internationalization processes of education in the world has shown that along with its traditional directions and aspects it was noted that university starts to play a special role in the modern world. It was shown that specificity of education in Russia formed due to big territory and historical traditions must be taken into account when forming the strategy of internationalization development of education in the country. Discussion and results: specificity of Russia poses a risk of abruption of Russian educational space in European and Asian parts accompanied with relevant economical, social and other consequences. To avoid this it's necessary first of all, to activate cooperation of Russian higher education institutions all over the Russian Federation. Secondly, Russia can become a kind of educational "bridge" between different regions of the world. It was concluded that to determine the basic components of the new stage of integration of education, joint researches of specialists in the sphere of international relations, teachers, psychologists, sociologists are needed (Lebedeva, 2017).

The article of Muravyova and Gorileva (2016) examines the role of joint educational programmes of higher education as a tool of internationalization in a wider context of modern trends of social development. Particular attention is paid to international/transuniversal general competencies and the significance of their formation for ensuring competitiveness of graduates at the labor market. General principles of design and realization of such programmes and problems connected with their realization were emphasized. Also the examples of realization of such programmes in one if the leading Russian higher educational institutions – the Lobachevsky University are given. Materials and methods: methodological foundation of the research is formed by general scientific methods of enquiry, such as analysis, comparison, generalization. Practical experience of the Lobachevsky University in realization of different educational programmes together with European universities was analyzed, namely: bachelor and master programmes of intramural form of study in two higher educational institutions; bachelor and specialist program of NNSU along with distance education in European educational institution; programmes to get two stages of the third level of education – candidate of sciences and Ph.D. The results of the research: in the result of the analysis carried out it was identified that designing joint educational programmes is the most efficient way of creating Common European space of higher education, significant tool of realization of principles of the Bologna

process. It was approved that the most common goal of joint educational programmes is, first of all, to enhance competitiveness of the European education (here the term European education incorporates Russian education) and ensure its high quality. Discussion and conclusion: general criteria of efficiency of joint educational programmes are justified which include: modular structure of programmes and necessity to rely on achievement results in learning; provision of high level of education quality in terms of cooperative programmes; use of student-centered methods of education when realizing cooperative educational programmes.

The article of Bogatova and Guseva (2014) relies on the data of sociological survey of students of N.P. Ogarev's Mordovia State University of non-linguistic specialities, who learn English within the programmes of additional education or with tutors with the purpose to bring to light social attitudes of students of non-linguistic specialities towards English outside the principal educational programme. The article highlighted the extent of social demand for foreign language skills in the modern Russian society and on the level of the subject of the RF – in regional society of the Republic of Mordovia; the motives of foreign language learning of Russian students were analyzed; the factors forming social preferences and motives of students of the Ogarev MSU connected with foreign language learning beyond the curriculum of the basic direction of training, and social expectations connected with perspectives of foreign language use in the future career of graduates were defined; practical recommendations to improve the quality of foreign language training in the system of higher professional education were formulated.

The article "Integral text methodology in the light of linguoculture: acme-axiological approach" highlights the topical problem of linguoculture acmeology - identifies essential features and indicators of human speech activity evolution in written and oral speech. For the first time in linguoculture science the author proposes acme-axiological methodology, suggests humanistic and constructive understanding of the world text linguoculture and considers text as acmeological process, as a human's pathway to the highest sociocultural knowledge verbalization. Acme-axiological criteria of the concept "language development" are put forward. The author develops the idea of applying anthropocosmic criteria complex to the study of the text linguoculture. Anthropocosmism formulates a value paradigm of text study and refers human's language development to the spiritual self-representation of a person (Belyatskaya, 2014).

Gafiyatova (2014) examines professional language personality. The author explains the choice of the language personality as an object of the study, analyses the bicultural language personality and describes the types of language personality. A range of research procedures of abstract-theoretical, experimental-practical, organizational and methodological levels to solve the set tasks are examined and offered.

Kurbatova (2013) in her work examines the integrative character of linguoculturology, which methodology is under development at present. So far, the scientific status and main tasks of linguoculturology as a science have not been identified; the specificity of basic linguoculturological terms and concepts has not been defined; the forms of keeping and co-existing of language and culture in human consciousness, from the point of view of culturology, have not been researched sufficiently.

The article of Altunina (2011) analyzes the possibilities and possible ways of development of higher education in Russia and Kaliningrad region within a framework of Bologna process. Different aspects of cooperation between Russia and countries of the EU (joint programmes and programmes with double diplomas) are examined. The total number of competencies of a graduate, as his socially significant integrative qualities, which are needed for his future professional career and personal growth create a new image of quality of higher education. Competitiveness of the graduate of the certain level of higher professional education can be considered as the main indicator of quality of his/her professional training which ensures the readiness for efficient professional activity in society. Introduction of such an indicator into the evaluation of quality of professional training promotes the establishment of close connection between higher professional education and a labor market. Specialists at the labor market offer readiness for professional career competing against each other for places of work. That is why, competitiveness of the specialist at the labor market is determined to be more perfect if compared with others by system of knowledge, skills, abilities, professional techniques, vocationally important personal qualities, competencies, higher qualification, ability to adapt rapidly to the reality and perform one's professional functions more efficiently. Competitiveness of the higher educational institution graduate can become obvious only after the final completion and mastering professional educational programme. For this reason, there arises a need to develop the indicators of successful mastering of a programme which allow to predict the level of the forthcoming competitiveness that can evidentiate it, as potential feature in the process of educational activity.

The students' stay in the information space is significantly longer than the time spent in class. Therefore, teachers should stimulate students' interest through the application of ICT that the students themselves use without losing the educational functions that they perform in class. In other words, teachers should find as many teaching approaches to present the educational information and external information flows by means of ICT as possible. The information and educational space created in modern conditions is inextricably linked with the use of media education technologies and this in turn is significant in the professional training of students of scientific professions. Thus, one of the main advantages of using media education technologies is that they provide co-adaptation of the

information and educational spaces in the pedagogical process, and also contribute to the formation of the media competence of the student's personality (Ivanova & Maltseva, 2012).

Analysis of Foreign Resources

The purpose of the article written by Hu (2016) is to clarify on the process of the internationalization of higher education from the point of view of human integration into urban cultural space. **Materials and Methods**: The methods applied in the article are mainly analytical and descriptive ones which show how the human integration and urban cultural space contribute to and influence the process of internationalization of higher education. **Results**: The motivation for the internationalization of higher education is closely linked to that of urbanization. In addition to economic and political incentives, modern urban culture caused by globalization also plays an important role in promoting the internationalization of higher education.

The internationalization of higher education has developed due to the change in the existing environment of the urban culture space against the background of urban internationalization. The human need for self-reliance in urban culture helps to stimulate the internationalization of higher education and people in their turn contribute to the development of modern cultural space and their separation in the space of urban culture accelerates the development of higher education. From the perspective of higher education internationalization, to sort out the cultural motivation for higher education and find its suitable form for the city's internationalization is crucial for adjusting the orientation and guaranteeing the efficiency of higher education internationalization. From the aspect of human beings' development, the separation between urban space and human beings caused by the city's ongoing internationalization is a burning problem that has to be solved. From the aspect of the construction of urban culture space, as an important means of retaining human beings' equilibrium, urban culture promotes the internationalization of higher education (Zhurin, 2001).

The study of Bećirović (2017) analyses the relationship between gender, motivation and achievements in the study of English as a foreign language. Fluent knowledge of English is of paramount importance for a person to be successful in professional, personal and educational aspects of life. The purpose of this study was to determine how gender affects motivation and personal accomplishments in learning English as a foreign language. The research comprised 185 students at the age of ten (fifth grade), fourteen (ninth grade) and eighteen (twelfth grade).

The results demonstrate a statistically significant relationship between gender and motivation. Ten-year-old students demonstrate the highest motivation for learning English as a foreign language, while eighteen-year-old students show low motivation. In addition, it turns out that female students are more successful in learning English as a foreign language than male students at each age group / class. Besides, the research outcomes display statistically significant deviations in measuring the ratio between students' accomplishments and motivation and can be very useful for teachers, parents and students in making the most effective approach to studying and teaching English as a foreign language (Popova & Beavitt, 2017).

Despite the fact that a great number of studies has been devoted to the teachers' attrition and mobility, teachers of English have attracted researchers' attention. The present authors, using the 1999-2000 Schools and Staffing Survey (SASS) and the Teacher Follow-Up Survey (TFS; National Center for Education Statistics, 2005) examined individual, academic characteristics and also mentoring and induction activities that affect beginning English teachers' attrition, mobility, and retention. The results showed that salary was a statistically significant incentive related to a great amount of hardships of beginning English teachers who were about to leave their profession. There were no factors related to decreased attrition. As regards teachers' mobility, no teacher or school characteristics were associated with migration (i.e., changing schools). While reviewing combined effects of mentoring and induction activities when controlling for teacher and school characteristics, the authors found that the results suggested none of the activities were related to attrition and migration (Hahs-Vaughn & Scherff, 2008).

The purpose of the international training programme in the case study was to provoke teachers to start rethinking potentially ethnocentric assumptions. The key issue of the research: "What outcomes can be expected if we combine OME and training in the field of service for teachers before the start of training?" The main focus of the document was on OMEs which took place in China and Malaysia. The outcomes included that joint programme contributed to the development of global thinking, training, presence, experience of the teacher in a new context and the development of the professional identity of participating students.

The Article written by Pherali (2012) entitled "Academic mobility, language and cultural capital: the experience of transnational academics in British higher academic institutions" is devoted to the experiences of transnational academics teaching and researching in British higher education institutions (HEI). Despite many studies related to the problems of foreign students and Western scholars teaching abroad, very little has been written about the recent global phenomenon in which scholars from non-English-speaking countries move to English universities. This under researched area is represented as a detailed study examining the cases of seven international academics in five different universities. The study revealed a range of their distinctive experiences which represent an exigent

"field" in their struggle to adapt to the new cultural setting. While providing opportunities for professional development is useful, the "offer of support" is a sensitive issue and can pose a threat to both their status and identity.

In the scientific work of Mitchell and Reushle (2013) "Mobile Learning and Professional Development: The Future of Academic Work in Higher Education" the findings are that educators use social media to enrich their teaching experience in the classroom. Besides, they use mobile phones for greater teaching performance across time and place. As learning becomes more mobile, social-based and informal, the divide between spaces, places and digital devices is merging.

Given the disruptive effect, learning mobility is having on the foundations of education, knowledge, learning and academic work, this paper investigates the possible relationship between mobile learning and professional development as potential enablers (or barriers) to academic motivation and engagement in transforming their professional practice (Duchovicova & Tomsik, 2017). This research holds the central tenet of 'educators are learners', adopts an 'as-lived' experiences approach which looks at the ways people experience, in this case, mobile learning in natural settings, and is fundamentally concerned with contributing to the body of knowledge on the changing nature of the higher education teacher's academic work in the modern academy. The principal questions guiding this exploratory paper are 'What alternatives are there to current professional development methods that support educators in ways of learning about mobile learning to transform professional practice?' and 'Why are some academics naturally motivated to engage, share and actively participate in alternatives?

Hoffman (2008), in his work "Changing Academic Models of Mobility and International Migration", asks the question "What will academic mobility mean in the 21st century?" Several scholars stressed the connection between academic mobility and international migration. This qualitative study explores a spectrum of academic mobility articulated by Teichler that empirically contributes to examine these connections. He studies e-mail excerpts from 20 migrant academics living in seven countries who have highlighted six different models of academic mobility and the main differences between regions of the world. Conceiving academic mobility in terms of traditional short-term internationalization the author finds many universities which focused on and staffed for academic mobility between countries. Other regions have long been oriented on academic mobility that occurs within countries. These patterns are the result of long-term migration. At the conceptual and practical levels, this study distinguishes between the time frame and contexts of academic mobility and the theoretical justification for this. The analysis suggests that the assumptions about the dynamics of academic mobility and their implications should be reconsidered.

In the article "Academic Mobility and Migration: What We Know and Do not Know" written by Teichler (2015), the author claims that although internationalization of the scientific world is a key issue in public attention and policy, the actual information base on migration and mobility of "teachers in higher education", "scholars", "academics" or "researchers" has remained weak. Most available statistics focus on "foreign" students or "foreign" scholars rather than persons mobile for academic and scientific purposes and provide information only on a single moment rather than on the life course of moving between countries. In recent years, some surveys of the "academic profession" and 'researchers' have been undertaken primarily in economically advanced countries or especially in European countries that provide an overview on various modes, e.g. migration prior study, short-term student mobility and mobility for the whole degree programme, mobility in the phase of doctoral education and training, professional mobility in various stages of the professional career and finally shorter visits linked to academic and research work. All available information suggests that substantial differences exist by country and that no signs of convergence are visible. Moreover, surveys confirm that international experience is a frequently valuable asset of academic research careers but often is viewed as less beneficial than conventional wisdom suggests.

Valiulis (2013) in the work "International mobility of students and teachers – an additional tool for better learning" emphasizes that for the past several years European higher education institutions (HEIs) have been increasingly facing the need to create a more diverse range of international activities. Universities are searching for new internationalization tools to implement those activities more effectively in terms of finance and time.

Learning mobility plays a great role in the process of quality assurance in higher education, expanding cross-border collaboration within the European Higher Education Area (EHEA) and beyond, and enhancing students' employability. A clear positioning of a country and identification of its strengths should be given special consideration. The image of the country, e.g. educational system, study and living standards and migration policy, have to be emphasized to win the attention of both international partners and prospective international students. A national strategy (with major strategic directions, priority activities for HE internationalisation, national financing, etc) is needed to support national HEIs in co-operative endeavours and in competitive efforts, taking account of the new European initiatives and aiming at non-EU regions.

Higher education is one of the social fields where inequalities are produced and reproduced. Nevertheless, we still know very little about the ways in which heterogeneities and inequalities have been experienced and interpreted by those involved in international academic mobility. In this introductory editorial, we consider some

of the crucial conceptual issues involved in the study of the nexus between inequalities and international academic mobility. First, we argue that it is important to take manifold inequalities into account when examining this nexus. After all, inequalities can be detected at different levels, and the mobility process is structured around multiple heterogeneities rather than by a single one. Second, we discuss how international academic mobility and inequalities attached to it go beyond nation-state borders. Third, we confirm that it is beneficial to extend the scope of the mobility process as a whole, as inequalities in opportunities and outcomes are intrinsically connected (Başak & Christof, 2017).

Despite the growing interest of researchers in the subject knowledge of teachers, the scientific understanding of teachers' professional knowledge for teaching English as a foreign language (TEFL) is very limited. This study therefore applies standardized tests to directly assess content knowledge (CK), pedagogical content knowledge (PCK), and general pedagogical knowledge (GPK) of preservice teachers for TEFL in Germany from different programmes and stages during initial teacher education (during their master's studies at university and at the end of their induction phase). Structural analysis provides evidence that teacher knowledge with respect to TEFL is a multidimensional construct and PCK is closely related to both CK and GPK. Test scores vary across preservice teachers from different programmes and stages, which adequately reflects differences in the learning opportunities they had during teacher education (König et al, 2016).

Although the professional development of graduate students in foreign language (FL) departments is of critical importance, discussion of its significance and evolution was all but absent in the 2007 Modern Language Association report "Foreign Languages and Higher Education: New Structures for a Changed World", a document advocating curricular and structural reforms of FL departments in forthright terms. This lacuna drove the current review, which traces the forms and foci of research appearing from 1987 to 2008 on the professional development of future professors of foreign languages. Empirical studies on the relation of graduate students' beliefs and identities to their FL teaching experiences have integrated increasingly sophisticated research designs and theoretical frameworks over the past two decades; however, the primary focus of this field remained moving from a training perspective to a professional development perspective and substantiating this change with new practices that address FL graduate students' long-term needs as teachers and scholars. The authors call for a renewed focus on empirical research in this field and a more symbiotic relationship between research investigating the processes and outcomes of FL graduate student professional development and the practices called for in FL departments (Allen & Negueruela-Azarola, 2010).

The current controversial socio-political climate provides an excellent opportunity for linguistic alienation that influences the change that helps shape the national discourse associated with multilingualism and multiculturalism. Our classes are diverse sites where languages and culture converge and thus providing opportunities for rethinking how to equip students with tools that must be critical consumers of linguistic, literary and cultural content. Although many of us are already aware of this opportunity, the impact of our work is diminishing if we do not think globally and at the same time effectively interact in our local contexts. By involving all the language colleagues in efforts to protect, and by informing your efforts with scientifically based SLAs, we will go far in breaking down divides and successfully developing and disseminating the mission and the social location of language departments in the 21st century (Paesani, 2017).

New empirical studies are presented in the forefront of research in the field of English language teaching and professional development, which are in different contexts around the world, including Canada, Denmark, Israel, Japan, Korea, Qatar, Sudan, and the U.S. It is framed by the volume editors' insightful overview and analyses of previous and ongoing work in a variety of related domains and an epilogue by David Nunan. The chapter studies are organized around three themes: teacher identity in ESL/EFL teacher education and professional development programs, second language teacher education programs for diverse contexts, and professional development for diverse contexts.

All chapters focus on the applied nature of the research and include a section on implications. To provide balance and a range of views, the volume includes both chapters reporting on empirical research funded by TIRF grant recipients and several from invited authors who are senior scholars in the field. This is the third volume in the Global Research on Teaching and Learning English Series, co-published by Routledge and TIRF (Crandall & Christison, 2016).

This study analyzes the online, peer-peer dialogue between two groups of nonnative English-speaking teachers who are attending graduate programs in Colombia and the United States. Framed by the theoretical concepts of critical pedagogy and global professional identity, a qualitative analysis of the data shows that their expert vs. novice roles played a significant part in shaping their positions on the four themes that they discussed: the role of English language teaching in the global world, institutional constraints on teachers, whose culture to teach, and linguistic diversity in the classroom. This study highlights the responsibility of teacher education programs to cultivate healthy nonnative English speaker teachers' professional identities given the global complexities that continue to unfold around these teachers (Guerrero & Meadows, 2015).

Based on the ideas received from communities of practice and the theory of critical discourse, this study examines how teacher identities are discursively created in the process of teachers education and under the influence of social structure. The participants were seven Hong Kong and nine Chinese pre-service teachers. Two interviews were conducted with a focus group and in-depth individual interviews were used with each of the participants. The study showed that the formation of the identity of these participants is carried out individually, is mediated by immediate contextual factors, formed by their socio-economic background and constructed taking into account social discourses about the teachers and teaching profession. This article discusses the sociocultural factors underlying the differences, and gives rise to implications for current pedagogical practices and future research (Gu & Benson, 2015; Si & Qiao, 207).

While research data concerning study abroad experiences of tertiary level students are easily accessible, relatively little attention has been paid to the role of international programmes in pre-service foreign language (FL) teacher education. The present study involved student teachers of English from three countries and aimed to explore their intrinsic motivation to participate in a short-term teacher-training course in Germany based on cooperative and interdisciplinary teaching approaches. It was also verified whether the results were determined by the participants' country of origin. The data for the investigation were collected by means of a questionnaire developed on the basis of the Intrinsic Motivation Inventory and focused on six subscales related to intrinsic motivation: interest/enjoyment, perceived competence, value/usefulness, effort/importance, felt pressure/tension and perceived choice during task-based activities of the workshop. The quantitative data were supplemented with the participants' written comments, which were later content analyzed with regard to the above-mentioned subscales. The results suggest that irrespective of the nationality, all participants reported relatively high levels of intrinsic motivation to participate in the programme. Additionally, the findings serve as a basis for a number of practical recommendations for planning and management of future mobility programs addressed to student teachers of FLs (Pfingsthorn & Czura, 2017).

Thus, the problem of the formation of academic mobility of future teachers of a foreign language by means of media education technologies is connected with the process of language adaptation, inculturation, together with the methodology of teaching a foreign language. The essential condition of the educational process is to involve media studies techniques, to develop program materials, teaching and methodological aids for effective foreign language teaching.

New Educational Media is definitely a signpost of an era of e-generation. Interactive media is indeed revolutionizing the world of communication nowadays. The new media's integration into the education sector is redesigning our perception of an educational paradigm. Online media facilitates students' inquisitiveness and interaction. As an agent of immense change, it is a great tool aimed at greater cognitive performance, self-expression and a skill enhancement enabling students to develop professionally. Having redesigned the academic process, media education is replacing traditional forms of education and makes individuals correspond to social demands of the competitive world (Shilpa, 2014).

The role and impact of information and communication technology on modern academic world is immense and cannot be left understudied. In view of this, the concept of `educational media and technology' is inestimable in teaching and learning activities and should be applied in Federal and State educational institutions, Non-Governmental Organizations and School Administrators (Mohammed & Yarinchi, 2013).

MATERIALS AND METHODS

Theoretical and Empirical Methods

To prove the hypothesis a set of various interrelated methods was used:

– theoretical – analysis of psychological and pedagogical works on the research problem; study of methodological and educational literature; theoretical analysis of the main provisions of the proposed methodology on the basis of which the hypothesis of the research was put forward; theoretical justification of the systematic work on the formation of academic mobility of future teachers of a foreign language by means of media education technologies;

– empirical – summative and confirmative assessment, check pedagogical experiment, conversation polls, interviews, questionnaires, testing, teacher observation; analysis of the results of experimental work.

Base of the Research

The research was carried out on the basis of Humanities and Pedagogics Academy (branch) of the Federal State Autonomous Educational Institution of Higher Education "Crimean V.I. Vernadsky Federal University" in Yalta. The experiment involved two hundred and seventy future teachers of a foreign language.

Stages of Research

The study was conducted in four stages:

At the first stage, the problem of forming academic mobility of future teachers of a foreign language was studied and analyzed; criteria and indicators of formation of academic mobility of future teachers of a foreign language were determined; the methods of diagnosis were chosen to identify the criteria and indicators.

At the second stage, the theoretical concept of the research was refined and corrected, an experimental model of the formation of academic mobility of future teachers of a foreign language was developed; the corresponding didactic-methodical support of the process of formation of academic mobility of future teachers of a foreign language was performed.

At the third stage, an extensive training experiment was conducted, an experimental verification of the model of the formation of academic mobility of future teachers of a foreign language was carried out.

At the fourth stage, theoretical interpretation of the results of experimental work and their interpretation were carried out; the results of experimental work and conclusions were formulated; the analysis, generalization and systematization of the data obtained, design of the study and approbation of the research topic in the publications and the author's reports at scientific conferences were performed.

Estimated Criteria

The author identifies the criteria and indicators of formation of the academic mobility of future teachers of a foreign language. They are operational and cognitive ones with the indicators: sufficient knowledge of special disciplines; developed oral and writing skills; communicative and action-based criterion with the indicators: formation of communicative abilities of future teachers of a foreign language; existence of practical skills for activity in the foreign-language environment; social criterion with indicators: the existence of knowledge of the academic mobility as a social phenomenon, formation of active living position; readiness for independent creative activity, readiness for foreign-language communication, aspiration to professional self-improvement in the foreign-language environment.

According to distinguished criteria and indicators, levels of formation of the academic mobility of future teachers of a foreign language are characterized. They are low, average, sufficient and creative.

Low level is characterized by the insufficient level of knowledge of special disciplines. The students' skills of interaction with the foreign language environment aren't created. They know about the existence of the academic mobility as a social phenomenon, but don't realize the importance of its formation. Besides, such students don't aspire to self-improve professionally. Future foreign language teachers have no motivation to start educational migration. Such group of students displays the lack of understanding what types of the academic mobility and technologies are applied in academic process. They don't want to go abroad with the purpose of professional exchange and improvement of their personal pedagogical excellence and skills of foreign language interaction. The students with low level got from 0 to 7 points for the overall performance.

The average level assessment evaluates certain knowledge of special disciplines and satisfactory communicative foreign-language competence. Future teachers are familiar with the specified phenomenon in society and education. Such students show willingness to go abroad for professional improvement, but don't understand how to fulfil this task. They are motivated to the academic mobility, understand the importance of the above-mentioned phenomenon, but can't figure out how it can be done. They lack theoretical knowledge of technologies of the organization of the academic mobility and its types. At the same time they aren't ready for independent creative activity and don't search for self-perfection in the foreign-language environment. Students with the average level got from 8 to 14 points for their overallperformance.

The students have the sufficient level if they are familiar with the significance of the specified social phenomenon; foreign-language communicative abilities are created, they are ready for professional self-improvement, have the sufficient level of knowledge of special disciplines.

For the sufficient level the professional mastery and desire of continuous career development are inherent. Such future teachers have rather high motivation to the academic exchange with the foreign universities. Furthermore, future teachers of a foreign language of this level have advanced skills of foreign-language interaction. Students with sufficient level received from 15 to 21 points for performance of all tasks.

The creative level is noted by orientation of students on the achievement of good results in formation of the academic mobility due to deep awareness broad-mindedness and systemacity of knowledge of methods and strategies of its development, the high level of feedback, critical thinking and the careful analysis of their overall performance.

Table 1. The total level of a formation of the academic mobility of future teachers of a foreign language

Level%	Operational and cognitive criterion		Communicative activity criterion		Social criterion		General level	
	EG	CG	EG	CG	EG	CG	EG	CG
Creative	8.4	9.5	10	10	7	8.4	7.2	7.9
Sufficient	10.6	9.2	15.4	14.9	11.2	12.8	10.9	11.3
Average	40.8	37.8	37.3	37.3	46	41.5	40	38.2
Low	40.2	43.5	37.3	37.8	35.8	37.3	41.9	42.6

Skills of communicative interaction in the foreign-language environment are created at future teachers, they are ready to independent creative activity and professional self-improvement by means of the academic mobility. Future linguists of the specified level show talent and mature knowledge and abilities of the academic mobility, they know how, when, by means of what and why the programs of the international exchanges function. They have the high level of motivation to professional activity and career development in their sphere. Future teachers of a foreign language with the creative level of formation of the academic mobility received from 22 to 28 points for performance of all tasks.

Process and Description of the Experiment

The research was conducted on the basis of Vernadsky Humanities and Pedagogics Academy (branch) of The Federal State Autonomous Educational Institution of Higher Education "Crimean V.I. Vernadsky Federal University" in Yalta.

Two hundred and seventy future teachers of a foreign language participated in the experiment. The analysis of a condition of the problem of the academic mobility of future teachers of a foreign language in the theory and in practice allows to say that in higher education institutions there is no accurately developed system of educational and methodical materials which would consider the specifics of formation of the academic mobility of student's youth.

RESULTS

The Summative Stage of the Experiment

The experimental work has involved 270 future teachers of a foreign language. Two groups of students who participated in the summative experiment were selected. In one group the diagnostic test has been taken as a basis during the planning process how to form the academic mobility of future teachers of a foreign language. Another group involved traditional approaches to teacher training. Thus, the experimental group contained 138 people and control group included 132 people. The diagnostics of level of formation of the academic mobility of future teachers of a foreign language has been carried out with the students of both groups using *operational cognitive criterion* with indicators: the knowledge of special disciplines; good speaking and writing skills; *communicative competence criterion* with indicators: formation of communicative abilities of future teachers of a foreign language; practical skills of interaction in the foreign-language environment; *social criterion* with indicators: existence of the academic mobility as a social phenomenon, an interesting world view, readiness for independent creative activity, readiness for foreign-language acquisition, aspiration to professional self-improvement in the foreign-language environment. Testing, communicative situations, conversations, role-playing games, interviewing, and development of the card of professional self-improvement were practiced with the students of both groups. More obvious results of the summative stage of the experiment are displayed in tables below (**Table 1**).

So, the creative level of formation of the academic mobility is detected in 7.2% of future teachers of experimental and 7.9% of respondents of the control groups. There were 10.9% of respondents of experimental and 11.3% of future teachers of control groups at the sufficient level. The average level of formation of the academic mobility is revealed at 40% of students of experimental and 38.2% of respondents of control groups. The low level according to the results of the summative evaluation is recorded at 41.9% of respondents of experimental and 42.6% of future teachers of control groups.

Analyzing a qualitative component of the obtained results, it should be noted that most of students weren't ready to take an active part in the foreign-language educational environment. In our point of view, first of all, it is connected with insufficiency of knowledge of English and existence of language and speech barriers, lack of motivation in general to professional and career development by means of the academic mobility. Students weren't familiar with the necessary documents for a trip to study abroad, didn't know how to make the motivational letter and the summary.

So, having analyzed the results of the summative experiment, it is possible to claim that the formation of the academic mobility of future teachers of a foreign language is close to low level. Thus, the received results confirm the need of development and deployment of a model and pedagogical conditions of formation of the academic mobility of future teachers of a foreign language by means of media education technologies.

The Forming Stage of the Experiment

The work on formation of the academic mobility of future teachers of a foreign language, consisting of three stages according to the components of the designed model, was organized during the forming experiment.

Not only the academic mobility but also culturological competence were formed in future foreign language teachers for the purpose of introducing students to cultural peculiarities of the countries of the studied language. Also the formation of communicative skills of future teachers of a foreign language, their ability to foreign-language interaction and implementation of technology into the interpersonal relations were in the focus of attention.

The expansion of knowledge of future teachers of a foreign language of the academic mobility as the social phenomenon and a formation of motivation to the development of the academic mobility and a development of communicative abilities was the purpose of the first stage – motivational and cognitive. So, at the first stage the propaedeutic and information module aimed at the formation of motivation for development of the academic mobility and communicative abilities was carried out.

At this stage there was a realization of a pedagogical condition – a creation of the information and education space that is saturated to maximum with foreign language information (Internet resources, information sources) active use of communication resources, opportunities of the information and communication technologies allowing to develop creative abilities, ability to interact effectively, ability for adaptation to another educational space – by use of such forms of work as round tables, the interactive lecture "History of the Academic Mobility as the Social and Educational Phenomenon", network projects, development of a route of the academic mobility, studying the ethical code of the academic migrant, a master class"Writing of the application for participation in the programs of student's exchange", "A training of personal and professional self-determination and self-improvement of the teacher", a lecture, which teacher-linguist is expected at modern school?, individual conversations, the presentations on the subject "The Country in Which I Would Like to Study", a round table together with Fulbright fund for the academic opportunities of the program, a briefing "Training abroad", work of club of exchange of experience "I studied abroad", a databank of "the program of student's exchange", a training "Twenty one ways how to find the necessary program of student's exchange".

Mastering the lexical and terminological units, didactic and methodical ensuring of the process of formation of the academic mobility of future teachers of a foreign language was the purpose of the second stage – organizational and actionable one. At the organizational and actionable stage such pedagogical condition as a systemic approach to mastering lexical and terminological units, professional knowledge, abilities, skills in the foreign-language environment; creation of didactic and methodical ensuring of the process of formation of the academic mobility of future teachers of a foreign language was realized.

The content of work at the second stage provided Skype conference, a training concerning interviewing for the program of the academic exchange, a round table "Standard legal support of the academic mobility", teaching of the course "Bases of the Economic Theory", psychology and pedagogical disciplines, the mini-lecture "Ways of Obtaining the International Student ID Card", photoreports, competitions of the essay and sketches "Why do I want to study abroad?!", a mini-concert on the subject "I Am a Tolerant Student Migrant".

Improvement of professional skills of future teachers of a foreign language, skills of communicative interaction was the purpose of the third stage – professional and communicative. At this stage such a pedagogical condition as a stimulation at future teachers of a foreign language of steady interest in mastering knowledge of the country in which they study, acquaintance with the history and the culture of this country was realized. The content of work of the third stage provided a fair of programs of student's exchange, a culturological video excursion, the creation of Google-reflexive cards, the use of game elements ("warming-up activity") through the creation of the problem imaginary situations, game exercises for repetition of vocabulary on subjects, a creation of situations of communication, role-playing and business games, educational and training seminars, development of the project "Teacher of the World of the 21st Century", an electronic discussion in the Nicenet system.

At the third stage there was a fair of programs of student's exchange to which the representatives of various companies, which are engaged in the academic transfer of students, have been invited. They have informed future teachers of a foreign language of relevant offers and rules of submission of the documents and passing of allcomers.

Analyzing the specified work form, it was noted that it has allowed to set once again knowledge of staging and pecularities of the process of filling an application by future teachers to take part in the programme of exchange, students have studied rules of representation of appliques on programs and means of optimization of own applications. The managers of the company not only presented their programs, but also showed models of

Table 2. The comparative table of the condition of formation of the academic mobility of future teachers of a foreign language (in %)

Level%	Motivation criterion		Contentive criterion		Operational criterion		Total sum	
	EG	CG	EG	CG	EG	CG	EG	CG
Summative experiment								
Creative	8.4	9.5	10	10	7	8.4	7.2	7.9
Sufficient	10.6	9.2	15.4	14.9	11.2	12.8	10.9	11.3
Average	40.8	37.8	37.3	37.3	46	41.5	40	38.2
Low	40.2	43.5	37.3	37.8	35.8	37.3	41.9	42.6
Control experiment								
Creative	20.3	10	30.3	10	22	10	21.2	8.6
Sufficient	35.8	11.3	38.7	15.5	29.7	14.2	32.6	12.8
Average	36.9	37.8	27.5	38.1	44.2	45.3	40.8	40.4
Low	7	40.9	3.5	36.4	4.1	30.5	5.4	38.2

application affairs. Besides, during the answers to the questions of participants, each of the agencies has lit advantages and shortcomings of programmes that has allowed future teachers to make a right choice.

The stage is extended with a culturological video excursion around the universities of the world during which students have personally seen educational institutions from different sides – lecture halls, material resources, hostels.

The Control Stage of the Experiment

The control stage of the experiment was performed in February, 2017. The purpose of this stage is to carry out the diagnostics of formation of level of the academic mobility of future teachers of English.

To determine the level of formation of the academic mobility of future foreign language teachers in the course of the experiment, the diagnostic assessment was carried out: summative one– the results of which have defined a condition of formation of the academic mobility of future foreign language teachers, intermediate – the dynamics of level of formation of the academic mobility of future teachers of a foreign language were defined during the forming experiment, and control one – to determine the total level of formation of the academic mobility of future teachers of the foreign speech.

The efficiency of the developed model of formation of the academic mobility of future foreign language teachers by means of media education technologies is confirmed by the positive dynamics of development of ways of understanding, introspection of own pedagogical activity in general and formation of desire to participation in programs of the academic exchange, in particular. The important confirmation of effectiveness of the specified model is a dynamics of development of abilities to communicative activity in the foreign-language environment.

At a control investigation phase students were suggested to carry out the tasks similar to the summative stage of the research. In particular, the operational and cognitive criterion was checked by methods of testing and problem-solving situations; communicative competence was assessed by tests, role-playing game; social competenc was evaluated by interviewing and a cards of professional improvement.

In control group there were also positive changes, though less essential ones. The number of students with creative (from 7.9% during the summative stage up to 8.6% during control inspection), sufficient (from 11.3% to 12.8%) and average (from 38.2% to 40.4%) levels of formation of the academic mobility has increased. The number of respondents with low level has decreased moderately: from 42,6% during the summative stage down to 38.2% at the control inspection.

We will analyse a qualitative component of the received results. During the control inspection future teachers of a foreign language appeared to know well the contents of programs of the academic exchange. They could select the appropriate programmes of the academic exchange. At the end of the experiment almost all the students could write their own motivation letter, collect documents for applying for a job, send them according to the established format and load into online system. Besides in a narrow sense of the academic mobility, future teachers have felt aspiration in own professional mastering by means of the academic exchanges and have shown willingness for constant exchange of experience with foreign colleagues.

Table 3. The efficiency of the developed and introduced model is confirmed with methods of mathematical statistics (criterion of independence χ2 Pearson)

№	Empirical frequency	Theoretic frequency	$(f_e - f_t)$	$(f_e - f_t)^2$	$(f_e - f_t)^2/f_t$
1	7.2	14.2	-7	49	3.451
2	21.2	14.2	7	49	3.451
3	10.9	21.75	-10.85	117.72	5.412
4	32.6	21.75	10.85	117.72	5.412
5	40.0	40.4	-0.4	0.16	0.004
6	40.8	40.4	0.4	0.16	0.004
7	41.9	23.65	18.25	333.06	14.083
8	5.4	23.65	-18.25	333.06	14.083
Sums	200	200	-	-	45.9

Differences between two dimensions can be considered as reliable if χ2Emp reaches or exceeds χ20.05 and more reliable if χ2Emp reaches or exceeds χ20.01.

Answer: χ2Emp is one-critical value or exceeds it, disagreements between divisions are statistically reliable (H1 hypothesis).

So, quantitative results have confirmed efficiency of the developed model of formation of the academic mobility of future teachers of a foreign language. At the end of the experiment the number of respondents with the creative and sufficient level of formation of the designated properties has increased, all students of experimental group showed motivation for participation in programmes of the academic exchange, a desire for professional self-improvement and increase the level of pedagogical excellence at the expense of knowledge and abilities received abroad.

DISCUSSIONS

Current trends in the development of language education at the beginning of the 21st century require updating the purposes and the content of training, learning of foreign languages in secondary and higher educational institutions in compliance with internationally-recognized standards. Europeanization of linguistic education as one of the directions of improvement of the national educational system imposes strict requirements to those both who teach and to those who study as they have orientation on training of specialists of new generation, capable to see the world from different angles in the conditions of multilingualism and a polylogue of cultures. At the present stage of development of our society, there is an urgent need to search for and develop essentially new approaches to provide future specialists with professional-oriented training. The academic mobility enriches national cultures, extends educational and professional experience of its participants, represents an essential factor of the system changes through extensive and versatile experience.

Modern educational standards emphasize the necessity of training highly qualified educators who display an appropriate professional level and capability of employing various programmes of the academic mobility of students' contingent. Having identified key features of academic mobility of students and its formation in future foreign language teachers, the research highlights the basic concept of the research "formation of the academic mobility of future teachers of a foreign language" which is subjectively considered by the researcher as the formation of personal qualities which are displayed in the students' readiness to get education in a foreign language environment. From culturological point of view the ability to perceive, respect and value foreign language culture and adapt to foreign language environment is emphasized; as regards the communicative approach, the ability for foreign language communication among students in foreign higher educational establishments is stressed; from the point of view of functional approach, the ability to understand the specific nature of education abroad, their willingness to study one or more semesters in other higher education institution where specialists of philological and linguistic specialities are trained, where disciplines (credits) and periods of education are granted, and also the ability to organize his/her own studying sphere and other spheres of life is of crucial importance.

The specific formation of the above-mentioned phenomenon during professional training of future foreign language training on the basis of comparative analysis of tendencies and levels of the academic mobility development of students in European countries and in Russia, which is from our point of view is defined by the mobility of the pedagogical profession, its continuous development and changes in accordance with national and world tendencies of reformation of higher school, professional pedagogical education, and also the demands towards the competitive specialist at the market of learning services. Specific features of formation of academic mobility of future foreign language teachers have been emphasized: introducing students to linguistic and cultural components; integration of language and information training; formation of communicative competence of future foreign language teachers; readiness for self-education, professional self-development; high level of foreign

language proficiency; high level of knowledge of professional special disciplines; reflection and self-reflection; formation of the sphere of empathy; high common-cultural level of a person.

The criteria and indicators of formation of the academic mobility of future teachers of a foreign language were defined. They are operational and cognitive criteria with the following indicators: knowledge of special disciplines; good speaking and writing skills; communicative competence criterion with the indicators: formation of communicative competence of future foreign language teachers; practical skills for communicative competence in the foreign-language environment; social criterion with indicators: awareness about the academic mobility as a social phenomenon, formation of active living position; readiness for independent creative activity, readiness for foreign-language communication, aspiration for professional self-improvement in the foreign-language environment. On the basis of the defined criteria and indicators the levels of formation of academic mobility of future foreign language teachers have been characterized. They are: creative, sufficient, average and low.

Pedagogical conditions ensuring an efficient formation of academic mobility of future foreign language teachers have been identified. They are the following: creation of common information-education space, which is saturated to maximum with foreign language information; active use of communication resources, means of information and communication technologies, which allow to develop creativity, ability to interact efficiently, capability for adaptation for foreign language education space; introduction of systemic approach to formation of professional knowledge, abilities and activity skills in foreign language environment; stimulation of sustainable interest of future foreign language teachers for acquiring knowledge about the country where they study, studying history and culture of the country the language of which they study.

The model of formation of academic mobility of future foreign language teachers by means of media-education technologies was designed and scientifically approved. Its methodological principles were the following: systemic, competence-based, synergetic, student-oriented approach. The system of the following principles have been highlighted: humanization, viability, self-education, succession, continuity, dialogic communication.

The proposed model was implemented in three levels (motivational-cognitive, organizational-actionable, professional-communicative) and provided the progressive motivation by future teachers for academic migration and the foreign-language communicative skills.

The purpose of this model is to develop such personal qualities that would facilitate students' readiness to pursue education in a foreign educational environment. The outcomes of the model facilitate the academic mobility formation of future foreign language teachers at a creative level. The effectiveness of the model for the academic mobility formation of future foreign language teachers is convincingly confirmed by the statistical proceedings of the research.

The results of the research show a positive trend in terms of the academic mobility level of future foreign language teachers. In the experimental group, there are significant positive changes in the redistribution of academic mobility levels of future foreign language teachers. So the creative level grew from 7.2% during the summative survey to 21.2% during the control experiment. The number of students who have developed a sufficient academic mobility level has significantly increased (from 10.9% in the survey to 32.6% in the control survey).

The number of respondents who were at an average level has slightly increased: from 40% before the beginning of education to 40.8% after graduation. The number of future foreign languages teachers with a low academic mobility level has significantly decreased: from 41.9% with the summative survey to 5.4% in the control test. There were no significant positive changes in the control group.

Further detailed consideration requires to increase motivation for academic mobility and search for effective ways of forming the skills of the communicative foreign language competence of future foreign language teachers, to develop scientific and methodological support for the academic mobility formation, to encourage academic information exchange for future foreign language teachers and also develop the model and practical pedagogical support of linguists during their stay abroad by means of academic exchange.

CONCLUSION

During the research on the formation of academic mobility of future foreign language teachers, a corresponding model was developed, which consisted of three levels and assumed the progressive obtaining of motivation for academic migration and the ability of foreign-language communicative competence by future teachers.

The model for the academic mobility formation of future foreign language teachers by means of media education technologies is based on understanding and using the conception and types of academic mobility, including the purpose, scientific approaches, principles, functions, pedagogical conditions, components, diagnostic criteria, work content, expected result, which creates optimal conditions for obtaining this kind of mobility for student youth.

The structure of the model is flexible and dynamic. It varies and develops in accordance with how the goals of the vocational training of future foreign language teachers are completed enabling us interpret and predict the process productivity of the forming academic mobility.

The research has developed the theoretical and methodological professional training foundations of future foreign language teachers; the peculiarities and perspectives of the professional education development of future foreign language teachers in the context of modern educational trends have been analyzed; the nature and structure of academic mobility of future foreign language teachers and the scientific and methodological approaches to its overall development have been proposed. We have determined the pedagogical conditions that provide the effective academic mobility formation of the future foreign language teachers (the creation of a single information and educational space that is as rich as possible with foreign language information; the active use of communication resources, the possibilities of information and communication technologies that allow developing creative abilities, the ability to interact effectively, the ability to adapt to a foreign educational space, the systemic approach introduction to the formation of professional knowledge, skills and activities in a foreign language environment, stimulating the steady interest of future foreign language teachers in obtaining the knowledge of the country where they study, the historical knowledge and culture of this country).

The materials of this article can be useful for teachers of higher education institutions, future foreign language teachers, future foreign language teachers who are involved in the process of academic mobility formation of future foreign language teachers.

ACKNOWLEDGEMENT

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Video Games as Teaching and Learning Tool for Environmental and Space Design

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ABSTRACT

Video games today have turned into an important commodity with the use of art, design, science-technology and marketing techniques together, and the target audience has constantly evolved their expectations from game producers with the goal of getting huge profits so this technology developed. One of the most important factors of this development is the environment and space design used in the game production process. "Assassin Creed Unity" is a game which is produced by using the technology in the environment and space design at a very good level. The 3-dimensional spaces used in the games, which have been modelled with great success, have recently been associated with real-world examples by directly copying the original spaces. While the player's perception of the environment and space during the game are both auditory and knowledge, which is a result of hand and eye coordination and this acquisition process is also facilitated with the guidance, instructions and directions provided by the game. The story, architectural and graphic elements used in the game made extremely important contributions to the success of the game. This significant impact has been confirmed with a survey conducted with on a number of people that is actively using video game.

Keywords: environment and space design, video games, Assassin Creed Unity, graphic design, interface design

INTRODUCTION

Innovations and facilities that technology has added to our lives are at an undeniable level. Portable, wearable technologies, devices and products, social media applications like Facebook are in every aspect of our lives. Thus, technology-based education and training inevitably entered into our lives. Nowadays, Facebook is one the largest social media applications with over 2 billion users. It is used as a part of education in areas such as statistics and mathematics despite all the obstacles and difficulties (Manca, 2013; Şenyapılı, 1996).

However, as a part of technology education, videogames and similar applications emerged as a popular topic in education today. In studies, the facilities and applications of games for learning as well as the key role of design are beginning to be used effectively (Clark et al., 2016; Kalınkara, 2006).

Interactive environment using a game-based approach can help students have fun while learning as it can be used as a game-based approach. In some studies, it was observed that the students who had fun and learned at the same time performed considerable progress in their learning ability and the persistence of the learned information was found to be more successful than the traditional way of learning (Liu et al., 2014; Ke, 2016; Griffiths, 2002). It seems that videogames have great positive potential in addition to their entertainment value and there has been considerable success when games are designed to address a specific problem or to teach a certain skill (Griffiths, 2002; Brooker & Stone, 2011)

Game-like applications provide training and supportive experiences in different topics. For example, game-like applications and foreign language learning activity were found in the studies of Berns and others. According to the findings of the study, foreign language learning processes showed a positive correlation with graphic designs in video games (Berns et al., 2013; Roth, 2000).

Contribution of this paper to the literature

- This study aims to contribute to a novel understanding of video games in education as it discusses the results of motivation for playing games with other studies. Study also contributes to form and change the limited understanding of the positive results of video games. The narrative language, created by combining the past, present or future environment and space design fiction with the basic rules of cinematography, has taken video games to another dimension today.

Figure 1. Project Ariana (Jenixe Wallpapers, 2007)

In the 21st century, traditional education and teaching processes in the public, private and businesses have begun to disappear, as this type schooling is not sufficient for today's conditions and expectations. Teaching processes have changed in a positive way by graphic designs in video games and so technological innovations have taken a more important role in teaching process (Miller, 2015).

Video games in which concept, character, environment, space, interface designs and computer engineering have realized into a dynamic medium, art, design, science, and marketing techniques used together transformed into a meta. Game producers prefer to use both technology and art and design as a privilege in order to be able to market their products easily and to make great profits. Therefore, design - especially environment and space design - can be the most important distinguishing feature that determines the success of a game in the production process of a game (Huizinga, 2016). The narrative language, created by combining the past, present or future environment and space design fiction with the basic rules of cinematography, has taken video games to another dimension today. The use of cinematography in games has put the design of space and environment foreground by making it the most powerful artistic element that brings out the narrative, story and game fiction to the fore and integrates the player with the game (Green & Kaufman, 2015).

Thanks to the technological development that is reflected in the gaming industry, spaces which are present or not in the real world and are difficult to create, are built by means of 3D software and very high resolutions which is very close to the real world are obtained with images supported by 3D game engines (Bowman et al., 2012; Stevenson, 2003). For this reason, technological developments are regarded as the most important scientific element in the rapidly growing success of the gaming industry. With the influence of science and art in video games, both game producers and game consumers are becoming greedier, leading to the discovery of new technologies. The world's first video projection system designed for video gaming is Project Ariana. With the ultra-wide fish eye lenses and advanced processing features, we can give a video projector that extends as big as room as an example (**Figure 1**).

ENVIRONMENT AND SPACE DESIGN IN VIDEO GAMES

During the game we use multiple sensory organs to locate the items in our environment. This point differs from the perception of the physical structures that exist in the real world and the perception of things in the game. Our senses support only our vision, hearing, and sometimes touching (sensing with vibration on joysticks). According to Arnheim, forms, colours, movements and voices are open to a specific and highly complex organization in terms

Figure 2. A scene from the game of DESTINY (The Wonders of the World, 2017)

Figure 3. The scene in ACU in which the character assault an enemy (Tech 4 Gamers, 2017)

of space and time when the sense of sight and hearing is concerned. Therefore, these two senses, namely, vision and hearing, are the perfect environment for using intelligence (Arnheim, 1997; Nitsche, 2009).

The combination of architectural forms, textures, materials, light and shadow balance, colour in the space and environment designs come together to make people feel the feature or the spirit of the space (Smuts, 2005). These are the atmospheric features that have a place in mind. The atmosphere, which means "the environment in which you live and you get affected" (http://www.tdk.gov.tr), is the most important element that creates the period, the style and the desired feelings in terms of being associated with the story. For example, if a future emulation game is edited as in "DESTINY", the atmosphere has to support the future lifestyle, events and feelings that should be given in the story. This is an unchanging rule from the most complex game to the simplest game (**Figure 2**).

Assassin's Creed Unity (ACU) and Third Person Shooter (TPS) games are highly successful examples of empowering the story with time and space. The TPS game type has a structure that is monitored by controlling the behaviour of the selected character in the game by watching from outside the camera with different camera angles. Looking at the character from the outside leads the player to follow the character. The camera usually looks behind the character. This makes it easier for the player to interact with all of the factors in the surroundings in the game, seeing the commands he gives to the character. For example, in ACU, a strategy for how to intervene and rescue a character from attackers, or the ability to perceive the escape points and make the right decisions can be shown as an example (**Figure 3**) (Saga, 2015).

The wandering around, movement and limitations of the character in the game are directly related to the design of indoor and outdoor spaces. For example, a narrow corridor or walking path makes it difficult for the player to move. The player cannot stand and wait in that area. Yet, a more comfortable and larger space gives players the opportunity to think, stand or look around. According to Ching, the movement route is considered as a perceptual link that connects architectural spaces or interior and exterior spaces. Since we move along the consecutive sequence of places in time, we get experiences related to a place, where we are, or where we are going (Ching, 2002; Walz, 2010).

There are other helpful factors that allow players to experience the space. These are some of the most important elements in Graphic Design that we use in our daily lives, such as warning and direction signs and symbols. Thanks to these, the player is able to perform his actions.

Figure 4. Associating the spaces designed with the real spaces that exist today (Donanım Haber, 2017)

It is seen that the decisions made during the game are directly related to the information obtained as a result of the perception of the space and the environment. If there is no way to walk in the game surrounding and this can only be realized through perception, the information about how to get to the point can be reached by jumping the obstacles (buildings, people, trees, etc.). Sometimes this can be given as a help to the player or the player can be visually assisted with the Graphic Design so it can be perceived. If new events are encountered during the game, decisions can change accordingly. Thus, new actions can be done by reaching new information. These options are often used in all recent games.

When the 3-dimensional designed spaces in the ACU are associated with today's examples, they are modelled with great success by imitating the original spaces (**Figure 4**). It is possible to say that the success of modelling spaces directly and positively influences the success and popularity of game quality.

METHODOLOGY

The basic purpose of the study was to measure whether the story, architectural and graphic elements used in the games have a profound effect on the game players and how much the game contributed to the success of the mission. The presence of such an important influence has been assessed with a survey of 200 people using video games actively. The survey was conducted via Internet using various platforms and participants shared their ideas about space, story, graphic design, etc. used in the games. The gender, age and education of the respondents were given in **Table 1**.

Table 1. Survey participants' profiles

Participants	% percentage	
Gender	Women	8.5
	Men	91.5
Age	20 and under age	62.5
	21-25	14
	26-30	11
	31-35	5.5
	36-40	2.5
	Above 40	4.5
Education	Primary	28
	Secondary	32
	University	28.5
	Post Graduate	11.5
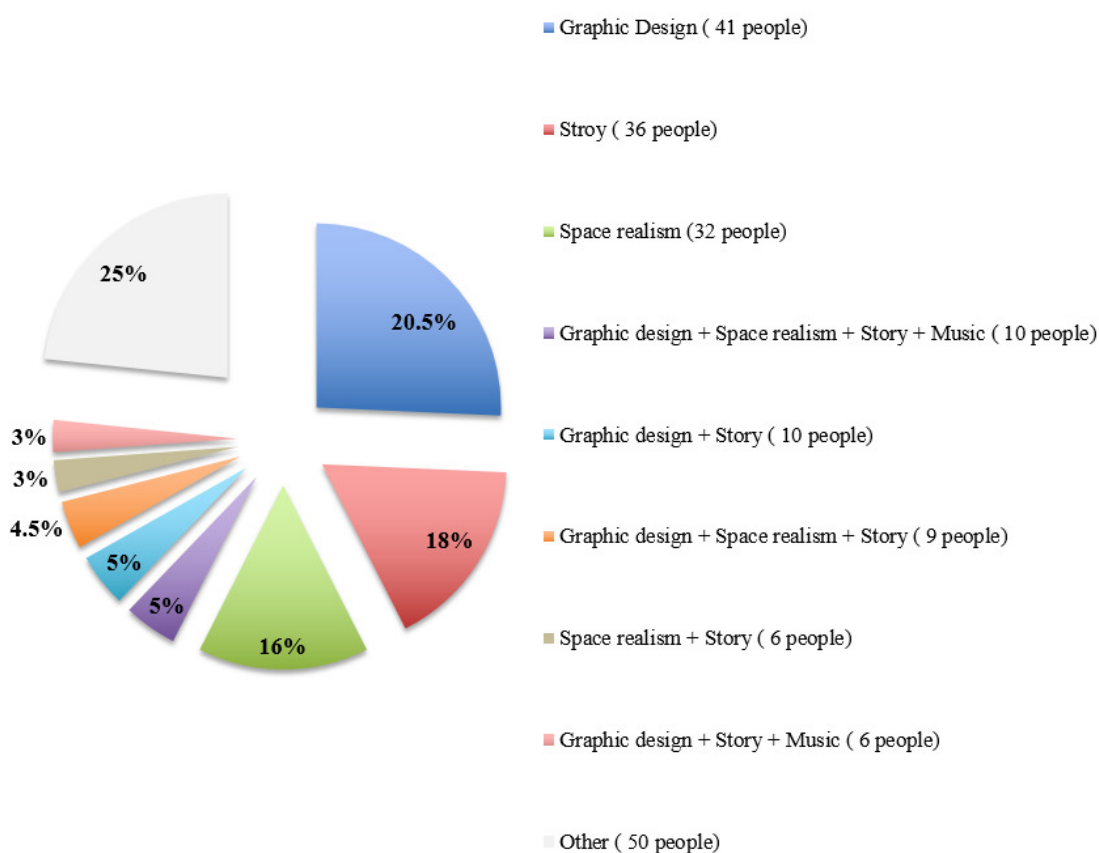
Figure 5. Important components preferred by players

RESULTS

According to the data obtained from the questionnaire, we can see that more men are interested in computer games, the most interested age group is under 20 years, and the number of people who play computer games show a reversed correlation with the education level.

Those who participated in the survey ranked the most important components they prefer in the games they play and this was shown in **Figure 5**. According to this, graphic design is the most important (20.5%), which contributes to the successful blending of storytelling, story (18%) and reality of spaces (16%) followed it respectively. Some participants noted that these components are equally important, not one by one (graphic design + space realism + story). Music is considered as a contributing factor to these components. The "other" group (25%) mentioned factors such as fun, playing style, online mode and thought provoking factors, which were evaluated differently by each participant.

DISCUSSION AND CONCLUSION

It is known that video games help especially children to build basic development skills such as visual patterns, speed and game story. It is known that game players learn and practice basic mathematical skills, reading skills and social skills, and that these skills progress even further as they play. According to Demarest, the language skills gained by video games are discussed and shared, followed by directives (understanding prepositions, etc.), giving directions, answering questions and making a discussion with visual aids to share with others (Gauthier et al., 2015). On the other hand, it is argued that game-based approaches can be effective on learning in all areas, messages that are deepened with graphic designs in school life can be given with a fun and interesting approach (Boyle et al, 2014).

Another study shows that video games play an important role in the development of basic mathematical skills because children learn to interact with the counter on the video. In the same study, the basic reading skills of the learners are shown on the screen ('Play', 'Exit', 'Go', 'Stop', Upload etc.). Besides these, video games develop social skills, as it makes a lot easier to talk and play together by creating a popular common interest with other children. There has always been and will be children who have a passion for playing video games in and out of school Griffiths (2002).

According to the findings of Gauthier et al., the integration of game design provides significant contributions to the context of educational tools and information assessment (Gauthier et al., 2015). These contributions are to the competence in the language, to the areas that require foreign language and in areas that require analytical thinking such as mathematics, and it also plays an effective role on users' social skills and communication skills (The Wonders of the World, 2017). With the expansion and persistence of these important contributions, entertainment should be included in the process in order to live and improve their emotional states and keep them at the top level (Gonzales et al., 2014).

Ruano et al.' s study was based on observations of student activities and learning processes for a long period of time for about 2 years. Ruano and others suggest that the design of video games can be a very effective activity. To demonstrate this, they used the design of the game with a group of subjects attended from Computer Sciences and History. So, for the first time, perhaps for the first time, the interdisciplinary teams collaborated in designing a video game (Fjællingsdal & Klöckner, 2017).

The experiment was repeated for over three academic years. The motivation of the students was evaluated in the last 2 years and the results indicated that the academic success of the students is higher when using the interdisciplinary design of video games as a way of learning instead of traditional learning methods (Ruano et al, 2014).

Besides their significance of teaching and learning, art, design, science and technology are used together with dynamic structures that turn into important products as video/computer games. It should be noted that environment and space designs are one of the important features determining the success of a game. In order to provide these features, it is important to make a contribution to the success of the game, especially when the team working for visual design has been trained in art and design, and has experience and culture with a certain aesthetic understanding, it is more possible and professional. It is important that basic design elements and principles such as colour, toning, foreground and background relation and reflection of formal relations are used in game design together with cinematographic and aesthetic expressions and this can be done better by professionals. A well-designed environment and space help players to perceive easily with his visual and auditory sense organs. As an example, Assassin's Creed Unity game in which the environment and space were realized identically like its real model and at the same time strengthened with story and fiction, can be seen as one of the important factors in the success of the game (The Verge, 2017). In the survey conducted with the people playing video games show that graphic design, story and the reality of the places used are important parameters.

In the study of Arnab and others the main focus was to discuss the description of the designers of serious games, which provide a more systematic aspect of the link between pedagogical principles and game elements. According to the findings of the study SG design has been linked with entertainment game design, particularly in the context of adopted game mechanics. In particular, the study revealed particular strengths of some games that are typical of entertainment games and are also suited for serious and educational games. (Arnab et al., 2015)

Videogame technology brings new challenges to the field of education. Video games are a technique that a classroom teacher can use. However, care must be taken that the use of enthusiastic in this technique does not replace other more effective techniques. Video and computer based games may have advantages not found in other learning strategies. For example, finding different solutions to a difficult problem and seeing those decisions in an imaginary cast will ensure that students have a problem-solving ability in a relatively safe environment (Flood et al., 2015).

Video games, besides being fun with the design by professionals, have a very positive potential. Significant success has been achieved when games are specially designed to produce solutions to a specific problem or to teach

a particular skill. Nonetheless, the generalizability beyond video game playing remains an important research question. Empirical studies in the literature suggest that the adverse consequences of playing games almost always involve people who are overly videogame users (Siegal, 2014).

There is little evidence from pioneering work in this area that moderate games have serious acute adverse effects on health, the adverse effects are relatively insignificant and temporary, presumably effects that are self-resolved, or affect only a small subset of players, with reduced game frequency. The extreme player is the ones most at risk of developing health problems. However, more research is needed in order to have more reliable results (Griffiths, 2002; Tech 4 Gamers, 2017).

RECOMMENDATIONS

Assassin's Creed Unity (ACU) and Third Person Shooter (TPS), Minecraft and similar games are thought to be user-friendly in classroom educational activities and to provide information flow through visual learning. For this reason, a video game can be used very easily in art curricula and for graphic design lessons (Overby & Jones, 2015). Therefore, we believe that the effects of the teaching process of the subject game and other similar games should be evaluated when the basic skills in learning with mathematics are given to the students. Scientists and Educational Technologists have great responsibilities in order to realize this.

"The CHERMUG quantitative and qualitative games (www.chermug.eu) are digital games designed to support students as they learn about research methods and statistics" (Boyle et al., 2014). It is believed that Chimug-like graphic design messaging videogames should be enabled and disseminated. Thus, it can be possible for teachers and lecturers to use them in their class. For this, scientists who are active in technology education have great responsibilities too.

Researchers argue that teachers and parents should make an effort to increase their awareness of the potential positive educational benefits of playing video games. What factors hamper teachers' use of computer and video games in the school should be researched and possible solutions should be proposed. The reasons preventing the purchase of computers and video games should also be researched. In service training should be available to increase the awareness that how video games meet teachers' present goals and their place in learning and teaching knowledge. On the other hand, relatively few researches in the field of game-based learning included teachers (Ketelhut & Schifter, 2011. Even this number is increasing which shows that game based learning has an increasing momentum and has a great place in education, more researches should be done including teachers and lecturers.

For many, researchers and policy makers lack in policy-making according to the potential of educational games. In addition, the practical skills of selecting and implementing video games in the classroom environment need to be improved. Research-based awareness in the articles of Turkay et al., and the discussion of the factors that would facilitate understanding of selecting and using video games have started to fulfil the needs in this field. Some basic design elements in an educational video game are discussed in the same article, it was concluded that educational games can be conceptualized from different theoretical perspectives on learning (Turkay et al 2014). Video games for education should be designed in the light of these discussions and continuous renewal should be provided. Also, educators should make policy decisions according to the literature review results and contribute to the findings of current studies so that development can be ensured.

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A Cross-cultural Comparison on Students' Perceptions towards Online Learning

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ABSTRACT

The aim of this study was to explore cross-country (Taiwan versus India) differences in students' perceptions of online leaning by gender. The self-reported instrument, POSTOL (Perception of Students towards Online Learning), was conducted to the students from Taiwan and India. Of the total 441 respondents, there were 233 students from India and 208 from Taiwan. A 2x2 between-subjects multivariate analysis of variance was employed on the four dimensions of the POSTOL scale. This scale consists of four dimensions: instructor characteristics, social presence, instructional design, and trust. Results showed that there were significant differences, between India and Taiwan, in the perception of students towards online learning. However, there was no significant interaction effect of country by gender. Findings indicated that culture did influence students' perceptions towards online learning. There is a need to raise awareness about factors that may affect online learning experience and to provide guidance and for practice and future work.

Keywords: cross-country, gender, online learning, perception

INTRODUCTION

The portrait of online learning has moved beyond students operating through Internet-connected desktops or laptops. A new generation of technology, including Smartphones and handheld devices are today's "learning hubs". The current online learning experience exploits information on the go for the sharing and exchanging ideas, without spatial barriers (Wong, 2012). The number of online course providers and number of participants are increasing exponentially (Barak et al., 2016). Some participants in online courses are from the different cultural and linguist background (Loizzo & Ertmer, 2016; Wang, 2007). This draws the attention of many educators and researchers towards online learning.

Currently, many studies have been conducted in the area of online learning. Recent studies focused on students' course satisfaction (Lee et al., 2011), learning outcome (Horzum et al., 2014; Joo et al., 2015; Lee et al., 2011; Wang et al., 2013; You, 2016), motivation (Barak et al., 2016; Chen & Jang, 2010; de Barba et al., 2016; Joo et al., 2015; Kim et al., 2015), engagement (Barak et al., 2016; Kim et al., 2015), instructional design (Joo et al., 2015), gender differences (Ashong & Commander, 2012; Cheng et al., 2012; Kupczynski et al., 2014) and social interaction (Eryilmaz et al., 2013; Joksimović et al., 2015; Xie et al., 2013). Loizzo and Ertmer (2016) mentioned understanding the specific perceptions and experiences of online learners from different countries are important research areas. Therefore, the present study focused on cross-country differences in gender and students' perceptions towards online learning.

THEORETICAL BACKGROUND

In this study, Vygotsky's (1978) sociocultural theory is applied to understand students' perceptions towards online learning across different cultures. According to the socio-cultural theory, learning is a social process and is composed of three important themes: culture, language, and the "zone of proximal development." "Zone of

Contribution of this paper to the literature

- This study contributes to the existing literature by showing that the perceptions of the students towards online learning differ in the cross-cultural context.
- In addition, no study previously has investigated the students' perceptions in relation to the combined effects of country and gender.
- Cross-cultural differences have major influence on students' perceptions towards online learning. Instructional designers should apply socio-cultural theory to take into account the effect of diverse cultural background on the learner's learning behavior to enhance learning effectiveness.

proximal development" is not the central concept discussed in this study; we concentrated on the effects of culture and language to understand online learning environments. Many research studies advocated the importance of language and culture. For example, according to Mercer (2000), "Language is a tool for carrying out joint intellectual activity, a distinctive human inheritance designed to serve the practical and social needs of individuals and communities and which each child has to learn to use effectively" (p.1). Delahunty et al. (2014) describe social interaction as an important component for knowledge building process in online learning. According to (Vygotsky), learning occurs at two levels:

First, through interaction with others, and then integrated into the individual's mental structure. Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher functions originate as actual relationships between individuals (Vygotsky, 1978, p.57).

Language plays a significant role in terms of learner's motivation, interaction and engagement in online learning environment (Barak et al., 2016; Mercer, 2000). However, language is one of the main barriers for the students who want to enroll in online courses from developing countries (Altbach, 2014; Kerr, 2014; Olesova et al., 2011; Osman & Herring, 2007). Participants are required to have some basic competencies, specifically digital literacy and a good level of English proficiency. If an institution offers a MOOC, it is probably in English, which is presently the international *lingua franca*. English is the native language for around 400 million people. Therefore, it still leaves around 70% of the world's total population who are unable to access the educational content published in English (Wikipedia, 2016).

Some researchers also advocate the importance of culture in online learning environment. "Culture is a set of parameters of collectives that differentiate the collectives from each other in meaningful ways. Culture is variously defined in terms of several commonly shared processes: shared ways of thinking, feeling, and reacting; shared meanings of identities; shared socially constructed environments; common ways in which technologies are used; and commonly experienced events, including the history, language, and religion of their members" (House et al., 2004, p.15). Ordóñez (2014) highlights the impact of culture in online learning and suggests instructional designers and instructor to consider culture during course development. According to McLoughlin (1999), "Culture and learning are interwoven and inseparable" (p.232). In addition, culture and language have a closed relationship. Language is an important element of cross-cultural communication that needs to be considered (Gunawardena et al., 2001). "The cyclical nature of the relationship between culture and language suggests that no complete understanding of culture can be obtained without understanding language and vice-versa" (Matsumoto, 1996, p. 266).

Barberà et al. (2014) raised an important issue that present day e-learning has expanded, and the scope for sharing academic courses between countries has increased. However, whether a course designed for the learners of a specific country for a specific discipline will be relevant to the learners of the same discipline in another country has not yet been determined. Recent literature suggests that culture plays an important role in online learning (Milheim, 2014). Some of the researchers have included culture as a dimension in their study. For example, Gunawardena et al. (2001) conducted a cross-cultural study to examine students' perceptions towards online group process and development. They found that culture influences participant's online learning behavior in terms of collectivism and context communication. Bates (2001) also concluded that culture differences influence the online teaching-learning process in terms of students' willingness to participate in the online discussion forum. Some researchers found that cultural differences create barriers in students' communication and social-interaction which affect learner's overall learning performance, motivation, and satisfaction in online learning (Hamdan, 2014; Kerr, 2014; Olaniran, 2009; Uzuner, 2009). On the other hand, some researchers advocated that students in online learning can be benefited by the international exposure and exchange of ideas among the students from different cultural backgrounds. This type of learning environments will develop and inculcate social learning and thinking of the participants (Gemmell et al., 2015; Stewart, 2004). Kim and Bonk (2002) investigated cross-cultural differences between U.S. and Finland, in online collaborative learning behavior, and found significant differences. Lim (2004)

conducted a cross-cultural study to examine differences and similarities in learner's motivation in online learning between Korea and U.S. and also how cultural differences and learner's characteristics and culture affect the learning motivation of online learners. The researcher suggested that identification of learning strategy better suited for learning environment with cross-cultural differences should be the priority for the instructors and instructional designers. In another study, Zhu (2012) investigated the cultural differences between Flemish and Chinese students in online learning with respect to students' satisfaction and performance. The results revealed significant differences in students' satisfaction and academic achievement across the culture. Yang et al. (2014) found that culture plays an influencing factor in learning online. Students were interested and very positive to know other participants' cultures and backgrounds.

Previous research studies have investigated the effects of gender differences in online learning. For example, the study conducted by González-Gómez et al. (2012) revealed that females were more satisfied in e-learning environment than males. Nistor (2013) investigated the impact of gender differences in university students' attitude and participation in online courses. They found no significance difference between male's and female's attitude towards online courses. However, there was significant differences in terms of participation. Female students were more participative compared to the male students. Kimbrough et al. (2013) examined the gender differences in mediated communication. The results revealed that women used text messaging, social media, and online video calls more frequently as compared to men. In another study by Song et al. (2015), results indicated no significant gender differences in online collaboration. Liu and Young (2017) found significant gender differences in terms of learning achievement and motivation in an online community-based English reading contest.

The above literature reviews of online learning indicate that studies related to gender differences in online learning are few and findings reported are mixed and inconsistent. As a result, it remains unanswered whether there are any gender differences exist in students' perception towards online learning across different culture.

Issues and Research Questions

From the above literature review, we can draw two conclusions. First, although previous studies have focused on cross-cultural differences in online learning motivation (Lim, 2004), satisfaction, performance and knowledge construction (Zhu, 2012) and online collaboration (Kim & Bonk, 2002), so far no researchers has compared students' perception towards online learning across countries. Second, those studies do not look at gender differences across cultures, although gender differences are treated in many non-Western educational systems. The present study endeavors to fill part of the research gap by focusing on two countries in Asia with very different cultures and historical treatment of women – namely, India and Taiwan. Hence, two objectives guide this study:

1. To examine whether there are any significant differences in the student's perceptions towards online learning between India and Taiwan.
2. To explore whether there are any significant gender differences between India and Taiwan in the student's perceptions towards online learning.

METHOD

Sample and Data Collection

Indian sample

The sample was collected from different parts India using convenience sampling method. The participants only who had online learning experience responded using Google Online survey via student forums. Of the total 233 Indian students who participated in the study, there were 189 (81.1%) males and 44 (18.8%) females. Participants' ages ranged from 17 to 43 years old with a mean of 21.15 years (*SD*=3.5). In terms of the educational background, 180 (77.2%) were undergraduate, 37 (15.8%) were masters, and 16(6.8%) were Ph.D. students. **Table 1** shows the demographic statistics of the participants.

Table 1. Demographic information of the participants

Measure	Category	Indian sample (n=233) Number	Taiwanese sample (n=208) Number
Gender	Female	44	112
	Male	189	96
Age(years)	16-20	133	38
	21-25	75	102
	26-30	19	27
	31 and above	6	40
Education	Undergraduate	180	96
	Master	37	95
	Ph.D.	16	17
No of smartphone users	Yes	135	187
	No	98	21
No of Facebook users	Yes	221	205
	No	12	03
Frequency of daily Internet use	Frequently(>5 hours)	62	123
	Normally(3-4 hours)	51	69
	Occasionally (1-2 hours)	100	15
	Rarely (<1 hours)	20	01

Taiwanese sample

The sample of Taiwanese participants from different parts of Taiwan was collected using the similar method via BBS (Bulletin Board System). Of the total Taiwanese 208 students, there were 96 (46.1%) males and 112 (53.8%) were females. Participants' ages ranged from 18 to 49 years old with a mean of 25.35 years (*SD*=6.55). In terms of the educational background, 96 (46.1%) were undergraduate, 95 (45.6%) were masters, and 17 (8.1%) were Ph.D. students.

Instrument

We employed the POSTOL instrument developed by Bhagat et al. (2016) and six items for demographic information. The POSTOL instrument is a 5-point Likert-type scale, which contains 16 items. The POSTOL instrument has four dimensions: *instructor characteristics* (5 items), *social presence* (5 items), *instructional design* (3 items), and *trust* (3 items). Bhagat et al. (2016) reported the psychometric properties of the POSTOL. Results showed that POSTOL is a reliable and valid to use. In the present study, internal consistency reliability coefficients of the four dimensions ranged between .70 to .89 for the Indian sample and .72 to .92 for the Taiwanese sample (see **Table 3**).

Data Analysis

To examine the normality of the data, skewness and kurtosis values were inspected. The skewness and kurtosis values are within the recommended values |3| and |10| for both the Indian and Taiwanese sample respectively (Kline, 2005). This proved the normality of the data. Box's M statistics was employed to examine the homogeneity of variances and was found to be 58.88 (*F*=1.91, *p*>.001). Correlation analyses and multivariate analysis of variance (MANOVA) were used to analyze the data obtained.

RESULTS

Means and standard deviations of the POSTOL subscales for Indian and Taiwanese males and females are shown in **Table 2**. For Indian sample, the highest mean was on trust subscale and the lowest mean was on instructor characteristics for both males and females. Similar results were found for the Taiwanese sample also.

Table 2. Descriptive statistics for POSTOL subscale scores on a 5-point scale

Dependent variables	Indian sample (n=233)						Taiwanese sample (n=208)					
	Gender						Gender					
	Male (n=189)			Female (n=44)			Male (n=96)			Female (n=112)		
	Mean	Skewness	Kurtosis	Mean	Skewness	Kurtosis	Mean	Skewness	Kurtosis	Mean	Skewness	Kurtosis
Instructor characteristics	1.72 (.90)	1.56	2.133	1.69 (.91)	1.28	.821	1.94 (.77)	1.22	1.65	1.84 (.81)	1.45	2.54
Social presence	1.93 (.86)	1.25	1.59	1.92 (.83)	.82	.206	2.05 (.77)	1.17	1.505	2.15 (.69)	.724	1.35
Instructional design	1.89 (.88)	1.08	.535	1.87 (.90)	1.251	.555	2.16 (.73)	.83	.707	2.24 (.75)	.646	.288
Trust	2.53 (.96)	.30	-.373	2.55 (.79)	.044	-.481	2.67 (.84)	.012	-.266	2.84 (.57)	-.298	.06

Note. Values enclosed in parentheses represent standard deviations

Table 3. Intercorrelations and internal consistency coefficients on the POSTOL subscale scores for the Indian and Taiwanese samples

Variables	Variables			
	1.	2.	3.	4.
1. Instructor characteristics				
2. Social presence	.775*(.603*)			
3. Instructional design	.697*(.509*)	.738*(.587*)		
4. Trust	.352*(.113)	.552*(.391*)	.466*(.231*)	
Internal consistency coefficients	.899(.920)	.854(.90)	.703(.727)	.706(.732)

*p<.01

Note. The correlation coefficients outside of parentheses belong to the Indian sample whereas values inside parentheses belong to the Taiwanese sample

Table 4. MANOVA results

Dependent Variable	Country			Gender			Country x Gender		
	F	Sig.	η^2	F	Sig.	η^2	F	Sig.	η^2
Instructor characteristics	14.16	.000	.03	1.06	.30	.002	.09	.76	.000
Social presence	9.48	.002	.02	.55	.45	.001	.90	.34	.002
Instructional design	30.12	.000	.06	.22	.63	.001	.01	.89	.000
Trust	8.41	.004	.02	1.98	.16	.005	1.81	.17	.004

Intercorrelations on the POSTOL subscales for the Indian and Taiwanese sample are shown in **Table 3**. In both the Indian and Taiwanese samples, the highest intercorrelation was between the instructor characteristics and social presence (r=.775 and r=.603 respectively). The lowest intercorrelation for the Indian sample was between the instructor characteristics and trust (r=.352) and between the instructional design and trust in the Taiwanese sample (r=.231).

MANOVA was used to examine the effects of the two independent variables (i.e., country and gender) and four dependent variables (i.e., instructor characteristics, social presence, instructional design, and trust), which were obtained by POSTOL. In addition, interaction effect of the two groups on the dependent variables was also investigated. As reported in **Table 4**, there was a significant effect of the country on students' perceptions towards online learning, Wilk's Λ =.905, F=11.40, p<.05, η^2=.09, showing a large effect. There was no significant effect of the gender on students' perceptions towards online learning: Wilk's Λ =.983, F=1.88, p>.05, η^2=.01. Interaction effects on students' perceptions were also not significant: Wilk's Λ =.985, F=1.67, p>.05, η^2=.01.

DISCUSSION AND CONCLUSIONS

Over the last decade, research in online learning has been growing exponentially due to the current advancements of information and communication technology in the education sector. Culture and language have long been found influencing factors in online learning (Barak et al., 2016; Ordóñez, 2014). Even though motivation, satisfaction, academic achievement, and instructional design have long studied, no studies have investigated students' perceptions towards online learning in the cross-cultural context. Therefore, the present study guided by socio-cultural theory, attempted to examine the differences in students' perceptions towards online learning in terms of gender and country.

An interesting similarity between the two samples was, in both Indian and Taiwanese samples and for both males and females; the highest mean was on trust. These results suggest that building trust in online learning platform should be the first priority for the course providers. This can influence students' participation in online learning and motivate them to complete the course. All the samples scored lowest on instructor characteristics. A possible reason for this result is that the students do not have the opportunity to interact with the instructor face to face.

When intercorrelations were examined, the highest correlation was between the instructor characteristics and social presence in both groups. These two variables shared 60% and 36% of variability in the Indian and Taiwanese samples, respectively. These results indicate that social presence could be an essential element for the instructors to be included in order to create an effective online learning environment to enhance and improve students' academic performance. Instructors should provide more opportunities for interaction, which can construct social presence.

The statistical results of this study showed significant differences between the Indian samples and Taiwanese samples across the fours dimensions (i.e. instructor characteristics, social presence, instructional design, and trust). India is known for multiculturalism in terms demographic, linguistic, religion and social (Bhattacharyya, 2003; Khandelwal et al., 2004). Currently, people speak in 780 different languages in India. But, English and Hindi are the official languages. On the other hand, Taiwan is a relatively monoculture country (Prowse, 2015). Taiwanese Hokkien is spoken by the majority of the population and Mandarin Chinese is used as official language. When the descriptive statistics were examined between the Indian sample and Taiwanese sample, demographic differences were found among the number of smart phone users, number of Facebook users, and frequency of daily Internet use. These results revealed that Taiwan has a better infrastructure for technology than India for providing online learning. Our results are consistent with the studies that indicated that culture and language play an influential role in online learning environment (Barak et al., 2016; Bates, 2001; Gunawardena et al., 2001; Mercer, 2000). The results of this study are also consistent with the study by Lim (2004) that highlight importance of cross-cultural settings in online learning. This study contributes to the existing literature by showing that the perceptions of the students towards online learning differ in the cross-cultural context. In addition, no study previously has investigated the students' perceptions in relation to the combined effect effects of country and gender. The results did not show a significant main effect for gender or an interaction effect between gender and country.

The discussion above leads to the conclusion that to promote active engagement of the learners and delivery of meaningful learning at a global level platform like MOOCs (Massive Open Online Courses), it is very important for the instructional designers to understand student's perceptions towards online learning in different cultural settings. Cross-cultural differences have major influence on students' perceptions towards online learning. Instructional designers should apply socio-cultural theory to take into account the effect of diverse cultural background on the learner's learning behavior to enhance learning effectiveness. Instructors and course designers need to be aware of the cultural diversity among the participants and provide more opportunities for peer to peer and instructor to peer interaction in order to solve the challenge of creating social presence. Instructors should be very careful while assigning the students from different cultural backgrounds to the same group assessment/tasks.

LIMITATIONS AND FUTURE DIRECTIONS

Our study has not violated any multivariate assumptions, but still there are some limitations, which need to be considered. First, finding the equivalent sample for comparison was the greatest challenge for us. There may be differences in the participants' socio-economic status or education system from India and Taiwan. Heterogeneity of the participants was difficult to match. Second, the effect of rural-urban digital divides was not considered. Third, we used convenience sample method for data collection, which may hinder the generalization of the results. Future studies should collect qualitative data (i.e. individual interviews, direct observations, etc.). Our study has included only two countries, which are from Asia. Including more countries from different cultural backgrounds will help to generalize the results obtained. Therefore, it is highly recommended to include Western countries for future studies to compare with Eastern countries.

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Knowledge, Attitudes and Behaviours towards the Environmental Issues: Case of Northern Cyprus

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ABSTRACT

The study aims to investigate the knowledge of students as well as the relationship between attitudes and behaviour also based on gender towards the environmental issues. For this purpose, a survey study was conducted using a group of students who are the eighth grade students at a secondary school in the North Cyprus. This study was performed in the second half term in the 2016-2017 academic year. In the study, the research data was gathered with "Environmental Knowledge Test", "Environmental Attitude Scale" and "Environmental Behaviour Scale" developed by Cömert (2011). Furthermore, in the analysis of data, the descriptive statistics, independent t-test and correlation analysis were used. According to the results, the majority of the eighth grade students have misconceptions and a lack of knowledge about the environmental issues. Additionally, we concluded that environmental knowledge, attitudes and behaviours of participants have not a significant difference based on the gender. The results revealed that the environmental knowledge of students and environmental attitudes have a moderately positive relationship.

Keywords: enviromental attitudes, environmental behaviours, environmental education, environmental knowledge

INTRODUCTION

Environment is the platform where humans and other living things interactively carry on their all biological, chemical, social, economic and cultural activities (Yıldız et al., 2008). Also, environment is comprised of all of the physical, biological, chemical and social elements that can be directly or indirectly influenced the organisms (Yücel, 1999). Unfortunately, the environment is destroyed in parallel with the rapid development of the industry by consumption of natural resources for raw materials and there is an increase in production waste and unconscious human activities (Seçgin et al., 2010).

With the improvement of living standards, many conditions are changing in our environment because of the substantive development of science and technology. If the environmental problems that arise in this way are not prevented, it will be the end of life on earth (Yılmaz et al., 2002). The most important threat on environment is the environmental problems such as; the decrease in energy resources, agricultural issues, desertification, aridity, reduction of forest areas, disappearance of living species, air pollution, water pollution, land pollution, global warming, greenhouse effect, ozone layer depletion, acid rain, nuclear pollution (Görmez, 2003; Hayta, 2006; Yardımcı & Kılıç, 2010). Both state and individuals have the responsibility in the formation and prevention of environmental problems (Ünal et al., 2001).

The main purpose of environmental education is to raise environmental awareness by increasing environmental conscience and to create pro-environmental behaviour (Başal, 2003; Mangas et al., 1997). It has an important role to educate students consciously and sensitively about the environment to find a permanent solution to the environmental problems (Uzun & Sağlam, 2006). Teachers and students as the basic elements of the education system are needed to be informed for the purpose of the protection of environment with favourable developments

Contribution of this paper to the literature

- The purpose of the present study was to investigate the knowledge of students and the relationship between attitudes and behaviour towards the environmental issues based on the gender for eighth grade students in the North Cyprus.
- In this study, we have shown that the environmental knowledge, attitude and behaviour of eighth grade students in secondary education were not sufficient in the North Cyprus. Environmental knowledge has moderate relation with the environmental attitude.
- The findings reveal that the environmental attitude has moderate relationship with the environmental knowledge and behaviour. Besides of this, it's found that gender neither effective variable on the environmental knowledge attitude nor behaviour.

in the attitudes and the behaviours of individuals towards to the environment (Ünal et al., 2001). Awareness about their responsibilities of individuals are particularly important because individuals have influential to the emergence of environmental problems. The level of education which most efficiently for individuals belong the environmental education is the secondary education (Sama, 2003). So the purpose of the present study was to investigate the knowledge of students and the relationship between attitudes and behaviour towards the environmental issues based on the gender for eighth grade students in the North Cyprus.

Researchers show that students have conceptual misconceptions about important environmental issues such as global warming, ozone depletion and acid rain. For instance, Boyes et al. (1993) had found that from fifth grade to tenth grade, students had misconceptions about the greenhouse effect, ozone depletion, reduction of biological diversity, air and water pollution, nuclear power. It was also stated by Boyes and colleagues that students also had difficulty in establishing relationships between these environmental issues. In another study conducted by Groves and Pugh (1999) extended the study of Boyes et al. and worked with students from different departments such as education, pharmacy, science and fine arts. It has been reported that the results support the work of Boyes et al. and also found that the primary education is the effective factor on the misconceptions through the environmental issues. In a research conducted by Andersson and Wallin (2000) which is about to determinate the knowledge and the conceptual misconceptions of grade ninth and twelfth students regarding environmental and natural resources performed with open-ended questions. According to the results despite students could not completely explain the greenhouse effect and related concepts; they were aware of the ozon layer depletion was a result of human activities. In order to determine the conceptual misconceptions about global warming and climate change issues Shepardson and his colleagues (2009), performed open-ended questions, drawings and assessment tools for seventh grade students. Similar to previous studies, it has been determined that students have conceptual misconceptions about global warming, climate change, especially greenhouse effect and it's relationship with global warming. Boyes and Stanisstreet (1997) reported that the most of the 13 and 14 years old students think that holes in the ozone layer cause the greenhouse effect rather than thinking that the greenhouse effect causes ozone layer damage. Similarly, pursuant to the literature review, students believe that the ozone layer depletion was the main cause of global warming (Meadows & Wiesenmayer, 1999; Rye et al.,1997). According to the study results of Çelikler and Aksans (2014) which aimed to analyse pre-service science teachers' knowledge and misconceptions about greenhouse effect by using drawing and writing; they reported that pre-service teachers had inadequate knowledge and misconceptions about the greenhouse effect. However, Cömert (2011) reported that some of the students from seventh grade had misconceptions about acid rains, ozone layer and greenhouse effect at low levels. Jeffreis et al. (2001) investigated consequences, causes and cures of the greenhouse effect with biology students and compare the results with their studies from 10 years ago. They found that many of students were unaware of the potential effect of global warming on the distribution of crop pests, or that ground level ozone acts as a greenhouse gas. Also, results reveal that students had misconceptions such as global warming was caused because of the increased penetration of solar radiation which was connected with holes in the ozone layer; as a result of this the risk of skin cancer increased and can be reduced by using unleaded petrol. They stated that despite of media publicity and inclusion of the issue of global warming in the formal curriculum, the results were not better than the study which had done before. Sargın et al. (2016), reveals that participants could answer the questions about the environment which were general and not detailed correctly but at exhaustive questions could not.

Most educational interventions depend on the knowledge transfer because knowledge has an essential effect on the behaviour of persons (Frick et al., 2004). Improving of environmental knowledge which is necessary as a requirement to ecological behaviour, viewed as basic component of the environmental education (Otto & Pensini, 2017). Bradley et al. (1999), found significant correlation between the environmental knowledge and attitudes of high school students.

Vicente-Molina et al. (2013) reported that while knowledge influences pro-environmental behaviour, attitude and informal education were not relevant variables among the university students from countries with different

levels of economic development such as; USA, Spain, Mexico and Brazil. Kose (2010), concluded that in contrast with the attitudes of secondary school students, the knowledge, environmental protection behaviour of their family, settlement area where they lived for the longest time; gender and level of education of their family was not influential. Akış (2011), reported a survey model study about environmental knowledge in the North Cyprus. According to the results, there were no statistically significant relationship between environmental knowledge and the variables such as age, level of education, area of residency, nationality and gender. However, Şafaklı (2012) studied about environmental attitudes in the North Cyprus and results reveal that respondents had pro-environmental attitude although environmental education and the participation in environmental groups are not efficient. Gunduz et al. (2017), performed a study to determinate the level of environmental citizenship of primary school students in the North Cyprus. Besides of these studies, there is not any study about environmental knowledge, attitudes and behaviours for the primary, secondary school or university students in North Cyprus.

Taking all these into consideration, almost no studies are analysing the environmental knowledge, behaviours or attitudes of students in the North Cyprus. Moreover, the determination of the knowledge of students and the relationship between attitudes and behaviour towards the environmental issues makes significant contributions to the literature in relation with the environmental education.

Purpose

The research aims to investigate the knowledge of students, the relationship between attitudes and behaviour based on gender towards the environmental issues. We focused on the research questions as follows:

- What is the level of knowledge about the environmental issues for eighth grade students who were educated in the North Cyprus?
- Is there any significant difference between attitudes, behaviour and knowledge about environmental issues for eighth grade students?
- Is there any significant difference between the environmental knowledge, attitude and behaviour of eighth grade students based on gender?

METHOD

The correlational survey method was used in this research The sample of the study consisted of 145 eighth grade students from a public school in the North Cyprus during the second half term of 2016-2017 semester. In the present study, the school was selected conveniently. All students have nearly same curricula and have taken the Science and Technology courses.

In North Cyprus, environmental education has started with forth grade students at primary education level. The Science and Technology curriculum aims to develop students with prerequisite skills for their future learning (MEB, 2016). At secondary education; sixth, seventh and eighth grades students have Science and Technology Couse which include several topics about the environmental issues. For the Science and Technology Course for the eighth grade students, the education manual has been written by Ünver (2014) and contain topics which through the environmental issues, such as renewable and unrenewable energy resources, acid rains, the chemicals which contaminating the land, water and air, water pollution, air pollution and land pollution.

Instruments

Environmental knowledge test

The knowledge test developed by Cömert (2011), was used to determinate the level of knowledge about environmental problems and their effects on students. The knowledge test consisted 23 multiple choice questions and reliability coefficient was found as 0.75. Distribution of the questions based on the environmental topics shows that a question for each was about air pollution and nuclear contamination, eight questions about the global warming and greenhouse effect, three each question about the acid rain, ozone layer and water pollution and four questions about land pollution.

The environmental test questions aim to determinate the knowledge level students under their Science and Technology curriculum. Two example of the questions have shown below:

1) Which of the following gases given below effects global warming more?
   a) The gases emitted from garbage heaps to the atmosphere
   b) The gases formed by burning of fossil fuels such as coal and petroleum *
   c) The gases which released during the respiration of living things

Table 1. Descriptive statistics for environmental knowledge of eighth grade students

Environmental knowledge range of scores	Number of students	Percentage of students
0-7	66	45.5
8-15	71	49.0
16-23	8	5.5

Table 2. Correlation analysis results related to the relationship between environmental knowledge, environmental attitude and environmental behavior scores

		Correlation Coefficient		
		Environmental knowledge	Environmental attitude	Environmental behaviour
Environmental knowledged	Pearson Correlation Sig. (2-tailed)	1.00	0.46[*]	0.21[**]
Environmenlal attitude	Pearson Correlation Sig. (2-tailed)	0.46	1.00	0.40
Environmental behaviour	Pearson Correlation Sig. (2-tailed)	0.21	0.40	1.00

[*]Correlation is significant between knowledge and attitude at the 0.01 level (2-tailed).
[**] Correlation is significant between knowledge and behaviour at the 0.05 level (2-tailed).

    d) The gases which used as a cooler in refrigerators and air conditions

2) "Did you know that it must take millions of years for a certain amount of soil to form in our school garden?"

    Which of the following below is not one of the precaution to reduce soil pollution?

    a) Popularize the organic agriculture

    b) Be conscious in fertiliser use

    c) Prevention irrigation without treatment of waste water

    d) Dissemination of agricultural pesticides *

The correct answers stated with *

Environmental attitude scale

The environmental attitudes measured through the questionnaire which was prepared by Cömert (2011), consisted of four-point Likert type 32 items. 18 items were in positive and 14 items were in negative meaning. Negatively worded items were scored in the reverse order. The reliability of the scale was high and Cronbach alpha coefficients calculated as a 0.85. The scale contains 3 sub-factors. First sub-factor consist of 9 items which explain the requests of students to be informed about the environment; second sub-factor consist of 16 items which explain the environmental awareness; and third one consist of 7 items which declaratory the desire to participate in environmental activities.

Environmental behavior scale

The Environmental Behavior Scale which prepared by Cömert (2011), used for data collection. The Environmental Behaviour Scale represents a popular format for a four-point Likert-type scale that consists in respondents can be asked to write down X in one the box between four possible responses: Strongly agree, Agree, Disagree, and Strongly disagree. The scale consisted of 22 items were in positive and 3 items were in negative meaning. Totaly there were 25 items and 3 sub-factors covering the Environmental Behaviour Scale: 10 items (1, 5, 6, 9, 12, 13, 14, 16, 18, 19, 22) to determinate the knowledge of students in explaining the level of behaviours; 9 items (2, 3, 4, 7, 8, 20, 21, 24, 25) to describe the level of informing of entourage; 6 items (10, 11, 15, 16, 17, 23) to explain their support to recycling.

Findings

Descriptive statistics related to the first research question of the study have shown in **Table 1**.

We classified the students in three groups belong the possible range scores for the environmental knowledge test. Distribution of scores for the Environmental Knowledge Test (**Table 1**) shown that only 5% of students get high score from the environmental knowledge test. Almost half of the students, approximately 49%, had an average score from the test.

In terms of the second research question, the correlation analysis was used to determinate the relationships between environmental knowledge, attitude and behaviour (**Table 2**).

Table 3. Classification of students based on gender

Gender	Frequency	Percent
Female	66	45.5
Male	79	54.5

Table 4. Independent t-test results related to comparison of the scores based on gender

Environmental Knowledge						
Gender	N	Mean	S	Sd	T	P
Female	66	8.80	3.72	143	0.39	0.69
Male	79	8.56	3.75			
Environmental attitude						
Female	66	94.89	14.51	143	1.53	0.13
Male	79	91.47	12.29			
Environmental behavior						
Female	66	63.65	10.57	143	0.34	0.74
Male	79	63.03	11.69			

We found statistically positive correlations between the environmental knowledge, attitude and behaviour of students. If the correlation coefficient is 1, the relationship between that variables is perfect; if the correlation coefficient is 0; there is no relationship. Explication of the correlation coefficient depends on its magnitude; if the absolute value of the correlation coefficient is between 0.70-1.00, the relationship is high; 0.70-0.30 is moderate; 0.30-0.00 is week (Büyüköztürk, 2017). The environmental knowledge did not have a higher correlation with environmental behaviour (r=0.21) than with environmental attitudes (r=0.46). However, environmental behaviour which responsible with the environmental behaviour, had a significantly stronger correlation with environmental attitude (r=0.46) than environmental knowledge (r=0.21). Therefore, the environmental attitude has a moderate relationship with the environmental knowledge and behaviour. However, the relation between the environmental knowledge and behaviour is weak.

According to the third research question, we firstly classified students based on gender (**Table 3**).

According to **Table 3**, total of 145 students; 45.5 % were females and 54.5% were males, completed the data collection tools. Independent t-test results related to comparison of the knowledge test, attitude scale and behaviour scale scores based on gender has shown in **Table 4**.

Comparison of the scores on the knowledge test, attitude scale and behaviour scale with gender showed that there was no significant difference (p>0.05).

CONCLUSION AND DISCUSSION

In this study, we have shown that the environmental knowledge, attitude and behaviour of eighth grade students in secondary education were not sufficient in the North Cyprus. Environmental knowledge has moderate relation with the environmental attitude. Thus improving of curriculum at secondary education in countenance to environment will enhance enviromentally attitudes and also behaviours.

There are several studies about the influence of gender on the environmental knowledge, attitude and behavior. Similar with our result, gender neither effective variable on the environmental knowledge, attitude nor behaviour, Kose (2010), reported that gender do not influence the environmental attitudes. In contrast of us, Uzun (2007) relieved that the environmental behaviour and knowledge of students were not found be statistically significant and also depends on the gender environmental behaviour and knowledge of female students were found to be higher than male students. Asunta (2004) reported that media and science teachers were the most important environmental sources and besides that the environmental behaviour and knowledge of girls were more positive than the boys. Besides of this, Akçay and Pekel (2017) had research with prospective teachers who were from different branches such as; biology, chemistry, physics, sociology, geography, history and primary science and established that gender in the branches and genders was not efficient factor through the environmental awareness and the environmental sensitivities.

Similar with our study, Kuhlemeier et al. (1999), reported that all relations between environmental behaviour, attitude and knowledge were substantial. Although the relations between environmental attiude and knowledge found were quite higher than other studies (Hines, 1987). According to the results of the study which performed by Sönmez and Yerlikaya (2017), there was a relation between the environmental behaviour and knowledge of eighth grade students, In contrast with us, they reported that female students had better knowledge through the environmental issues than males. On the other hand, Evans et al. (2007) proved no correlation between environmental attitudes and behaviours.

The knowledge, awareness and attitudes of the students towards the environment can be determined and improved to educate environmentally sensitive individuals at the level of secondary education (Uğulu & Erkol, 2013) since the level of education is one of the most important factor influencing environmental awareness and environmental behavior (Wright, 2007; Zilahy & Huisingh, 2009; Zsoka et al., 2013). Michalos et al. (2009), reported that students and adults had attitudes favourable to suistainable development was relatively more effective than age, levels of education and knowledge. At the same study, Michalos et al. determined gender was most influential factor through the environmental behaviour while the attitudes were for adults. Atasoy and Ertürk (2008) studied sixth, seventh and eighth grade of students to detect knowledge and attitudes about environment and found that students environmental knowledge and attitudes were not adequate level. Review of literature demonstrates that education creates a positive impression on the environmental behaviours (Blomquist & Whitehead, 1998; Brecard et al., 2009; de Silva & Pownall, 2014; Meyer, 2015).

Our finding suggests that environmental knowledge has relation with environmental attitude and behaviour. Even so, the environmental problems keep increasing from day to day, that makes important to in relation with more environmental issues to curriculums. Future research is needed to investigate teaching approaches and help to improve curricula on environmental issues.

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Probe into the Collaborative Path of Production-Study-Research in University

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ABSTRACT

Collaborative development of production –study-research in university is an important measure to improve the quality of talent cultivation in China. The so-called collaborative development of production–study-research, namely, enterprises, schools and scientific research institutions in the industry coordinate with each other, and give full play to advantages respectively, forming Integrated advanced systems for research, development and production, and also reflecting comprehensive advantage in the process of the whole system operation. Enterprises are the demand side of the talent and technology, universities and research institutes, through technological development and training students in teaching, provide enterprises with talents and technology to meet various needs in the process of enterprise production and ensure that the high-quality talents can get better development and adapt to the social environment. In this paper, the method of documentary and field interview are used, firstly, the current research status of the collaborative path of production –study-research in university is analyzed, reflecting the main perspective of the collaborative path construction of collaborative path of production –study-research in university. Secondly, the research results shows the involving condition for building collaborative path of production–study-research in university, indicating the significance of constructing material basis, strengthen the credibility foundation of the cooperative subject, coordinate the property rights of each subject as well as establish integration mechanism of production-teach-research, and it provides theoretical support for the further research work.

Keywords: "Production–study-research" in university, collaborative path, research status, results and discussion

INTRODUCTION

Collaborative development of "Production–study-research" in university not only helps for universities to change the traditional cultivation mode of elite talent, but also help school, enterprises, government and institute to develop value-added effect. During the 13th five years, we should focus on upgrading the contribution of science and technology innovation in economic growth, and stick to facing to the market demand and concern industrialization, promote institutional reform in the field of education. In terms of current construction of "Production–study-research" in university, the perspective of research is too centralized and there are obvious limitations in the analysis of existing problems. Therefore, in the aspect of exploring production-study-research cooperative path, we should start from small aspect, analyze from the perspective of interest relationship, ensure that realize win-win collaborative path among university, enterprise and scientific research institutions (Chen and Shi, 2015; Durksen et al., 2017; Instefjord and Munthe, 2017).

LITERATURE REVIEW

Collaborative development of "production–study-research" in university refers to that knowledge increment as the center, collaborative subjects such as enterprise, research institutes and government participate in, achieving the goal of win-win cooperation. There is an obvious difference between the collaborative development of "Production–study-research" in university and the cooperation of "production–study-research", the latter is the foundation and the former is the highest form of the latter. China begun to implement "Production–study-research joint development project" in the early 1990s, many scholars has carried on the related exploration work in this field, China started the innovation ability improving plan of higher education until 2012, laying a solid foundation for collaborative development of production–study-research .So far, many scholars in China have put forward some representative opinions and suggestions on the construction of production–study-research collaborative path (John and Zapata Roblyer, 2017; John et al., 2017). Chen Zhuowei believes that universities should always adhere to the purpose of establishing the majors around the industry, and building good majors to promote industry, find the ecological niche of production–study-research integration development, penetrate into the enterprise actively to help enterprise solve practical problems. Zhan and Sun think that university-enterprise cooperation is an important form of collaborative development of production-study-research and also an important measure for China to build an innovative country and an important driving force for its own development. Shi Guizhou thinks that in the process of production–study-research collaborative development, through the collaboration of innovation subject, realize benefit sharing, risk-sharing and research cooperation, produce synergistic effect, which greatly promote university scientific research innovation and knowledge innovation, reform the way of talent cultivation in colleges and universities. These research views play an important role in cooperative path building of production–study-research in the universities of China (Krause and Lopez, 2017; Flaherty et al., 2017).

METHODS

The Method of Documentary

Through the method of documentary, this paper makes a search and collation of relevant literatures on the collaborative development of production–study-research in universities. Through literature analysis and research, the paper expounds the present basic situation of production–study-research collaborative development, and use representative and constructive points in the literature for reference, find a suitable cooperative path of production–study-research for the popularization of higher education development (Tao and Zhu, 2017; Wang, 2014).

Field Interview

Field interview refers to the researchers carrying out investigation in the definite range, and make face-to-face interview to research object, namely, school leader of higher education, in order to understand the respondents' information and behavior, etc. This study, through interviewing with relevant leaders, is to know the ultimate goal of establishing the collaborative path of production–study-research in universities (Yan, 2014).

RESULTS

In the process of research and exploration in this paper, first of all, the existing material on collaborative development of production–study-research in universities should be conducted collection and sorting out, in order to know the basic situation on collaborative path construction. The feasible research conclusion and research points

can be used for reference, exploring suitable collaborative path of production–study-research in universities for China's higher education development (Gabel and Dreyfus, 2017; LaChausse, 2017).

Create a Soft and Hard Environment for Collaborative Development through Building Material Foundation

Material is the precondition of all things run, and the coordinated development of production–study-research in universities is no exception. Improving material basis not only expand tangible material resources, but also bring invisible material resources into the material base, thus providing good soft environment and hard environment for coordinated development of production–study-research in universities (Lawson et al., 2017).

Physical or material resources can be observed by the naked eye is sharing network platform of production–study-research information, university, enterprise, scientific research institution and functional departments of government, with the application of network technology, jointly establish resource sharing and exchange platform which meets the requirements of talent supply, technology supporting, technology training and counseling service involving production–study-research participants. During this period, resource sharing and complementary advantages as the premise, we should work together to carry out scientific and technological innovation activities so as to realize the overall synergistic effect and form synergy of innovation and development. As a new organizational paradigm of production–study-research cooperation and scientific and technological innovation, the participating subjects should be managed jointly, in order to ensure the information symmetrical of participating subjects. However, intangible material resources mainly include the improvement of the incentive mechanism and the establishment of technology Incubation Park in university. The former can encourage the innovation of all participating subjects in production–study-research, while the latter helps the coordinated development of production–study-research go into a deeper level. As is known to all, the key of production–study-research coordinated development lies in the transformation of teaching and research achievements, universities as the major participant, the reward system needs to be improved, promote achievements with awards can ensure teaching research continuously make new achievements. Scientific research institutions should also improve the reward system to ensure that the research level continuously deepen to provide the prerequisites for the transformation of research results. In the aspect of technology incubation park construction, government, enterprise, university and research institutions should make concerted efforts, government provide the necessary financing and policy support, enterprise provide the corresponding technical guidance and facilities, while the university undertake training and teaching work, scientific research institutions, aiming at the most concerned and needed project by the government, enterprises and social, carry out research, so as to ensure the normal operation of the coordinated development and build a good soft and hard environment for coordinated development (Shilova and Sibgatullina, 2017; Goren and Yemini, 2017).

Through the construction of material base, a good soft and hard environment for the development of production–study-research system can be created, the main task, duties and obligations of each party have been further cleared, interest demand of participant will show clearly. In this case, the participants can keep the information open and transparent in aspects such as talent demand, technical requirements and cultivation, degree of information symmetry will be significantly improved, cooperation depth and breadth between partners can be further cleared, solving the collaborative development cost rising problem caused by information asymmetry (Zhan and Sun, 2016; Yi and Li, 2014).

Strengthen the Sincerity Basis to Realize the Connection of the Collaborative Subjects

As for collaborative path construction of production–study-research in universities, the acquisition of interests is the fundamental purpose, and one of the key issues to promote the collaborative development is to deal with the distribution of interests. However, the generation of interests lies in whether the cooperative relationship and depth can be steady and strengthen. Cooperating with honesty and sincerity naturally becomes the invisible basis of cooperation between collaborative subjects, which also concerns long-term and deepen cooperation between each other. Many universities in China all explore the coordinated development path of production–study-research, but they ignore the interests' pursuit between collaborative subjects, and universities, interests as the center, impose on the cooperation between enterprise and research institutions, thus universities become the subject of supervision and administration in coordinated development of production–study-research, while enterprises and research institutions become subjects of receiving management. Under such situation, the latter two cannot achieve their wishes, the stability of the coordinated development is influenced seriously, so the coordinated development of production–study-research lack of sincerity basis. How to strengthen the sincerity basis between collaborative subjects is the key to solve unstable cooperation caused by uneven distribution of interests (Taggart, 2017; Sit and Brudzinski, 2017).

Collaborative subjects should start from the following three aspects to strength sincerity basis among them. Firstly, a scientific communication mechanism should be established between the collaborative subjects, the establishment of communication mechanism is mainly around the contents, frequency of communication and solving method after divergence, ensure smooth flow of communication, meanwhile solve the existing problems in the communication as soon as possible, thus the communication and exchange between subjects can be programmed, and it is conducive to enhancing the mutual trust between collaborative subjects. Secondly, the collaborative subjects shall establish the fund for default liability. Establishing the fund for default liability is a sign of mutual commitment, the collaborative subjects, according to certain proportion, deposit a sum of money in advance, which is used for paying for breach of the liability clause. This not only can avoid using judicial process when not reaching an agreement, but also improve the trust basis between the parties and do good faith cooperation. When building the fund for default liability，each party should determine default behavior through consultations, and clear the corresponding default terms, so collaborative subjects make mutual promises, benefiting for enhancing cooperation relationship and strengthening cooperation basis. Thirdly, strengthen the maintenance of the obtained trust results. In this aspect, sincerity and morality must be strengthened as fundamental principles, not only make unremitting efforts to establish sincere cooperation relations, but also strengthen conscious behavior in establishing partnership, restraining the generation of default behaviors. In the period of cooperation, collaborative subjects shall realize what it means a breach of contract, meanwhile notice if there is default behavior out of human control, and how to deal with it, and take measures to make up for in the shortest time. In addition, we should realize that sincere cooperation can produce the benefit in collaborative development, and what kinds of benefit can be obtained. In this way, the virtuous circle of the collaborative development of production–study-research in university can be achieved, and the value added effect can be brought about, promoting the interconnection between collaborative subjects (Singh-Pillay and Sotsaka, 2017).

Coordinate the Property Rights of Each Subject to Ensure Fair Distribution of Intellectual Property Rights

The key link of collaborative development of production–study-research in university is the sharing of the core technology, generic technology and cutting-edge technology. Many universities at present still not pay attention to this important link, leading to the isolation among production, teaching and scientific research, and technological monopoly phenomenon is extremely common. The reason is that intellectual property has the characteristic of invisibility, while law can only make mandatory provisions in time and space authority, aiming at the ownership of intellectual property rights, but there is a lot of uncertainty about rights protection, thus making the monopoly on intellectual property (Kwon and Block, 2017).

How to coordinate the property rights of each subject to ensure the fair distribution of intellectual property rights? It can be start from the following three aspects. Firstly, in the initial stage of coordinated development, we should establish a reasonable and fair scientific research approval system and supervisory mechanism. Secondly, in the management process of collaborative development, various systems must be perfected. Thirdly, in the post-management phase of coordinated development, the proportion of intellectual property rights should be determined according to the contribution value. The coordinated development of production–study-research in university is a long-term cooperation projects, and the invisible benefits that can be generated by each collaborative subject will be different. Therefore, in the process of coordinating the relationship of property rights, the contribution of each collaborative subject needs to be conducted detailed evaluation and statistics, computing the corresponding contribution rate, and based on it, the proportion of intellectual property rights can be judged.

Improve the Mechanism of University-Enterprise-Research Cooperation and Meanwhile Establish a Mechanism of Integrating Production- Teaching- Research

The establishment of university-enterprise cooperation mechanism has been valued by many universities, while in the preconditions of running mechanism of university-enterprise-research cooperation, enterprise productions, university teaching and the research work should be integrated together, establishing a long-term effective mechanism, in this way, the running effect of mechanism of university-enterprise-research cooperation can be ensured. Undoubtedly, the collaborative development of production–study-research is an inevitable choice to improve the innovation ability of universities and realize connotative development, so the construction of these two mechanisms plays an important role. In the establishment of university-enterprise-research cooperation and production- teaching- research integration mechanisms, firstly, a complete legal system and operational mechanism should be established. The national local government should enact a series of laws and regulations and rules to increase support of universities, enterprise and research institutions from the perspective of responsibility, rights and profits, of which, it shall include funds supporting policy and tax system, providing a powerful force for coordinated development of production–study-research in university (Hershkovzt and Forkosh-Baruch, 2017).

Secondly, a new talent training mode should be established. Enterprises, school and scientific research institutions need to study the trends of industry development and market development situation, then the three parties work together for major settings, thus it can meet the needs of the market environment. With the rapid development of society, the trend of local economy development in China has also changed, industrial upgrading and the transformation of industry development are imminent, industry and talent demand are also constantly changing, and talent training in universities servicing the economy development needs many parties to make unremitting efforts. Enterprises, within the industries, can timely know the major changes of industrial development, and the scientific research institutions, based on the basic situation of industrial development, carry out a series of scientific and technological research, providing knowledge and skill capital for colleges and universities. Therefore through three parties working together, the following aspects should be achieved including the balances of professional setting and market demand and industrial development, talents cultivation and position, talent training objective and enterprise standard of employing people to the great extent. In this way, the coordinated development of production–study-research in university can aim at the same goal.

DISCUSSION

As for the collaborative path establishment of production–study-research in university, the core lies in how the enterprise, school and scientific research institution maintain harmonious cooperative relationship. In the previous literature research, the perspective mainly centered on the related elaboration of the collaborative innovation mode, and the distribution of benefits was not involved in the ideas. While in the research of this paper, from the perspective of three parties pursuing profits, achieve the purpose of tripartite win-win situation based on the realization of each profit, set up cooperative relations and meanwhile increase the depth of cooperation, and provide more important and basic condition for the coordinated development of production–study-research in university.

CONCLUSION

The purpose of production–study-research coordinated development in university is to maximize the benefit of the collaborative subjects, while cooperation is only a form, collaborative development is just indulge in empty talk without profits existing. As for the collaborative development path establishment of production–study-research in university, we should explore this point of view more deeply, based on satisfying the interests of the collaborative subject, close the gap between university, enterprise, scientific research institution and the government, ensure closer relationship between the collaborative subjects and satisfy the profits pursuing.

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The Influence of Gender, Learning Background, Participation, and Topic Limitation on the Imagination of Industrial Design Students in Taiwan

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ABSTRACT

In this study, five industrial senior designers are invited to observe and record a required design practice course of an industrial design department of a university for one semester, 18 weeks, each week for 5-6 hours. During the process, the imagination indicators proposed by Vygotsky is adopted in combination with a 5-point Likert scale. The sophomore class, 63 students in total, is observed. The outcome of study indicates that when the topics are with limitation, the gender factor has significant influence during design stages, and the influence of students' pre-university learning background is significant as well. When the topics are not limited, the influence of the gender factor also appears to be significant. The pre-university learning background has more influence on the performance of imagination and vocational high school graduates do better than regular high school graduates. In the meantime, students with higher level of class participation exhibit better imagination.

Keywords: design course, imagination, industrial design, learning background, students' learning

INTRODUCTION

Today, in spite of the rapid advancement in technology, imagination is still the best soft power in the development of human civilization. It is also an important ability to present human intelligence. Imagination is required to stimulate innovations and breakthroughs in every field, especially the design industry where creativity and innovativeness are highly essential. At present, all advanced nations, besides emphasizing the importance of cultivation of creativity, have started to work out plans to cultivate imagination. Industrial design is a problem-solving process. Professional designers must have great imagination and creativity to solve problems (Liang, 2008; Smith et al., 1995). In Taiwan, the industrial and academic sectors highly value and are also in urgent need of product development and design personnel and design students with creativity, integrated ability and planning ability. These abilities are considered important indicators for industrial competitiveness in the future.

However, the industrial sector and the academic sector hold different views toward the factors that have influence on imagination. Some scholars suggest the length of time of design activities can have an effect on thinking and imagination (Lin et al., 2014; Wieth & Zacks, 2011). Others try to study the influence of situations on imagination (Folkmann, 2013; Smith et al., 2009). Overall, studies conducted in Taiwan on actual use of imagination still lack definition of other factors and experiments, particularly in research of design education in university (Liang et al., 2016), making it an area urgently calling for exploration. Other than that, during the process of application of design methods and design thinking, there is often the black-box phase, a part of the process that takes places in the mind of the designer. Whether verbal or nonverbal study approaches are adopted to analyze and examine it (such as thinking out loud or interview), it is impossible to establish the designer's complete thinking

Contribution of this paper to the literature

- This study attempts to analyze the influencing factors of black box of imagination and design thinking, furthermore, to explore the references of different scope.
- This study explored students' performance in design imagination from four different influencing factors, and the results can be the references to university teachers for their teaching strategy.
- The findings of this study can serve as references in introduction and development of further imagination stimulation courses to improve the imagination and performance design student in university in order to train more talents with innovative thinking.

process and design logic (Liang et al., 2010). Therefore, finding out how to guide or stimulate the imagination of designers or design students is a rather important issue in development of creative product design, especially cultivation of future design talents—students. In Taiwan, students of design departments in university include vocational and regular high school graduates. So far, studies on the influence of pre-university learning backgrounds on imagination have been few. If this area can be examined by including also the student gender and class participation factors, it may be possible to learn more about imagination in design.

The objective of this study is to discuss whether factors such as the pre-university learning background, gender and class participation have any effect on the use of imagination of students when they engage in product design for industrial design courses. The imagination indicators proposed by Vygotsky (2004) are adopted in this study. Design experts are invited to form a team to analyze the contents of each design stage in practice courses in Taiwan to establish data in correspondence with the said indicators and then, based on the data, the experts observe a design class for 18 weeks, record the results and complete related statistical work to study whether the pre-university learning background, gender and class participation have influence on the imagination of the students at each design stage. In Chapter 2, literature associated with design thinking and design imagination, innovative integration and design imagination, and imagination experience, logical thinking and non-logical thinking will be discussed.

LITERATURE REVIEW

Design Thinking and Design Imagination

The factors that can influence design thinking and design imagination in the design industry and business environment are not only limited to the know-how, skills and aesthetic literacy of the designer; they may also hide in the overall design process and development (Bruce & Cooper, 1997; Cross, 1994), including project experience, information changes and use, and customer relations which all can have direct or indirect effects on the development of the designer's design thinking and design imagination and even affect the final outcome and presentation of the project (Ulrichj & Eppinger, 1995). Hence, the dissimilarities in design characteristics, practices and perception and depiction of design problems between different designers can lead to different contents and directions of thinking as well as distinct results (Liang, 2008). Therefore, the importance of design thinking and design imagination goes without saying. In other words, they form the soft power of each designer and have a deep impact on the innovativeness and competitiveness of products designed.

Design thinking and cognition are a creative and innovative problem-solving process in which designers examine and determine the factors that can cause differentiation. At this point, creativity can also take place. This process is a rather important issue in research of design thinking and imagination today (Cross, 1994; Holt, 1990). When an experienced designer stresses the significance of the problem-solving process and the result can make customers satisfied and gain profit at the same time, design activities are just like a creative problem-solving process (Lawson, 2006; Pahl et al., 2007). Development of design thinking is to assure the outcome can better comply with the expectations and experiences of consumers (Chang, 2010). This kind of design mode is called consumer-oriented creative design mode which can usually lead to products that sell better and also set the guideline for the tendency of further development of the products.

A number of studies on design thinking and imagination indicate (Liang, 2008; Vygotsky, 2004; Worst, 2007) that when design thinking first begins and imagination is in a stage of "extraction, association, preparation and fermentation, the contents belong to "restoration of memory, association of memory, generalization of memory, analogy of memory and other mental activities. These are related to "extraction and rephrasing" in the process of design imagination to extract appropriate materials or elements to solve design problems and create products. Creative imagination occurs as a result of the stimuli gathered for designers to reassemble and think to come up with solutions.

Innovative Integration and Design Imagination

Since the Arts and Crafts Movement, the foundation of development in the field of design and related research has been laid down in the UK. The contents of design and techniques in the UK include industrial design and engineering design. Industrial design involves product quality and attractiveness and consumer recognition, whereas engineering design focuses on technical innovations and how to turn concepts developed through industrial design into products (Liang, 2008). Product innovation used to emphasize more on functions, but now the stress is placed on taste, features and market differentiation. Steve Jobs once pointed out in an interview when he was young that functions were emphasized in the products of Microsoft but taste was lacking (Isaacson, 2011). The success of the various products of Apple since then has proven this.

Innovative integration refers to the consolidation of originality, strategy and specification during the product planning stage (conception, proposal and specification). US-based HaA Design has pointed out that "originality" is the path indicators, including the "direction" and the "blueprint," of the "map." It is a concise explanation of the aforesaid "originality" and "strategy" (HaA Design, 2016). With the emergence of the experience economy, businesses are taking the initiative to "create consumers' new feelings about their products," in other words, to interpret "originality" from a new angle (Pine & Gilmore, 1998). Many studies have also suggested (Liang, 2008); Shan et al., 2002; Yu et al., 2001) that design strategies are intended to incorporate innovativeness in products to allow users to have new experiences. Subsequently, the framework of a product is precisely established to guide designers to understand the background to find inspirations and solutions through design development and discussion. Then inspirations are transformed into applicable concepts, operating modes or interactive product simulations to bring imagination to realization. In the end, the concepts are converted into mature concrete products to be tested and marketed through trade shows and catalogs. In other words, through divergence and convergence, related knowledge is incessantly internalized and externalized to create new products. Therefore, application of the core knowledge of industrial design in the product planning stage to maximize its influence on design imagination will make significant contributions to the innovativeness and sustainable management of the design industry.

Imagination Experience, Logical Thinking and Non-Logical Thinking

Imagination experience is an industrial design concept derived from application of the scenario method with the scenario design method in teaching. It is intuitive, perceivable, as well as logical and non-logical at the same time. Stimuli are needed to trigger the use of the concept. Inspirations may occur in a series and alone, depending on the growth environment and the formation of experience and cultivation of knowledge (Xu & Bien, 2002). As pointed out in Experiences in Visual Thinking by McKim (1980), images are to stimulate the thinking mode of "visualization, imagination and drawing." Goldschmidt (1994), on the other hand, suggests images first appear in an individual's mind and are modified to become the images the individual intends to express. Knowledge is processed professionally (for example, industrial design approaches) and developed into innovative know-how through comparison, verification, association and communication to develop core competitiveness that takes form as a result of extension and accumulation of diverse knowledge and makes it possible for an enterprise to have positive development (Wu, 2002).

Logical thinking is a guideline and mode according to which humans infer and deduce their ideas. That is to say humans can adopt various approaches to know the truth. Each way of recognizing an idea can be seen as a form of logic (Lucas et al., 2003). It is related to imagination to some extent. As indicated in studies on logical thinking (Pezzuti et al., 2014; Wang, 2003) and non-logical thinking (Hitchcock, 2009; Su, 2002), the diverse forms of thinking can be contradictory to, different from and opposite to existing logic and, because of such relations, stimulate imagination.

METHODOLOGY

In this study, an industrial design department that has been around for more than 15 years is selected to examine its required practice courses and the research is conducted in three phases: analyzing the connection of the contents of different stages of the design course by using imagination indicators, observing how the courses are taught and recording the use of imagination, and analyzing the imagination of students in different stages of the design course.

Analysis of the Connection between the Contents of Different Stages of Design Courses with Imagination Indicators

During this phase of study, the contents of the target course each week are analyzed to understand the framework of teaching of practice courses of industrial design or product design. Five designers each with more than ten years of design experience are invited to form the focus group and study whether the contents of the design

Table 1. The scale indexes of imagination: initiation, fluency, flexibility, and originality

Index of imagination	Description of content
Initiation	An individual with past achievements as a result of his or her imagination has a lot of mental images that could serve as topics. The more experience an individual accumulates, the more diverse the mental images that can be extracted will be. It is related to past experience.
Fluency	The existing cognitive schema of an individual's database can be developed into imagination with a brand-new schema through logical analogy triggered by internal or external stimulation. In other words, it is the quantity of associations of similar types generated as a result of internal or external stimulation.
Flexibility	The existing cognitive schema of an individual's database can be developed into the ability to make associations with a brand-new schema through logical analogy triggered by internal or external stimulation. Different from fluency, flexibility allows an individual to break through the current condition. At the same time, different angles are adopted to think about possibilities and directions of flexible changes, including type conversion and diversified association between dissimilar types.
Originality	Mental images created by an individual based on his or her ability to make associations are assembled, converted and twisted to become an ability through creative thinking. It is breakthrough thinking ability generated by integration of the ability to make associations and the ability to "create something out of nothing. The individual will be able to break through conventional boundaries and come up with new and unique ideas without the restraints of older systems.

courses to be taught for 18 weeks are associated with the imagination indicators proposed by Vygotsky (2004) or related to the arguments presented in the literature reviewed earlier about stimulation of students' imagination. The items to be evaluated in the imagination evaluation scale are the imagination indicators proposed by Vygotsky in his publication *Theoretical Conceptions of Imagination*: initiation, fluency, flexibility and originality, as shown in **Table 1**.

Observation of Design Course Teaching and Recording of Use of Imagination

The five experienced designers participating in the first experiment observe design class teaching through participant observation and record the processes of ten design class sessions for one semester, 18 weeks (the time spent on class regulation explanation, departmental evaluation, mid-term and final examinations deducted) to assess the use of students' imagination in different design stages. Low-involvement participant observation is adopted, meaning that the participation is mainly to observe. The experts observe as teaching assistants and do not disturb the class by engaging in conversations or interactions with the teacher or students. It is a sophomore class and there are 63 students in total. The class is observed five to six hours per week, depending on the class arrangement.

When observing, the five experienced designers take notes and each one uses an imagination evaluation scale to record the students' use of imagination in different design stages. There are also research assistants to take pictures of each work designed by each student and film the design processes to facilitate subsequent quantitative and qualitative analysis. A five-point Likert scale is adopted and the imagination indicators, namely initiation, fluency, flexibility and originality, proposed by Vygotsky are applied to evaluate the imagination of students as they design their works each week. Among the many studies conducted with regard to imagination, these indicators are the ones more generally accepted.

Analysis of Students' Imagination in Different Stages of the Design Course

In this phase of study, the contents of observation and results recorded by the focus group are quantified for statistical analysis and qualitative work analysis to examine whether the use of students' imagination in different stages of the design course is affected by factors such as gender, the pre-university learning background, participation and topic limitation. Three hypotheses are also explored according to the results of statistical analysis:

- Student gender and pre-university learning background have no significant influence on students' use of imagination (1-5 points) (two-way analysis of variance).
- Student participation in discussions (1-5 points) has no relation to students' use of imagination (Pearson correlation analysis).
- Whether there is topic limitation or not has no significant influence on students' use of imagination (1-5 points) (dependent sample t-test).

In subsequence, quantitative work analysis is conducted to examine the results from the quantitative study. The photographs taken in ten class sessions and electronic files of the students' works are also referred to for the research team and focus group to undergo.

Table 2. Result of analysis of the connection between the contents of different stages of the design course and imagination indicators: design course topic 1

Design Course Topic 1: Design of Sound-playing Products									
Time	**Week 2**		**Week 3**		**Week 4**		**Week 5-6**		**Week 7-8**
Design Stage	1. First draft		2. Second draft		3. Draft Refinement		4. Model Production		5. Product Precision Mold and Presentation Board
Connection to Imagination Indicators	Initiation Index A	Fluency Index B	Initiation Index A	Fluency Index B	Initiation Index A	Fluency Index B	Flexibility Index C		Originality Index D
Course Contents	Students draw in total 30 drafts of products with sound-playing concepts in different styles.		After discussing with the teacher, each student chooses three of the concepts in the first draft and establishes two more drafts.		After discussing with the teacher, each student selects two concepts from the second drafts and draws a refined design that includes details and various aspects.		Based on the two concepts presented in the refined draft, each student produces the engineering drawing and then builds the model accordingly.		After discussing with the teacher, each student chooses one of the two concepts to produce the product precision mold and also designs the presentation board.

Table 3. Results of analysis of the connection between the contents of different stages of the design course and imagination indicators: design course topic 2

Design Course Topic 2: Design of Products with Light, Sound and Heat									
Time	**Week 10**		**Week 11**		**Week 12**		**Week 13-14**		**Week 15-16**
Design Stage	1. First draft		2. Second draft		3. Draft Refinement		4. Model Production		5. Product Precision Mold and Presentation Board
Connection to Imagination Indicators	Initiation Index A	Fluency Index B	Initiation Index A	Fluency Index B	Initiation Index A	Fluency Index B	Flexibility Index C		Originality Index D
Course Contents	Students draw in total 30 drafts of products with light, sound and heat concepts in different styles.		After discussing with the teacher, each student chooses three of the concepts in the first draft and establishes two more drafts.		After discussing with the teacher, each student selects two concepts from the second drafts and draws a refined design that includes details and various aspects.		Based on the two concepts presented in the refined draft, each student produces the engineering drawing and then builds the model accordingly.		After discussing with the teacher, each student chooses one of the two concepts to produce the product precision mold and also designs the presentation board.

RESULTS

Results of Analysis of the Connection between the Contents of Design Stages and Imagination Indicators

After a joint analysis conducted by the research team and the focus group, the contents of ten class sessions (the time spent on class regulations explanation, departmental evaluation, mid-term and final examinations deducted) in which design activities take place are adopted as the subject and what happen in different design stages of the courses is examined. In the end, the Vygotsky imagination indicators are applied to evaluate the results of observation and recorded use of imagination. It is concluded in this study that the stages of first draft, second draft and draft refinement have a lot to do with initiation and fluency, while the stage of model production is closely related to flexibility and the final product precision mold establishment stage is closely related to originality. The design course observation activities are divided into two parts, each a complete product design project. The first project is carried out in the first five class sessions. The topic is "design of sound-playing products" and limitation exists. The second one is conducted in the second five class sessions. The topic is "design of products with light, sound and heat." There is no topic limitation; hence, the design topic is more open. The stages of the design course and the connection between the course contents and imagination indicators are as shown in **Tables 2** and **3**.

Results of Observation of Design Course Teaching and Recording of Use of Imagination

The design imagination evaluation scale is established to measure the results obtained in the first half of this study. Class participation is included in the scale since one of the purposes of this study is to examine whether it will affect design imagination. The results are as shown in **Table 4**.

Table 4. Design of the teaching observation and design imagination evaluation scale

Student Code	Gender 1= male; 2= female	Learning background 1= High school; 2= Vocational	Evaluation of Use of Imagination in Different Design Stages (Indexes A~D) (5-point Likert Scale)								Participation
			Week 2 First draft		Week 3 Second draft		Week 4 Draft refinement		Week 5-6 Model Production	Week 7-8 Product Precision Mold and Presentation Board	
			Index A	Index B	Index A	Index B	Index A	Index B	Index C	Index D	
A01											
A02											
A03											
A61											
A62											
A63											

(Index A = Initiation; Index B = Fluency; Index C = Flexibility; Index D = Originality)

Figure 1. The process of observation of design course teaching and recording of use of imagination

The five experts used the design imagination evaluation scale to record the two design projects implemented by the 63 students in the class. The results are the quantified data on the use of imagination in ten class sessions. The research team also filmed the process of each of the ten sessions, including the students' participation in discussions and the status of the works designed in each stage. The results will be analyzed in the following section. **Figure 1** shows the process of teaching observation and recording of use of imagination.

Results of Analysis of Students' Imagination Exhibited in Their Works for the Design Course

Descriptive statistics on the overall use of students' imagination

As indicated in the quantitative data established in the imagination evaluation scale by the five experts observing the ten class sessions, there are 63 students. There are 26 males and 37 females when classified by gender,

Table 5. Descriptive statistics on the performance of students' imagination when designing products with topic limitation

Gender	Learning background	N	First Draft: Initiation		First Draft: Fluency		Second Draft: Initiation		Second Draft: Fluency		Draft Refinement: Initiation		Draft Refinement: Fluency		Model Production: Flexibility		Product Precision Mold and Presentation Board: Originality		Participation	
			M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
male	Senior high School graduate	19	2.83	0.80	2.45	0.73	2.57	0.68	2.17	0.77	2.21	0.77	1.97	0.95	3.00	0.91	2.63	0.97	2.66	1.21
	Vocational high school graduate	7	3.00	0.48	2.54	0.77	2.75	0.41	2.43	0.53	2.29	0.37	1.93	0.53	3.46	0.80	2.89	0.66	2.89	1.04
	Total	26	2.88	0.73	2.47	0.73	2.62	0.61	2.24	0.71	2.23	0.68	1.96	0.84	3.12	0.89	2.70	0.89	2.72	1.15
female	Senior high School graduate	30	3.21	0.55	2.84	0.70	2.97	0.52	2.46	0.68	2.56	0.65	2.22	0.65	3.21	0.81	2.93	0.82	3.29	0.88
	Vocational high school graduate	7	3.64	0.38	3.18	0.51	3.46	0.47	2.93	0.57	3.14	0.48	2.60	0.38	4.07	0.43	3.64	1.05	3.89	1.44
	Total	37	3.29	0.54	2.91	0.68	3.06	0.54	2.55	0.68	2.68	0.65	2.30	0.62	3.37	0.82	3.07	0.89	3.41	1.01
Total	Senior high School graduate	49	3.06	0.68	2.69	0.73	2.81	0.61	2.35	0.72	2.43	0.71	2.12	0.78	3.13	0.85	2.82	0.88	3.05	1.05
	Vocational high school graduate	14	3.32	0.53	2.86	0.71	3.11	0.56	2.68	0.59	2.71	0.60	2.29	0.58	3.77	0.69	3.27	0.93	3.39	1.31
	Total	63	3.12	0.65	2.73	0.73	2.88	0.61	2.42	0.70	2.50	0.69	2.16	0.74	3.27	0.85	2.92	0.91	3.12	1.12

Table 6. Descriptive statistics on the students' use of imagination when designing products without topic limitation

Gender	Learning background	N	First Draft: Initiation		First Draft: Fluency		Second Draft: Initiation		Second Draft: Fluency		Draft Refinement: Initiation		Draft Refinement: Fluency		Model Production: Flexibility		Product Precision Mold and Presentation Board: Originality		Participation	
			M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
male	Senior high School graduate	19	2.36	0.64	2.14	0.86	2.58	0.63	2.22	0.81	2.76	0.96	2.68	0.77	3.00	0.86	2.70	0.96	2.44	1.05
	Vocational high school graduate	7	2.64	0.89	2.68	0.86	2.43	1.07	2.21	1.18	2.25	0.95	2.38	0.90	3.32	1.15	2.75	1.09	2.54	1.33
	Total	26	2.43	0.71	2.29	0.88	2.54	0.75	2.22	0.90	2.63	0.97	2.50	0.86	3.09	0.93	2.71	0.98	2.47	1.11
female	Senior high School graduate	30	2.82	0.58	2.37	0.83	2.93	0.58	2.43	0.76	2.67	0.65	2.32	1.04	3.21	0.79	3.10	0.83	3.24	0.82
	Vocational high school graduate	7	3.61	0.69	3.21	0.92	3.60	0.64	3.18	1.12	3.32	0.49	3.11	0.61	3.46	0.85	3.89	0.79	4.11	1.00
	Total	37	2.97	0.67	2.53	0.90	3.05	0.65	2.57	0.87	2.80	0.67	2.71	0.91	3.26	0.79	3.25	0.87	3.41	0.91
Total	Senior high School graduate	49	2.64	0.64	2.28	0.84	2.79	0.62	2.35	0.79	2.71	0.78	2.59	0.85	3.13	0.81	2.94	0.90	2.93	0.99
	Vocational high school graduate	14	3.13	0.91	2.95	0.90	3.02	1.04	2.70	1.21	2.79	0.91	2.52	0.89	3.39	0.97	3.32	1.09	3.32	1.40
	Total	63	2.75	0.73	2.43	0.89	2.84	0.73	2.43	0.89	2.73	0.80	2.55	0.87	3.19	0.85	3.03	0.95	3.02	1.09

and 49 regular senior high school graduates and 14 vocational high school graduates when classified by pre-university learning background. The descriptive statistics on the performance of the students' imagination when designing according to a topic with limitation are as shown in **Table 5**.

The descriptive statistics on the students' use of imagination when designing according to a topic without limitation are as shown in **Table 6**.

Table 7. Statistics on the influence of student gender and pre-university learning background on imagination when designing products with topic limitation

Factors	First Draft: Initiation		First Draft: Fluency		Second Draft: Initiation		Second Draft: Fluency		Draft Refinement: Initiation		Draft Refinement: Fluency		Model Production: Flexibility		Product Precision Mold and Presentation Board: Originality		Participation	
	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.
Gender	7.373	0.009*	5.858	0.019*	10.816	0.002*	3.552	0.064	9.490	0.003*	4.727	0.034*	2.705	0.105	3.848	0.055	6.265	0.015*
Learning background	2.587	0.113	0.985	0.325	4.344	0.051	3.036	0.087	2.630	0.110	0.749	0.390	7.166	0.010*	3.279	0.075	1.641	0.205
Gender* Learning background	0.490	0.487	0.336	0.564	0.854	0.359	0.259	0.612	1.544	0.219	1.146	0.289	0.647	0.424	0.699	0.406	0.315	0.577

Table 8. Statistics on the influence of student gender and pre-university learning background on imagination when designing products without topic limitation

Factors	First Draft: Initiation		First Draft: Fluency		Second Draft: Initiation		Second Draft: Fluency		Draft Refinement: Initiation		Draft Refinement: Fluency		Model Production: Flexibility		Product Precision Mold and Presentation Board: Originality		Participation	
	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.
Gender	13.039	0.001*	2.118	0.151	1.103	0.298	4.930	0.030*	0.623	0.434	0.492	0.486	0.444	0.508	7.981	0.006*	15.888	0.000*
Learning background	7.456	0.008*	7.041	0.010*	6.131	0.022*	1.937	0.169	0.083	0.777	0.854	0.359	1.215	0.275	2.389	0.128	2.583	0.113
Gender* Learning background	1.622	0.208	0.363	0.549	non	non	2.037	0.159	non	non	4.392	0.040*	0.015	0.903	1.831	0.181	1.714	0.195

Results of statistical analysis of the influence of the students' gender and pre-university learning background on their design imagination

The statistics on the influence of the students' gender and pre-university learning background on their use of imagination indicate that the gender factor has a larger effect on use of imagination. When this finding is combined with the descriptive statistics shown in **Tables 5** and **6**, it is obvious that the female students outdo the male ones in initiation and fluency in the first draft stage, in initiation in the second draft stage and in initiation and fluency in the draft refinement stage. In the meantime, the pre-university learning factor has significant influence on flexibility in model production. Vocational high school graduates outperform regular senior high school graduates. The statistics are as shown in **Table 7**.

The statistics on the influence of student gender and pre-university learning background on use of imagination when designing according to a topic without limitation indicate that the pre-university learning background has more influence on use of imagination in the beginning of the design work. When this outcome is combined with the aforesaid descriptive statistics, it is obvious that vocational high school graduates outperform regular senior high school graduates in initiation and fluency during the first draft stage and in initiation during the second draft stage. Meanwhile, the gender factor appears significantly different in initiation during the first draft 1 stage and in originality in the last stage of establishment of the product precision mold and presentation board. Female students outdo males ones. The statistics are as shown in **Table 8**.

Statistics on the influence of student participation in discussions on design imagination

The correlation statistics on the influence of students' participation in discussions on design imagination when they design products with topic limitation reveal all the design course contents have high positive correlations (Pearson correlation coefficient>0.7), meaning the students' performance and attitude when discussing designs with topic limitation are highly positively correlated with the performance of their imagination in each design stage. The statistics are as shown in **Table 9**.

Table 9. Correlation statistics on the influence of students' performance in discussion of products designed with topic limitation on their imagination

	First Draft: Initiation	First Draft: Fluency	Second Draft: Initiation	Second Draft: Fluency	Draft Refinement: Initiation	Draft Refinement: Fluency	Model Production: Flexibility	Product Precision Mold and Presentation Board: Originality
Pearson Correlation Coefficient	0.840*	0.803*	0.849*	0.818*	0.836*	0.780*	0.767*	0.819*
Sig. (two-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 10. Correlation statistics on the influence of students' performance in discussion of products designed without topic limitation on their imagination

	First Draft: Initiation	First Draft: Fluency	Second Draft: Initiation	Second Draft: Fluency	Draft Refinement: Initiation	Draft Refinement: Fluency	Model Production: Flexibility	Product Precision Mold and Presentation Board: Originality
Pearson Correlation Coefficient	0.671*	0.418*	0.713*	0.549*	0.493*	0.429*	0.579*	0.845*
Sig. (two-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 11. Statistics on the influence of topics with/without limitation on the students' imagination

	M	N	SD	t	Sig. (two-tailed)
Design topic with limitation-first draft: Initiation	3.12	63	0.65	5.074	0.000*
Design topic without limitation-first draft: Initiation	2.75	63	0.73		
Design topic with limitation-first draft: Fluency	2.73	63	0.73	2.970	0.004*
Design topic without limitation-first draft: Fluency	2.43	63	0.89		
Design topic with limitation-second draft: Initiation	2.88	63	0.61	0.506	0.615
Design topic without limitation-second draft: Initiation	2.84	63	0.73		
Design topic with limitation-second draft: Fluency	2.42	63	0.70	-0.074	0.941
Design topic without limitation-second draft: Fluency	2.43	63	0.89		
Design topic with limitation-draft refinement: Initiation	2.50	63	0.69	-2.413	0.019*
Design topic without limitation-draft refinement: Initiation	2.73	63	0.80		
Design topic with limitation-draft refinement: Fluency	2.16	63	0.74	-3.359	0.001*
Design topic without limitation-draft refinement: Fluency	2.54	63	0.86		
Design topic with limitation-model production: Flexibility	3.27	63	0.85	0.901	0.371
Design topic without limitation-model production: Flexibility	3.18	63	0.85		
Design topic with limitation-product precision mold and presentation board: Originality	2.92	63	0.91	-1.418	0.161
Design topic without limitation-product precision mold and presentation board: Originality	3.03	63	0.95		

The correlation statistics on the influence of students' participation in discussions on design imagination when they design products without topic limitation reveal most design course contents have high positive correlations (Pearson correlation coefficient>0.7), meaning the students' performance and attitude when discussing designs without topic limitation are highly positively correlated with the performance of their imagination in each design stage. The statistics are as shown in **Table 10**.

Statistics on the influence of topics with/without limitation on the students' imagination

The statistics on the influence of topics with/without limitation on the students' imagination indicate that during the beginning of draft initiation and concept convergence in the draft refinement stage, the students use their imagination better, but there is no significance difference in other stages. The statistics are as shown in **Table 11**.

Results of qualitative analysis of imagination exhibited in the works produced by the students for the design course

(1) Using "gender" as a variable in examination of design of products with/without topic limitation

When using imagination to initiate concepts for products, the female students outperform the male ones during both the draft and draft refinement stages. They produce better combinations of straight and curved lines as well as more form variations. As a consequence, the styles of their products are more changeful and this explains why the statistics indicate female students do better than the male ones in initiation and fluency during the first draft stage, in initiation and fluency during the second draft stage and in initiation and fluency during the draft refinement stage. However, in the second half of the design process, during the model production stage and the product precision mold and presentation board product stage, the works show there is no significant difference between the female and male students. Moreover, when there is no limitation on the topic, the use of imagination of the female students is also not significantly different from that of the male ones, as indicated in the statistics.

(2) Using "pre-university learning background" as a variable in examination of design of products with/without limitation

During the first draft stage, the students show no significant difference in use of imagination. Nevertheless, in the second draft stage, each student with a vocational high school background can continue to produce a certain number of drafts with various concepts and again develops more related drafts based on those drafts, exhibiting decent initiation and fluency. On the contrary, students with regular senior high school education produce drafts that contain less diversity while the contents are also excessively similar to currently available products. For this reason, the experts are unable to give them high scores in initiation and fluency. In addition, during the model production stage, the vocational high school graduates are able to convert 2D designs into initial 3D models which also turn out to be more complete compared to the ones produced by those with a regular high school background. Therefore, the statistics show that the ones with a vocational high school background perform better in flexibility in the model production stage than those with a regular senior high school background. However, when the topic has no limitation, the use of imagination between these two groups of students is not significantly different. One thing certain is that the use of imagination of all the students appears to be better when the topic is limited.

(3) Using "participation in discussions" as a variable in examination of design of products with/without limitation

It is discovered that students with higher ratings in discussion participation ask more questions in class and they also are able to brainstorm based on the teacher's answers and suggestions to get more inspirations and implement them in the following stage of design work. Besides, students who participate more in discussions can also produce more and diverse drafts and come up with products of more changeful forms. The operating methods of their products are more innovative and their design performance in subsequent design stages is better than those with lower-level participation in discussions. In comparison, the latter type of students spends less time discussing with the teacher and asks fewer questions. Their drafts normally contain one or two product concepts and the designs are more realistic. The concepts are often similar to those in existing products and the final results are common and lack imagination. When the topic is without limitation, the discussion participation ratings are more or less the same as when the topic is limited. In every design stage, students with higher ratings in discussion participation perform better than the ones with lower ratings.

(4) Using "with/without topic limitation" as a variable in examination of imagination performance in each stage of the design process

When the topic is limited, all the students are able to come up with product concept drafts according to the topic given by the teacher in the first draft stage. For instance, some students adopt environmental protection and energy saving as the theme and draw out car lights, digital bus stops, sports equipment and solar street lights. The lines in the drawings are fluent and changeful and the styles are also more diverse, formed with geometric and curved lines or irregular lines. The functions are clearly defined and there are innovative ideas. On the contrary, when the topic has no limitation, there is not enough imagination in the initial drafts and repeated concepts are obvious.

When the topic has limitation, the students perform better in styling, color distribution and component arrangement in the draft refinement stage, compared to when the topic has no limitation. For example, some, students draw out aromatic hydrotherapy machines in the shape of flowers and try different numbers of flower petals and color distribution and leaf form variations whereas some others incorporate necklaces, zippers and bracelets in portable emergency first-aid kits. However, when the topic has no limitation, the results of draft refinement are relatively less characteristic and the final products lack imagination and are also similar to existing products available on the market.

CONCLUSION

The results of exploration of related issues in studies of design imagination can serve as references in introduction and development of further imagination stimulation courses to improve the imagination and performance design student in university in order to train more talents with innovative thinking. This study is intended to find out which factors have significant influence on student imagination stimulation and guidance in design education in university in Taiwan. The results of this study can serve as references for further studies on design imagination. They can also be helpful for teachers of design courses to make suitable adjustments when various factors are taken into consideration to improve design courses and students' imagination.

By studying the contents and teaching of current design courses and students' use of imagination, more factors that stimulate imagination can be identified to offer substantial suggestions for design education. Future studies can also include other teaching materials or methods that stimulate imagination. It is hoped that the findings in this study can have concrete benefits in establishment of projects to develop the theoretic foundation for research on imagination and improvement of imagination in design education to upgrade the imagination of design students in university in Taiwan to make substantial contributions to the industrial design industry.

ACKNOWLEDGEMENTS

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Design of Intelligent Comic Make System for Educational Application Based on Comic Script Creation

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ABSTRACT

A comic book with rich picture and storyline, which needs to combine the storyboard creation and visual picture design. In the comic production process requires a lot of manpower and time cost to complete the work. This study presents an intelligent comic production system (ICPS) in which cartoons are subdivided into many design elements and integrated into the framework o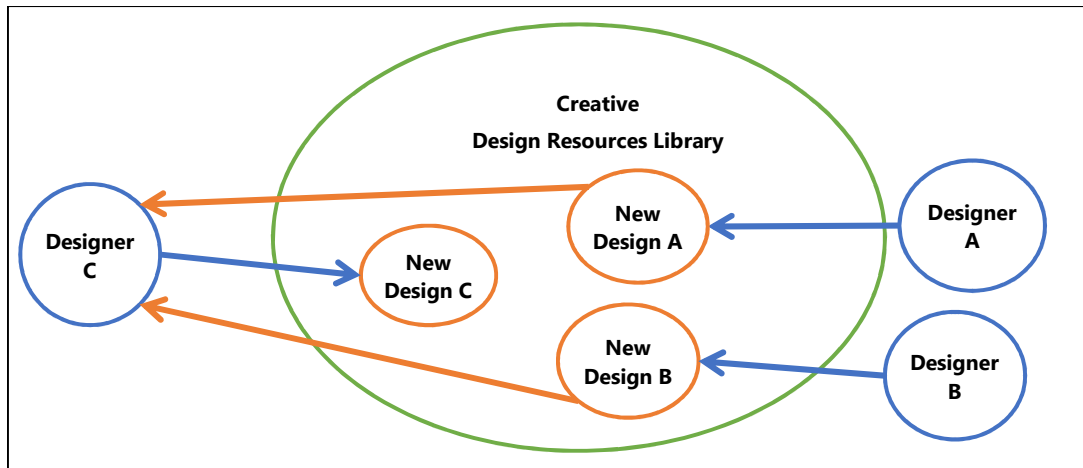f Creative Design Resource Integration (CDRIM). By analyzing the creative requirements of cartoon scripts, ICPS reconstructs the new comic design elements and completes the new Comics. The comic design of the paper is to let the author use the text script directly to produce a sub-mirror screen and the role of dialogue in the system.

ICPS model to help cartoonists to achieve another comic creation, the use of writing scripts to produce comics, can reduce the traditional cartoon design process of human, capital and time costs. The system provides professional cartoonist design elements during the design of the comic context, as well as non-professional one creative cartoon design training courses.

Keywords: comic design elements, creative design resource integration, intelligent comic production system, comic script writing, comic creation reference

INTRODUCTION

In this study, the use of comic design-related teaching story situation, and then education or training learners, compared with the general description of the main text of the text reading teaching methods, but also allow learners to accept and leave a deep image, such as in medicine education (Babaian & Chalian, 2014) and patient care (Wilson, 2005; Green & Myers, 2010), or for contextual teaching research in science (Tatalovic, 2009), as well as children's art education (Wilson, 2005), have been very effective. At present, the research on cartoon creation teaching is mainly based on the use of multimedia environment (Marianthi et al., 2001), providing interactive digital narrative environment for creators to generate cartoon development, which leads to learners' interest (Azman, 2015), or use script creation Demonstrating related comics, improving students' ability to apply relevant knowledge (Chang et al., 2017), and designing an interactive cartoon creative teaching application platform integrated into the Internet environment to stimulate learners to be full of freshness under the network multiplayer (Kingsley & Brinkerhoff, 2011) guided by the creativity.

Comic is a kind of cultural innovation that can promote human thought and flexibility. To become a popular cartoonist, who need to accept a long painting training? The cartoonist uses the delicate drawing skills and the rich ability to create the subject matter, to draw the conceptual storyline on paper. Complete the steps of a comic book, as shown in **Figure 1**. First, the author conceived the story structure and the scene, to meet all the role style, and then the story in order to develop, the use of split screen way to design all the characters of action and dialogue (Ichino et al., 2010; Wang et al., 2012; Jamaludin, 2011; Tsai et al., 2016; Tsai, 2016; Tobita, 2010). Readers from the comic works to understand the author to express the idea, but the lengthy training process so that many creative learners quit, resulting in the loss of many potential talents.

Figure 1. Comic Design and Creation Process
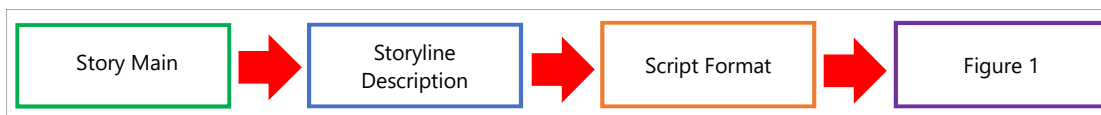
Figure 2. Comic Script Creation Process

The script is created by writing the development of the whole story, and the main elements of the comic is the picture, and a small amount of text coherent. Cartoonist want to convert text scripts into comics (Tobita, 2015), which requires long hours of painting. The comic script is the basis of a comic creation idea. The main purpose of the comic script creation is to record the main plot in the comic story plot conceived by the cartoonist, and to translate the description into comic drawing content (Tobita, 2015). Comic design is the story of the coherent picture to the illustrative way to make the reader easy to read, while the design team is conducive to reading and communication, and thus effectively complete the Split Screen design and division of labor, as shown in **Figure 2**.

In this paper, the "creative design resource integration model"(CDRIM) is applied to comic design. **Figure 3** shown a CDRIM architecture (Tsai, 2016) provides designers to share their own creative and design resources, or uses other design resources shared by other designers to join their designs to form new design works (Sanders & Stappers, 2008). And the new design works are also shared to the design resources (Goldner & Birch, 2012), to stimulate the creative ideas of many designers groups (Wang et al., 2012). CDRIM helps designers create design work and share design resources (Kangas, 2010), with the goal of reducing design costs and increasing creative design speed.

Figure 3. Creative Design Resource Integration Model
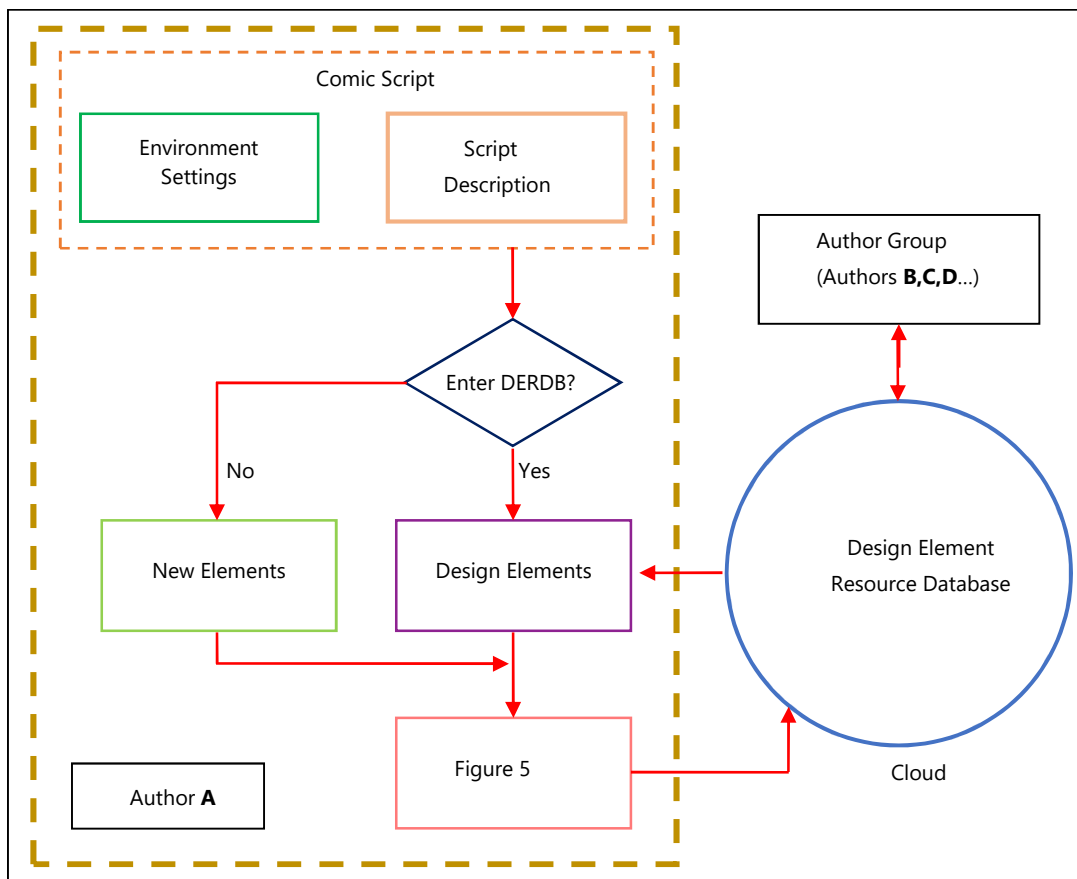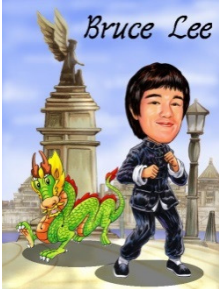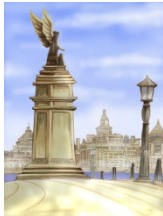
Figure 4. Flow of Intelligent Comic Make System

INTEGRATION COMIC MAKE SYSTEM

Based on CDRIM architecture, the paper provides a design element database (DED) platform that provides designers with the main comic design elements (Deterding et al., 2011) such as head, body, object, font, background, etc., uploaded to the DED platform, and the formation of integrated modeling database. Designers can enter this database platform to play the creative choice of the comic design elements needed to produce new styling designs (Barab & Squire, 2004). **Figure 4** is the flow of the intelligent comic make system (ICMS) presented in this paper. First, Many designers provide works and classify works into the design elements (Tsai, 2017) of **Table 1**, and store them into the database platform.

Table 1. Design Elements Content Classification

Designer works	Design Elements				
	Head	**Body**	**Item**	**Font**	**Backgroup**
				Yes！ We Can	
				Iron Man	
				海角七號	
				Bruce Lee	
				蘭陵王	

When the creator creates the script, the script will be divided into two main parts to control the performance of the drama (Tsai et al., 2016), mainly for the top of **Figure 5** drama theme, scene, role, date, time and other story settings, and **Figure 5** shows the role of dialogue, action, narration, emotions, expressions and other performance sequence.
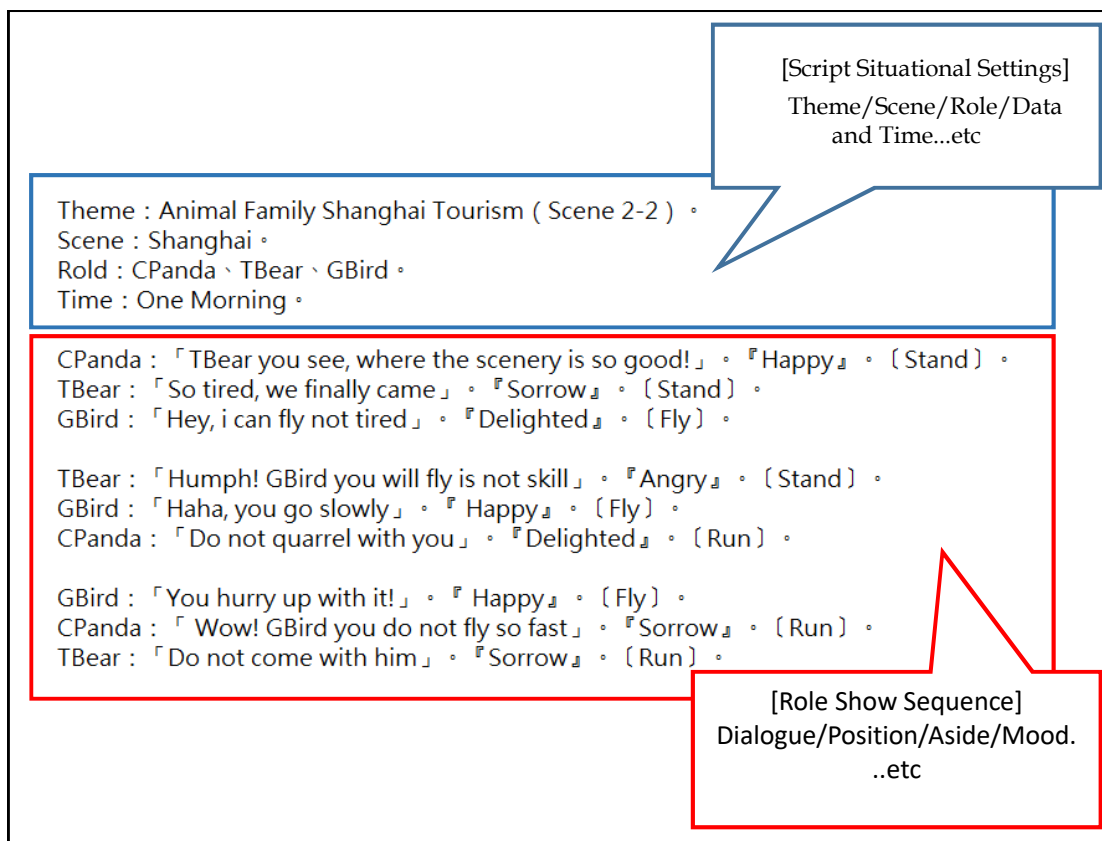
Figure 5. Script Format Structure Analysis

Table 2. Script Control Symbol Table

Symbol	Explanation
◆	Aside
「」	Dialogue
:	Role Select
『』	Facial expression
〔〕	Action
()	Position
。	Paragraph

In this study, we add various control symbols (Tsai et al., 2016), as shown in **Table 2**, which can directly control the expression, position and action of each role in the script. The paper uses the control symbols to increase the readability of script content, let a un-imagination cartoonist can quickly understand the idea of the script, this way can shorten the time to read the script and quickly understand the director to express the situation (Tobita, 2010).

This study analyzes the structure of the script text, to find out the interaction between the roles, such as expression, dialogue, action, etc., and split screen planning. System analysis the interaction between the main role and the secondary one, and then specify the comic image produced by the first person, second person or third person, as shown in **Figure 6**. Among them, the first person's image expression or action is the most distinctive. The system will be divided into a number of split screen, the dialogue of the role of each split screen is divided into: I to You, You to Him, He to Him. The system provides the director to select the control symbols for each role, and the cartoonist enters the DED platform to select the appropriate comic design elements group to match the control symbols. The cartoonist can combine the design elements into a new comic style, and arrange for the distance, size, location between the roles. If there is no suitable design element in the DED platform, the cartoonist designs the new elements to match the director's needs.
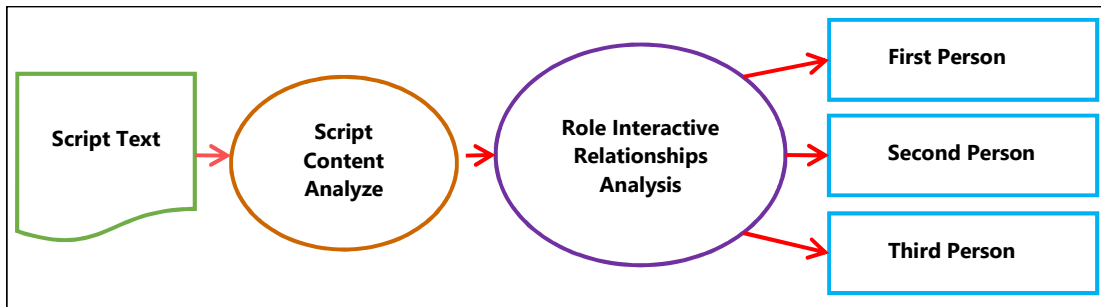
Figure 6. Script Role Interactive Relationships Analysis

COMIC MAKE SYSTEM ANALYZE

Comic Make System Process

This study will be stored in the "Comic Script Library", within the text format script comic script (Williams et al., 2005), defined as "KDS", and analysis of comic books in the various groups and related attributes (Object and Attributes), then these Analyze the Information System Table, find out the similar values of RX, and then use the Decision Tree method to predict the dialogue action of the comic script characters. The analysis dialog is first person, second person and third And then determine whether each of the analysis accuracy training can be accepted, if it is acceptable to the system automatically match the "Design Element Resource Database", the relevant comic modeling elements, and modeling integration Corresponding to the comic style, if not accepted, the system continues to find the relevant comic script information, and analyze the relevant attributes and analysis of the information list (**Figure 7**).
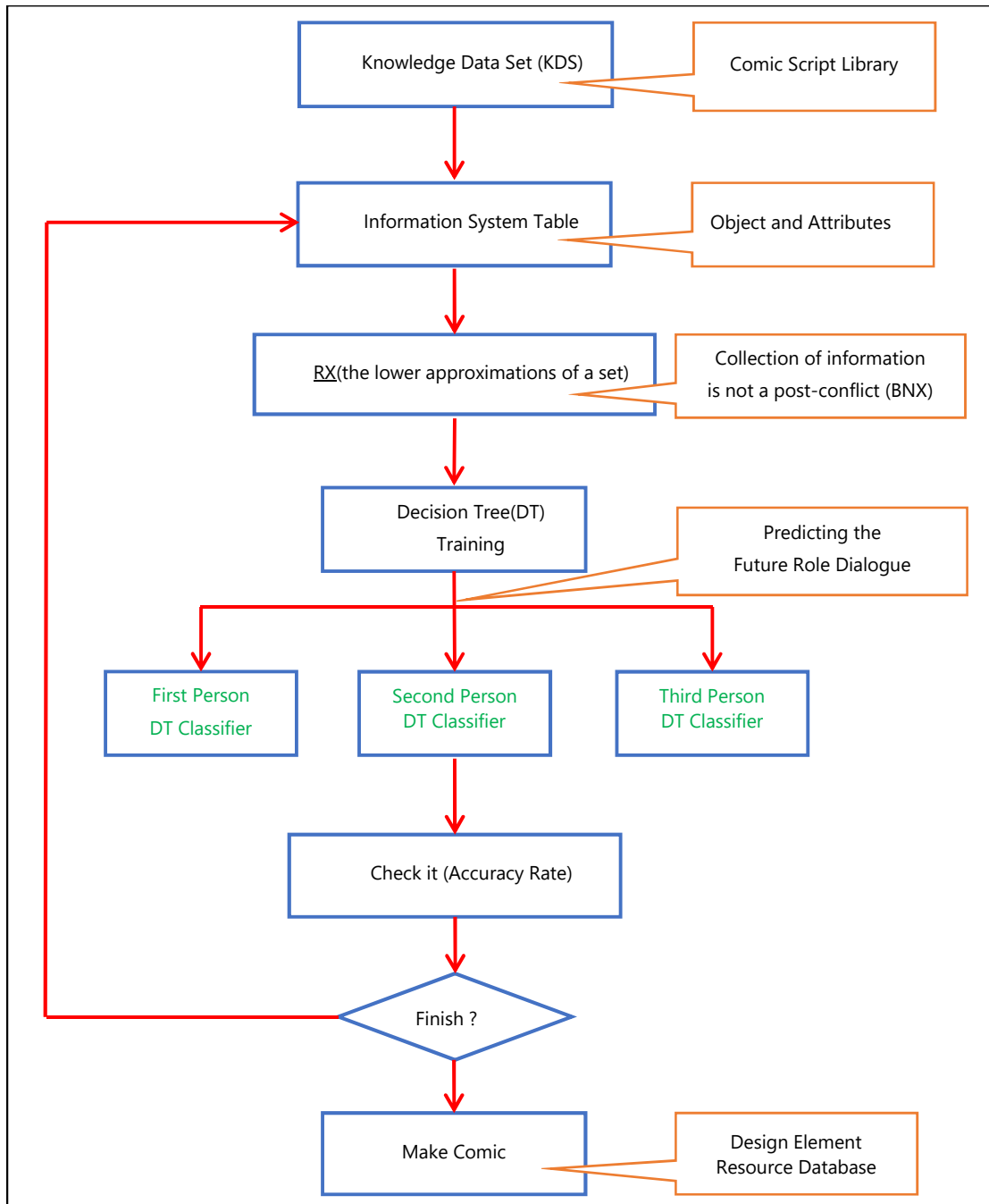
Figure 7. Comic Make System Process

The author designs the comic script creation system based on comic script creation, and provides the comic writer input script text, let the system compare the script information in the comic system database and find out the similarity drama, scene, Dialogue (Wang et al., 2012), and so on, and then one by one than the script of the role of dialogue is the first person or second person or third person, and finally the results of the information will be passed to the design elements of the integration of the library comic picture.

Comic Make System Examples

In accordance with **Figure 4**, this study presents an "animal family Shanghai tourism" comic script. This script is presented in accordance with **Figure 5**, as shown in **Figure 8**. cartoonists in the DED platform to find the "Shanghai" background, "Black Car" Item, and CPanda, TBear, GBird roles, and these design elements are organized as shown in **Table 3**.

Theme：Animal Family Shanghai Tourism（Scene 2-1）。

Scene：Shanghai。

Role：CPanda、TBear、GBird。

Time：One Morning。

CPanda：「TBear you see, where the scenery is so good!」。『Happy』。〔Stand〕。

TBear：「So tired, we finally came」。『Sorrow』。〔Stand〕。

GBird：「Hey, i can fly not tired」。『Delighted』。〔Fly〕。

Theme：Animal Family Shanghai Tourism（Scene 2-2）。

Scene：Shanghai。

Role：CPanda、TBear、GBird。

Time：One Morning。

CPanda：「TBear you see, where the scenery is so good!」。『Happy』。〔Stand〕。

TBear：「So tired, we finally came」。『Sorrow』。〔Stand〕。

GBird：「Hey, i can fly not tired」。『Delighted』。〔Fly〕。
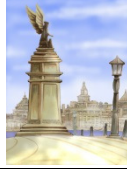
Theme：Animal Family Shanghai Tourism（Scene 2-3）。

Scene：Shanghai。

Role：CPanda、TBear、GBird。

Time：One Morning。

GBird：「You hurry up with it!」。『Happy』。〔Fly〕。

CPanda：「Wow! GBird you do not fly so fast」。『Sorrow』。〔Run〕。

TBear：「Do not come with him」。『Sorrow』。〔Run〕。

Figure 8. Animal Family Shanghai Tourism Comic Script
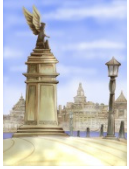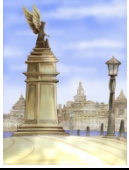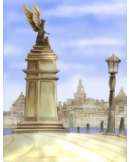
Table 3. Design Elements of Animal Family Shanghai Tourism
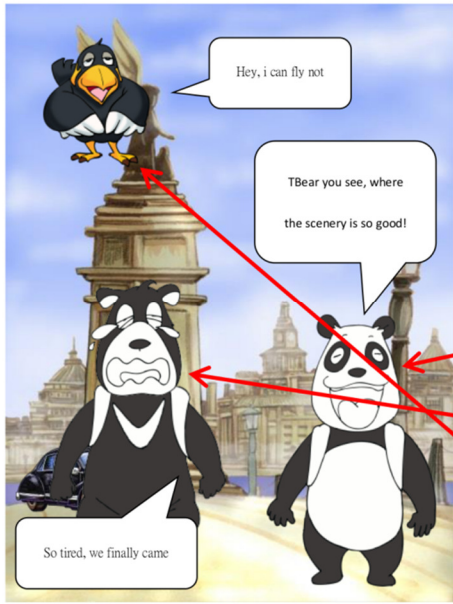
Design Elements				
Head	**Body**	**Item**	**Font**	**Backgroup**
			CPanda	
			TBear	
			GBird	

This content is divided into three split screen by the script in **Figure 8**. The first split screen is to specify the role of the Panda for the first person, in accordance with the requirements of the script's Control Symbols, the design elements of **Table 3** is revised to **Table 4**, and complete **Figure 9** comics.

Table 4. Design Elements of First Split Screen

Design Elements				
Head	**Body**	**Item**	**Font**	**Backgroup**
			TBear you see, where the scenery is so good!	
			So tired, we finally came	
			Hey, i can fly not tired	

Figure 9. CPanda Dialogue First Person Make Comic Examples

The second split screen is Bear role for the first person, with the script to complete the design elements in **Table 5** and **Figure 10** comics.

Table 5. Design Elements of Second Split Screen
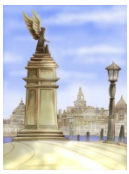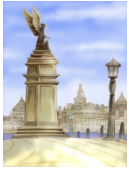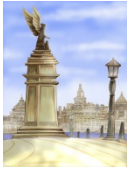
Design Elements				
Head	**Body**	**Item**	**Font**	**Backgroup**
			Humph! GBird you will fly is not skill	
			Haha, you go slowly	
			Do not quarrel with you	
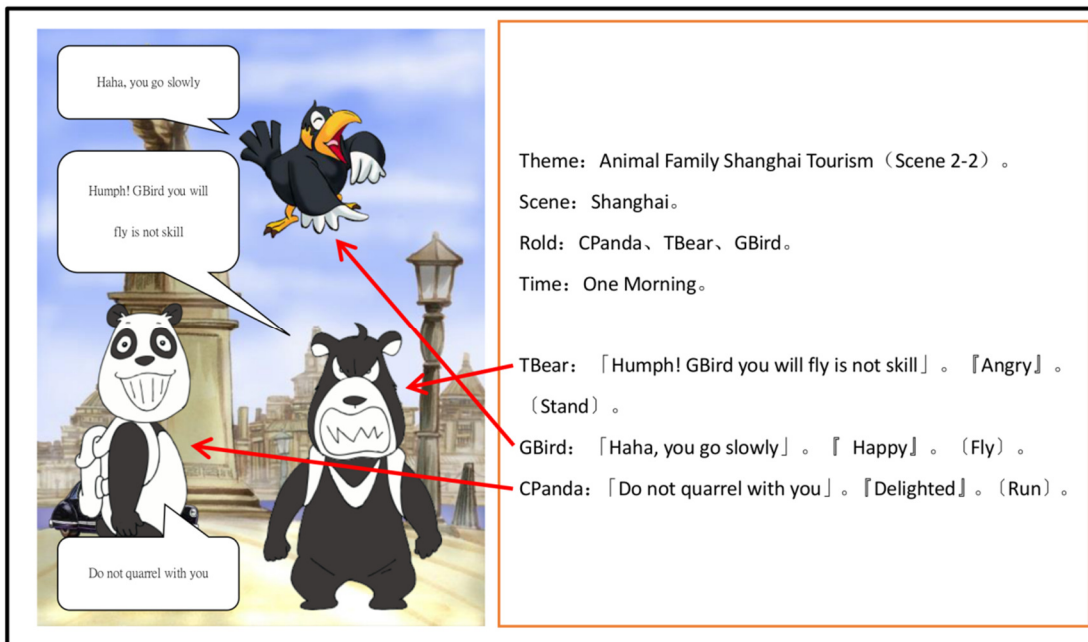
Figure 10. TBear Dialogue First Person Make Comic Examples

Finally, Bird role for the first person in the comic production, with the script to complete the design elements of **Table 6** and **Figure 11** comics. The experimental results show that the ICMS can change the expression, action and position of each role according to the different script contents, such as the appearance order or the distance ratio, and produce the corresponding comic image.

Table 6. Design Elements of Third Split Screen

Design Elements				
Head	**Body**	**Item**	**Font**	**Backgroup**
			You hurry up with it!	
			Wow! GBird you do not fly so fast	
			Do not come with him	

Figure 11. GBird Dialogue First Person Make Comic Examples

After the cartoonist completes all the split screens, the design elements from Table 4 to Table 6 can be stored in the DED platform of **Figure 4** for use by other cartoonists.

This study tests the script in **Figure 11**, the original TBear lines and sad expression and walking action control code "TBear：「Do not come with him」。『Sorrow』。〔Run〕。", change into "TBear：「I cannot walk!」。『Angry』。〔Stand〕。", Anger expression and standing action control code, found that the original TBear expression and action will be in accordance with the script control code changes and changes, and other characters in the order or distance ratio will also be produced in proportion to the corresponding comic image (as shown in **Figure 12**).
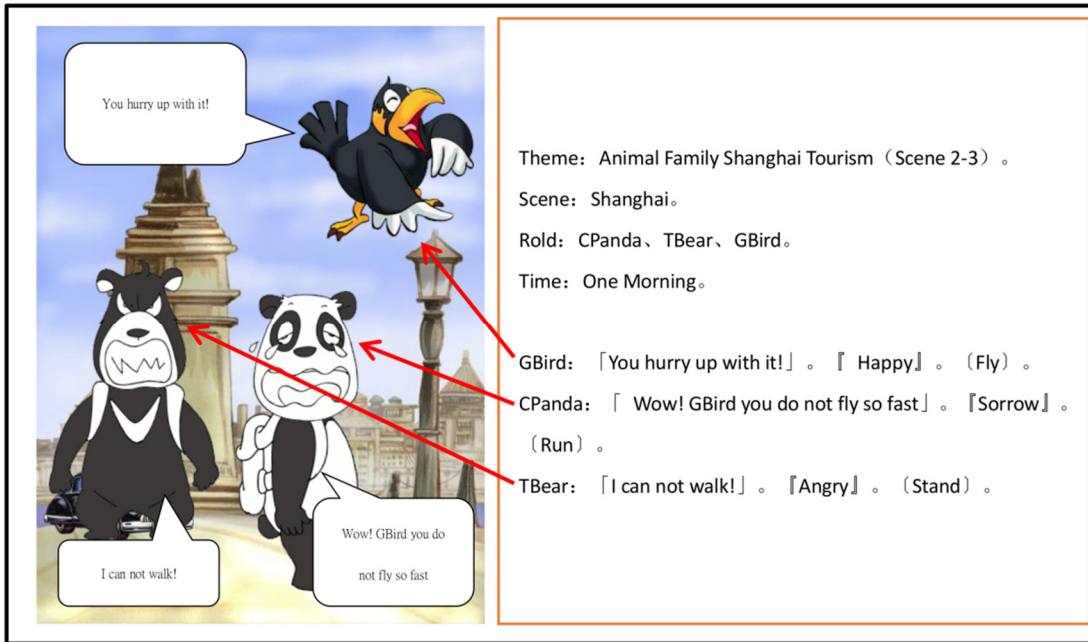
Figure 12. Edit TBear Script Make Comic Examples

COMIC FRAME MAKE SYSTEM ANALYSIS

Comic Frame Design Analysis

Comic frame design, the main purpose of the design is to guide the reader in accordance with the comic designer, Set the comic reading order to read (Arai & Tolle, 2010), and thus into the comic continuous image design, Brought the story of the situation, so that readers feel the story of the changes.

General graphic comic design in the visual expression, and cartoon animation is not the same, Cartoon animation is mainly a fixed play cartoon animation screen, and the continuous production of a different design screen to provide to the viewer to watch, While the performance of comics more static plane design screen, Must be by the reader to follow the comic frame set the order, in order to watch the comic frame in the comic design content. The comic designers in the design of comics, in addition to the design of the comic frame to develop the main reading order, but also take into account the comic layout as a whole to the design aesthetic, as well as the comfort of reading in the comic design of the overall technology is not An easy thing, comic designers must go through long practice, with a lot of accumulated experience.

After the above experimental analysis, the author's comic script, through the "comic script database" system analysis of the script content, the role of dialogue is the first person or second person or third person, and then the analysis of these content the message is sent to the "Design Element Integration Database" to produce a comic picture. This study follows the previous experimental analysis, designed to the first person and the second person and the third person of the comic frame, and the Institute designed comic frame, Through the survey of 500 questionnaires, most of the investigators' backgrounds were art designers or comic lovers, and the contents of the survey were the first person and the second person, as well as the third person comic frame, and the reading order of the comic frame, According to the results of the questionnaire to develop the first person and the second person and the third person of the comic frame style version and comic frame reading sequence design (**Figure 13**).
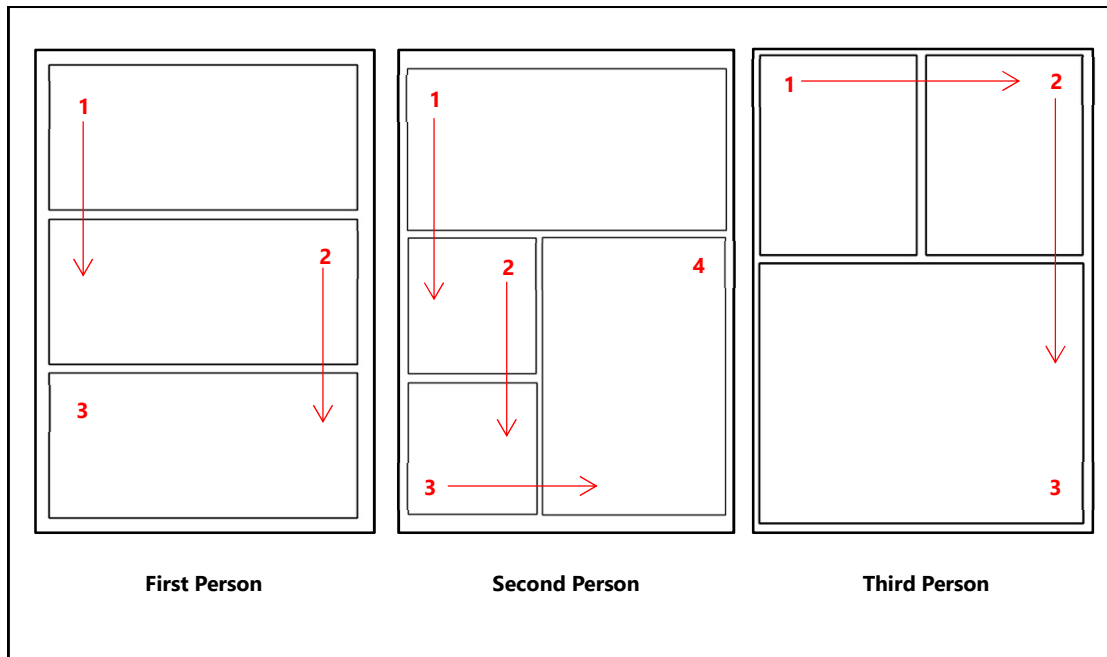
Figure 13. Comic Frame Design Type Analysis
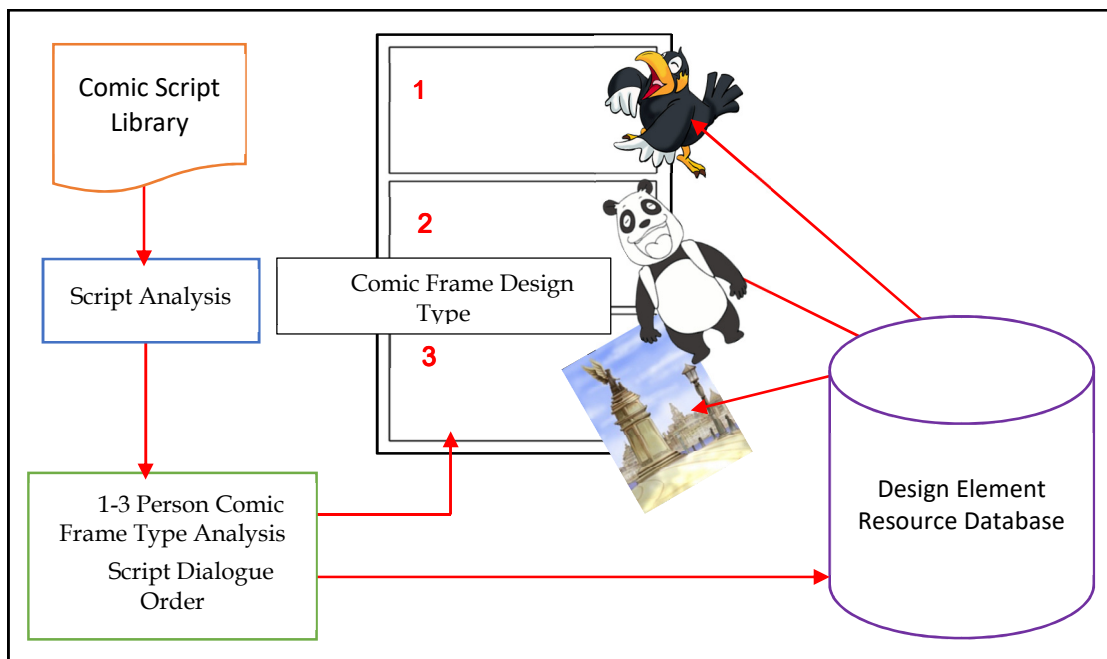
Figure 14. Comic Frame Make System Process

Comic Frame Make System Process

This study collects the comic scripts of the creators and classifies them into comic script databases for analysis, will analyze the content of the comic script content belongs to 1-3 person, and then specify the generation of exclusive roles 1-3 person called comics frame type, and then the system will be in accordance with the analysis of the cartoon script within the role of the dialogue sequence, the role of walking and other attribute parameters, and "Design Elements Integration Database" within the design elements to match, to find the corresponding comic modeling elements, and comic frame Integration, comic design designers need to have frame style of the contents of the comic design (**Figure 14**).
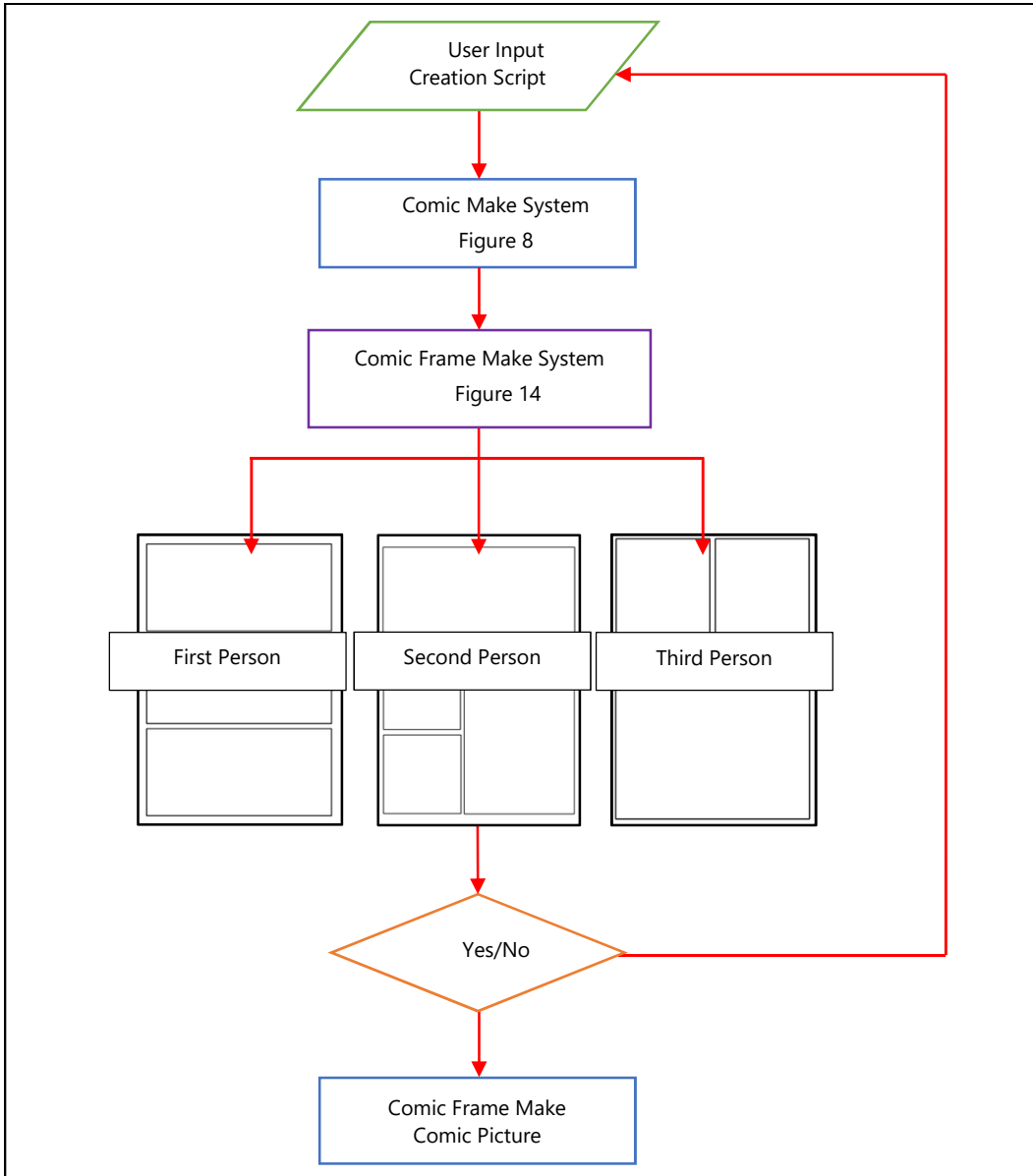
Figure 15. Comic Make System Integration Comic Frame Make System Process

Comic Make System Integration Comic Frame Make System Process

This study provides the creator to input the comic script files created by the comic, and these comics into the comic production system within the comic script database, comic script content of the group analysis and comparison, the performance of the comic script analysis and comparison, such as the role of dialogue order, the role of the interaction between the role of the location and other related parameters, passed to the comic frame system to integrate the system, analysis and create a dedicated 1-3 person comic frame type, and then comic production system produced by the comic modeling elements integration, resulting in creators created by the comic script content, the layout with a comic frame style Content, comic design modeling graphics, and respond to the creator, and if the comic design of the resulting graphic design, non-creator want comic design style, the creator can try to modify the comic script content, and then re-submitted to the system, re-produce comic graphics, until the creation of Satisfaction (**Figure 15**).

Figure 16. System Make First Person Comic Frame Example

Comic Make System Integration Comic Frame Make System Examples

This study will be the creation of the "animal family Shanghai Tourism" comic script a total of three episodes, enter the "comic script database" to provide a systematic analysis of these three comic script content, and comic production system integration frame system, Produced in accordance with the content of the comic specified 1-3 person called comic frame style modeling experiments.

The study found that the system produced the first person of the comic frame style, the ratio between the comic role and the distance, as well as the proportion of the comic background and the angle and the role of the dialog box display position is correct (**Figure 16**), and the system produces a second person comic frame style modeling, found that the comic characters between the role of the more incorrect, and the comic role of the dialog box is too large cover the role of comic role, Abnormal condition (**Figure 17**), and the system produces a third person comic style of frame style, the normal situation and the second person's comic frame style modeling almost, but the situation is slightly better (**Figure 18**).
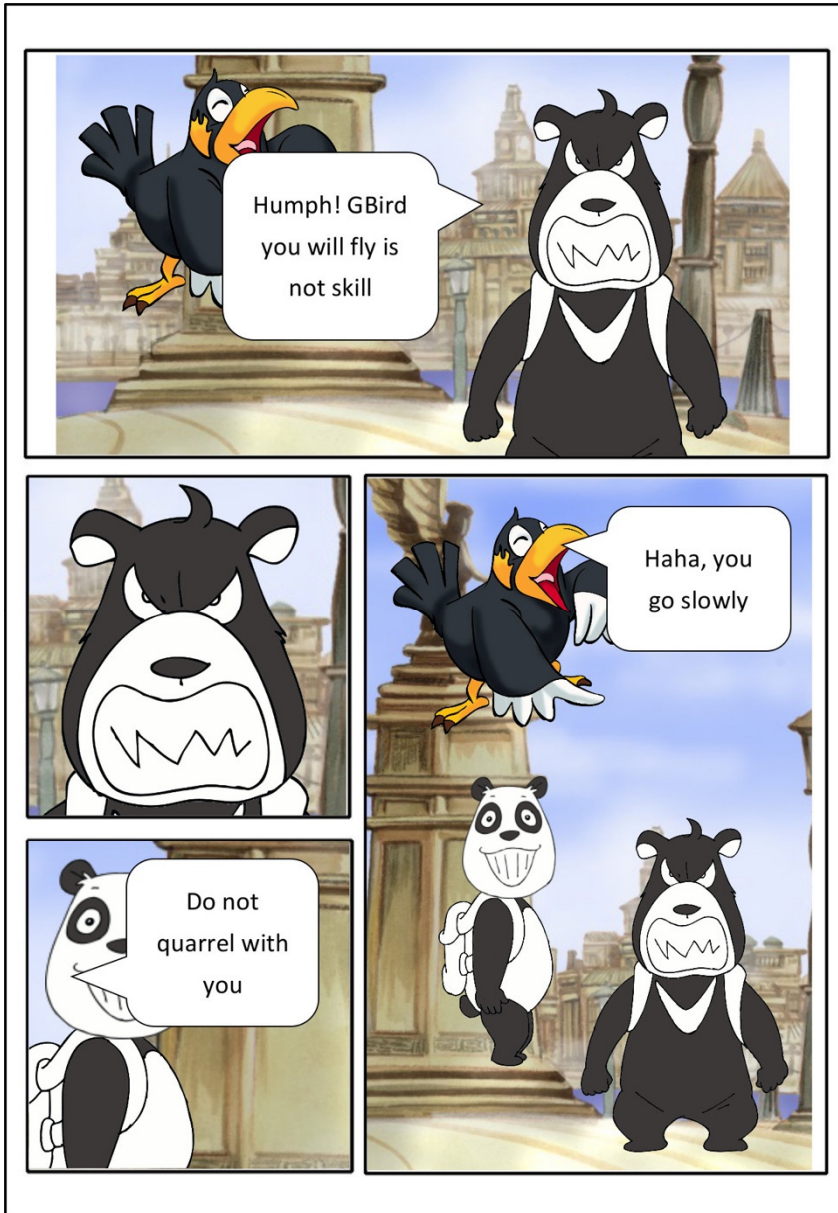
Figure 17. System Make Second Person Comic Frame Example
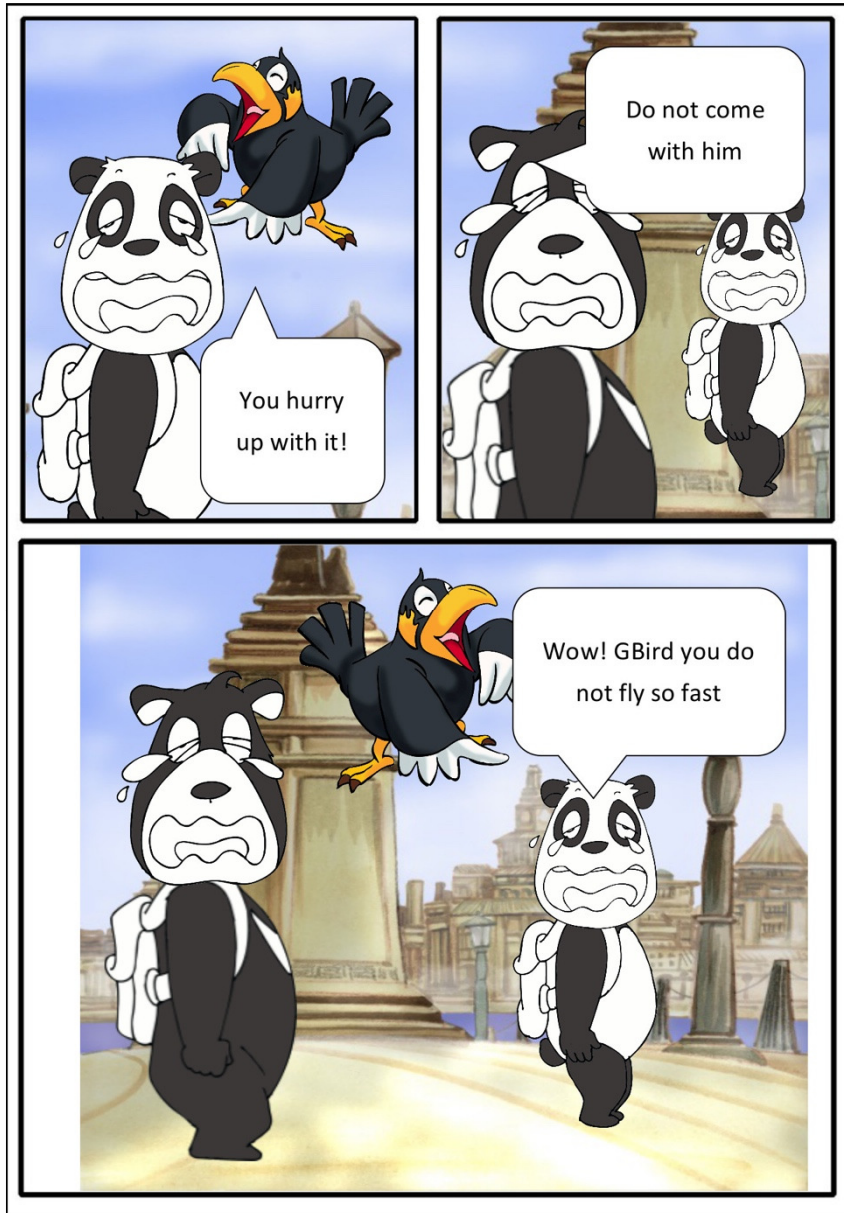
Figure 18. System Make Third Person Comic Frame Example

From the above experimental results can be found, the system produced by the comic frame style modeling the more the number of comic images produced by the wrong situation will be relatively high proportion of this part of the need for more creators continue to modify the comic script Practice, and compare the comic script changes between the data analysis, the gradual improvement.

COMIC SCRIPT CREATION EDUCATIONAL APPLICATION ANALYSIS

In this study, the author has produced the "Questionnaire for the use of comic script creation system" in the application of comic script creation, and has designed six questions about the use of this system by the subject, and the application of this system to comic bookwriter education of the relevant satisfaction issues, to investigate and study. In this study, a total of 2000 questionnaires were collected, and most of the subjects were art designers or comic lovers. The way of this experiment was to let the subjects learn to use the system, write their own comic script, and let the system produce comics Modeling drawings, if the subjects are not satisfied with the system produced comic modeling files, they try to modify the comic script, until the system to produce their own satisfaction with the comic modeling picture , and in the subjects experienced such a creative comic Script, produce comic modeling process, then let the subjects fill out the questionnaire, and statistical analysis of the contents of the questionnaire.

Table 7. Comic Script Creation Educational Application Questionnaire

The Comic Script Creation System Usage Questionnaire	Very Agree -------- Very Disagree					
	6	**5**	**4**	**3**	**2**	**1**
1. This system can help me create comic scripts.	565	689	580	23	30	13
2. I will continuous to use this system to creation comic scripts.	548	632	437	165	127	91
3. I think this system can help comic creation education applications.	881	524	516	17	31	31
4. I think this system can improve the interest of learners.	855	528	542	40	23	12
5. I would recommend other people to use this system.	459	617	636	64	125	99
6. I expect this system to continue to develop other functions for comic script education.	620	517	640	125	72	26

This study collects the questionnaires and analyzes the respondents' questions, and finds out the distribution of the system satisfaction indicators, and the system can help the comic creation education related applications, and can improve the learner's interest Questionnaires on the issue, get a relatively high level of consent (Hosler & Boomer, 2011). The results of this study show that the system is designed to create a comic script by the creator of the comic script, with a considerable degree of fun (Deterding et al., 2011, May; Kam et al., 2008; Lazarinis et al., 2015), can improve the interest of learners (Kim, 2008), and can help learners used in comic story writing writing exercises, and tested It is hoped that the sustainable development of this system, for the development of comic bookwriter creation of other functions, is a worthy of continuous research direction (**Table 7**).

CONCLUSIONS AND FUTURE WORK

This paper analyzes the creative factors of comic design and the development process of cartoon script creation, and designs the Design Element Integration Database system through CDRIM architecture, and provides the system platform for comic group to share the design works, and these comic design elements of the content grouping, easy to manage. This study analyzes the content structure of the comic script and designs the script control symbol, which can control the expression and action of each role and so on, and make the comic image for the system.

After the experiment, this study realizes the cartoonist or comic bookwriter, can write the script directly through the imagination, and the creation of the script into the system, to achieve the direct occurrence of the scene and the role of expression and action and location size of the integrated comic image professional cartoonist design comics constitute the context of the comic of reference, with the reduction of the traditional production of comic design manpower and capital as well as time and other costs, as well as non-professional creative comic design training courses.

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Introducing School Gardens to the Omani Context: A Preliminary Study with Grade 7 Classes

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ABSTRACT

The Sultanate of Oman is beginning to experience a rapid increase in 'lifestyle' diseases, most notably diabetes and cardiovascular diseases. These may be linked to increasing poor dietary habits, and a more sedentary lifestyle, amongst the younger generation. In a number of Western contexts, school gardens have been shown to improve not only student attitudes to diet but also improved learning and affective outcomes. A pilot school gardening project involving a mixed method quasi-experimental design was undertaken in Oman with a number of Grade 7 classes. While the outcomes of this study should be treated tentatively, the quantitative findings indicate that employing school gardens as an educational resource might improve learning outcomes in the area of science skill development. The qualitative findings suggested that the project had a positive impact on the affective domain of students and in some cases encouraged them to pursue healthier eating habits.

Keywords: diet, mixed methods, Oman, pilot study, school gardening

INTRODUCTION

This article reports on the findings of a pilot school gardening project started in the Sultanate of Oman in 2014. The project established school gardens in six schools and research was conducted with Grade 2 and Grade 7 students (Years 2 and 7 of schooling in Oman respectively), who were involved in establishing and maintaining the gardens while also receiving a science teaching intervention that employed the gardens as a resource. The research involved a quasi-experimental mixed methods design and was intended to address the following research question:

Can school gardens be an effective pedagogical resource in schools within the Sultanate of Oman?

This question was broken down into three sub-questions:

- Does school gardening improve students' content knowledge in science?
- Does school gardening improve students' process skills in science?
- Does school gardening encourage students to consume more fruit and vegetables as part of their everyday diet?

For each research question, findings for experimental groups who were exposed to school gardens were compared with control groups who received the same teaching but without the use of the school garden as a resource. This paper presents the findings for the Grade 7 cohort only. Those for Grade 2 will be reported in a future article.

CONTEXT AND LITERATURE REVIEW

Located on the eastern edge of the Arabian Peninsula, the Sultanate of Oman has an extensive coastline that includes the strategically important mouth of the Persian Gulf, the Gulf of Oman and the Arabian Sea. On its western side, Oman is bordered by the United Arab Emirates, Saudi Arabia and Yemen (**Figure 1**). The country occupies an area of 309,500 square km. Its coastal regions are generally verdant and fertile but much of the interior is "sandy, treeless, and largely waterless", inhabited only by Bedouin nomads (Crystal & Peterson, 2016).

Contribution of this paper to the literature

- In this article we present the finding of a pilot study employing a mixed methods methodology on the introduction of school gardens to the Sultanate of Oman. This is the first study of its kind to be undertaken in this country.
- The quantitative findings indicated that using school gardens in Oman as pedagogical resource in science may improve learning outcomes in the area of science skills.
- There was strong evidence from interviews with students and teachers that the school gardens had a positive impact on the affective domain of students.

Figure 1. Map of the Sultanate of Oman with neighbouring countries

Like its neighbours, Oman is heavily dependent on oil resources, which generate 84% of government revenue (CIA World Factbook, 2016). However, dwindling oil reserves and reduced prices for oil internationally, along with increased demands for social welfare benefits in the wake of the Arab Spring uprisings of 2011, have pushed the country's budget deficit to $6.5 billion. The government is pursuing a diversification, industrialisation and privatisation plan, aiming to reduce the oil sector component of GDP from its current 46% to 9% by 2020. Expansion of tourism and gas-based industries are key aspects of this strategy (CIA World Factbook, 2016).

Oman has a population of 3.35 million, 40% of whom are immigrants, mostly low-paid, unskilled workers from South Asia and the Philippines (CIA World Factbook, 2016). In 2015, GDP per capita was $US15305, equivalent to 121% of the world's average (Trading Economics, 2016). With almost half the population being under the age of 25 and the population growing by an estimated 2.05% per year, rising numbers of young Omanis are seeking to enter the workforce (CIA World Factbook, 2016); therefore, a national policy of 'Omanisation' has been attempting to replace expatriate workers with locals.

In 1970, the newly-crowned Sultan Qaboos bin Said established a Ministry of Health charged with making dramatic improvements to Oman's health care system. Financed by the nation's oil and gas revenues, Oman imported medical expertise from other developing nations and prioritised the provision of free, universal primary health care (Treacy, 2014). Within three decades, Oman's public health system was ranked eighth best in the world (World Health Organization [WHO], 2000, p.154). In 1958, the country had only two hospitals and 13 physicians; by 2008, the country had 58 hospitals and over 5,000 physicians (Treacy, 2014).

However, the last decade has seen rapid increases in the chronic 'lifestyle' diseases that are common in affluent, urbanised societies (Ambusaidi & Al-Balushi, 2012). In urban areas, where three-quarters of the Omani population live, Al-Moosa et al. (2006) report a high prevalence of type II diabetes, obesity, hypertension and high cholesterol. These authors suggest changes to dietary and physical activity patterns as probable causes. They also point to the likelihood of an escalation in diabetes and associated coronary diseases as the relatively young population in Oman ages, unless effective lifestyle interventions are undertaken, such as reduction in the consumption of high-fat, high-calorific food.

A newspaper article in the Times of Oman, titled 'Parents declare war on junk food in schools', indicates that an increase in childhood obesity is causing concern amongst Omani parents. Parents were demanding that "low quality meat, French fries, fizzy drinks and chocolates" be removed from the canteen menu, and that children should be encouraged to eat a more balanced diet (Al Shaibany, 2011). The establishment of school gardens, in which children grow their own fresh produce, may help promote healthier dietary choices among young Omanis.

International research on school gardens is accumulating evidence demonstrating benefits both in terms of health and educational outcomes. For example, a report evaluating the Royal Horticultural Society's school gardens campaign in the UK (Passy et al., 2011) found students who took part in school gardening projects developed a positive attitude to healthy food choices, became more willing to try new vegetables and incorporate them into their diet, and also improved in terms of their behaviour, emotional wellbeing and fine motor skills. Educational benefits for the students included greater scientific knowledge, enhanced literacy and numeracy, and better awareness of food production (Passy et al., 2011). Similarly, another major review of school gardening projects conducted by Desmond et al. (2002) for the United Nations reported that school gardens could positively impact nutrition and health as well as academic performance, ecological literacy, school environment/culture, community linkages and vocational education. They suggested that garden based learning "has the potential to enrich basic education in all cultural settings" (p. 20).

SCHOOL GARDENS AND EDUCATIONAL OUTCOMES

As an experientially-based, flexible teaching and learning tool, school gardens can be adapted to suit the needs and objectives of individual teachers. Having specialised gardening knowledge and experience is not a prerequisite; however, what school garden projects do demand from teachers, principals and schools are time, energy, support and funding (Passy, Morris & Reed, 2011). Integrated into the curriculum, the hands-on learning environment offered by a school garden can be used to teach core academic subjects, including science, environmental science, mathematics, arts and language (Graham et al., 2005).

Evidence has been accumulating for several decades that school gardening projects can lift academic performance across a range of areas. Using standardised testing, Sheffield (1992) demonstrated that higher mathematics and literacy scores were achieved by an experimental group of gardening students as compared to a control group of non-gardening students. More recently, Passy, Morris and Reed (2011), in their report on UK school garden projects, found teachers nominated a wide range of enhanced cognitive outcomes for students engaged in garden-related activities. Within the domain of science, teachers saw improvements in the children's understanding of concepts (e.g., taxonomy), methods (e.g., experimentation), knowledge (e.g., life cycles) and in use of appropriate scientific language. Mathematically, the students improved in measurement, estimation, and use of data and graphs. Literacy was also impacted, via reading and writing of various text types, from reading seed packets through to producing imaginative work such as poems and riddles inspired by the garden.

Improvements in self-confidence and self-esteem can be another beneficial effect of school gardens, particularly for underachieving students (Sheffield, 1992; Hoffman et al., 2004). Ruiz-Gallardo et al. (2013) found school failure and disruptive behaviour decreased and skills, academic performance and self-esteem improved amongst 'at-risk' secondary students in Spain after a two-year garden-based learning program. Exploring the therapeutic associations of horticulture, Smith and Aldous (1994) found that gardening resulted in students with learning disabilities feeling more valued as individuals. Clarke (1997) noted that gardening promotes responsibility, and encouraging children to care for plants and respond to living things offers a rare opportunity to guide them in an affective style of learning. Another study of children in the USA indicated that they developed better interpersonal skills and attitudes toward school by engaging in a school gardening program (Waliczek et al., 2001).

THEORETICAL CONSIDERATIONS

Less formal settings such as school gardens can allow learning to be more autonomous and independent, which are aspects students value (Falk & Dierking 2000; Paris, 1997). Out-of-class settings enrich students' learning experiences, motivate them to learn science, encourage lifelong learning and expose them to future careers (Tal, 2012; Bamberger & Tal, 2007). As these settings tend to be informal and idiosyncratic, learning is more influenced by the students' personal and social context.

Table 1. Sample size for each dataset per school

	Control Group			Experimental Group		
	*SPS	#SCK	^ASGHDH	*SPS	#SCK	^ASGHDH
School 1 (All Females)	30	47	51	47	60	64
School 2 (All Males)	60	63	61	54	55	58
School 3 (All Females)	63	65	65	64	50	60
School 4 (All Males)	50	50	50	68	68	64

*SPS=Science Process Skills; #SCK=Science Content Knowledge; ^ASGHDH=Attitudes to science, gardening and healthy dietary habits

Personal identities are influenced during out-of-class activities through 'learning talk', which may constitute up to 89% of students' conversation time in school gardens (Griffin, 2007; Leinhardt & Gregg, 2002). Students see learning outside the classroom as part of their social environment, and small group work gives them an optimal context for sharing information and finding answers to complex issues (Falk & Dierking, 2000; Paris, 1997). Students appreciate socially-mediated learning environments that allow them to exercise choice and control (Griffin, 2004).

METHODOLOGY

The focus of this study – Can school gardens be an effective pedagogical resource in schools within the Sultanate of Oman? – falls within a larger research project whose preliminary design was presented in an earlier paper by Ambusaidi et al. (2015). This study involved six schools within three geographical regions, Muscat (Seeb), Al-Dakhlyai (Nizwa and Samail) and Batinah South (Wadi Al-Maael). The schools were selected from Basic Education Schools Grades 1-10, with two being co-educational Grade 1-4 schools and four being single-sex Grade 5-10 schools (two male and two female). Schools were chosen based on their willingness to participate in the project and the presence of a teacher willing to oversee the management of the garden, preferably someone with some expertise in gardening. However, none of the schools involved had ever previously had a school garden, as such a concept is unknown in Oman. The project employed three research assistants, one in each location. The research assistants reported to the principal investigators, advised on maintaining the school gardens, provided advice on pedagogy and collected data from the project (Ambusaidi et al., 2015). The project involved a quasi-experimental design employing a mixed-methods methodology and was run in a series of phases described below:

Phase 1 – Pre-intervention Data Collection

Three pre-test instruments were developed for and administered to Grade 7 students in both the control and experimental groups. These were designed to test content knowledge, process skills and attitudes towards science, gardening and healthy dietary habits (**Table 1**). Some of the items were adapted from existing questionnaires employed by Block and Johnson (2009) in their evaluation of the Stephanie Alexander Kitchen Garden Program in Australia.

The content knowledge instrument comprised 24 items with eight being multiple-choice items and the remainder being short-answer items. The science process instrument comprised 18 objective items covering six skill sets each made up of three items: observation, drawing inferences, data interpretation, prediction, hypothesising and identification of variables.

Finally, the attitudinal instrument comprised 32 Likert items with three response options (agree, disagree, neutral). This instrument was designed to assess student attitudes towards the three subscales of healthy dietary habits, science and gardening.

Phase 2 – Establishing the School Gardens

In this phase, the researchers worked with each of the six selected schools to establish the gardens (**Figures 2** and **3**). Compost bins were also established in each school to provide an ongoing source of growing medium for each garden.

Figure 2. Grade 7 students preparing beds and planting school gardens

Figure 3. Grade 7 students sorting seedlings

Phase 3 – Linking Gardening to the Curriculum

During this phase, the researchers worked with teachers to develop a set of garden activities that linked to the school curriculum at the Grade 7 level. This involved conducting an in-depth analysis of the Omani curriculum from Grades 1-7 inclusive, and then adapting existing published activities to the Oman context and developing some new ones to match curricular outcomes.

There was considerable scope for linking school garden activities to the formal curriculum in Oman, predominantly the science curriculum, which also encompasses key aspects of environmental and health education (see Ambusaidi & Elzain, 2008; Ambusaidi & Al-Rabaani, 2009; Ambusaidi & Al-Balushi, 2012). For the purposes of this research project, the focus of the teaching was science, and specifically plants, at Grade 7, and a series of draft activities were developed around these topics and produced as unit booklets.

Phase 4 – The Intervention

Following the establishment of the school gardens and preliminary data collection, a three-month teaching intervention took place at each of the six schools. During this period teachers used the draft activities written in Phase 2. At each school, specific teachers were provided with initial intensive training in using the activities. As part of this training, the researchers modelled some of the activities with the students and the teachers to allow them the opportunity to experience the garden as a learning resource from a learner's perspective. Parents and other members of the local community were invited to an open day at each participating school, at which point the project was outlined in detail, including the nutritional and health benefits of growing and consuming their own vegetables, and they were given instructions on establishing small scale vegetable gardens in their own localities.

The same curriculum content was delivered in the control and experimental schools. However, in the control schools it was delivered without the use of school gardens as a resource. The content was linked to the Omani Science Curriculum in Grade 7 and covered topics such as plant structure and the functions of the various structures, germination and plant growth, transpiration and photosynthesis. The activities in the experimental group involved amongst other things, examining and observing the main parts of plants, growing plants for seeds and cuttings, and measuring and graphing plant growth to determine growth rate. The control classes covered the same content but did so according to their normal practice, which in Oman is generally guided inquiry, although many teachers employ a more didactic approach to teaching science (Ambusaidi & Elzain, 2008).

Phase 5 – Post-intervention Data Collection

At the end of the teaching intervention, students from both control and experimental groups completed three post-tests using the pre-intervention data collection instruments on content knowledge, process skills and attitudes towards the three subscales of healthy dietary habits, science and gardening. A series of post-intervention interviews were undertaken with a subset of participants from the experimental group to help with data triangulation.

ANALYSIS OF DATA

All statistical analysis was undertaken with SPSS version 24. Independent samples T-test was used to analyse the science process skills and the science content knowledge data. Furthermore, a one-way between-groups multivariate analysis of variance was performed to assess group and gender differences in attitudes to healthy dietary habits, science and gardening.

A number of semi-structured interviews were conducted with Grade 7 students and teachers who had been involved in the gardening project. These interviews were conducted in Arabic then fully transcribed and translated into English. They were then coded based upon a number of themes, such as learning, enjoyment, family involvement and dietary change. Excerpts from the interviews with students and teachers are reported below under qualitative findings.

FINDINGS

Quantitative Findings

The science process skills test

The independent samples T-test indicated that within the experimental group (N = 233), taught using the school garden as a resource, there was a statistically significant improvement in overall performance between the pre- test

Table 2. Independent samples T-test summary for individual science process skills for experimental group

	Observation Skills		Inferring Skills		Interpretation Skills		Prediction Skills		Hypothesizing Skills		Identification of control variable Skills	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
N	233	234	233	234	233	234	233	234	233	234	233	234
Mean	57.51	61.68	38.2	39.6	34.41	42.17	40.41	46.87	36.34	46.72	25.32	33.9
Std. Deviation	22.84	20.862	27.205	27.599	32.678	33.623	29.905	30.253	34.506	34.163	25.759	28.383
Std. Error Mean	1.496	1.364	1.782	1.804	2.145	2.198	1.959	1.978	2.261	2.233	1.688	1.855
Sig. (2-tailed)	.04*		.58		.012*		.021*		.001*		.001*	

Statistically significant (*$p < .05$)

Table 3. Independent samples T-test summary for individual science process skills for control group

	Observation Skills		Inferring Skills		Interpretation Skills		Prediction Skills		Hypothesizing Skills		Identification of control variable Skills	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
N	203	203	203	203	203	203	203	203	203	203	203	203
Mean	62.97	66.42	38.34	46.72	36.86	39.57	51.31	50.41	39.08	43.6	33.91	33.09
Std. Deviation	21.4	19.16	29.958	27.101	30.935	32.062	26.862	29.267	32.874	34.149	27.67	28.89
Std. Error Mean	1.502	1.345	2.103	1.902	2.171	2.25	1.885	2.054	2.307	2.397	1.942	2.028
Sig. (2-tailed)	.088		.003*		.387		.746		.175		.770	

Statistically significant (*$p < .05$)

($M = 39.46$, $SD = 14.186$) and post-test ($M = 45.31$, $SD = 15.719$; $t (465) = -4.22$, $p = .000$, two-tailed). However, although there was a small improvement in the control group (N = 203) performance between the pre- test ($M = 44.47$, $SD = 14.19$) and post-test ($M = 47.1$, $SD = 13.91$; $t (404) = -1.889$, $p = .06$, two-tailed), this was not statistically significant.

Males in the control group (N = 110) showed a statistically significant difference in overall performance between the pre-test ($M = 43.86$, $SD = 14.764$) and post-test ($M = 48.52$, $SD = 15.519$; $t (218) = -2.283$, $p = .023$, two-tailed). A similar result was also shown by the males in the experimental group (N = 122) with a statistically significant difference in overall performance between the pre-test ($M = 37.28$, $SD = 13.597$) and post-test ($M = 45.81$, $SD = 16.414$; $t (243) = -4.429$, $p = .000$, two-tailed). The results indicated a higher gain in mean test score for the experimental group.

No statistically significant difference was noted for the females in the control group (N = 93) when their pre-test scores ($M = 45.19$, $SD = 13.524$) and post-test scores ($M = 45.42$, $SD = 11.587$; $t (184) = -.127$, $p = .899$, two-tailed) were compared. A similar finding was noted for females in the experimental group (N = 111) when their pre-test scores ($M = 41.85$, $SD = 14.491$) and post-test scores ($M = 44.75$, $SD = 14.966$; $t (220) = -1.466$, $p = .144$, two-tailed) were compared.

In the six skill areas, the experimental group showed a statistically significant improvement in five of the skill areas, the exception being the skill of inferring (**Table 2**). Interestingly, for the control group, the skill of inferring was the only skill to show a statistically significant improvement (**Table 3**). In terms of gender within the experimental group, only females made a significant improvement in observation, inferring and prediction skills.

The science achievement test (content)

In the case of the achievement test for content knowledge, the control group (N = 225) showed a statistically significant difference in overall performance between the pre-test ($M = 33.61$, $SD = 11.69$) and post-test ($M = 57.97$, $SD = 17.095$; $t (448) = -17.644$, $p = .020$, two-tailed). A similar result was also shown by the experimental group (N = 233) with a statistically significant difference in overall performance between the pre-test ($M = 33.23$, $SD = 11.87$) and post-test ($M = 51.84$, $SD = 18.352$; $t (464) = -12.993$, $p = .000$, two-tailed). Thus the use of the school garden as a resource had impacted positively on the learning of content knowledge but was apparently no more effective in this domain than normal teaching without this resource.

These results were also reflected within gender. A statistically significant difference was noted for the males in the control group (N = 113) when their pre-test scores (*M* = 34.46, *SD* = 12.929) and post-test scores (*M* = 52, *SD* = 17.299; *t* (224) = -8.633, *p* = .000, two-tailed) were compared. Similarly, males in the experimental group (N = 123) showed a statistically significant difference when their pre-test scores (*M* = 29.92, *SD* = 13.155) and post-test scores (*M* = 49.96, *SD* = 20.492; *t* (244) = -9.125, *p* = .000, two-tailed) were compared.

A similar finding was noted for females in the control (N = 112) and experimental groups (N = 110). A comparison of pre-test scores (*M* = 32.75, *SD* = 10.276) and post-test scores (*M* = 63.99, *SD* = 14.662; *t* (222) = -18.467, *p* = .000, two-tailed) for females in the control group showed a statistically significant difference. Similarly, females in the experimental group showed a statistically significant difference when their pre-test scores (*M* = 36.94, *SD* = 8.943) and post-test scores (*M* = 53.94, *SD* = 15.441; *t* (218) = -9.995, *p* = .000, two-tailed) were compared.

Attitudinal survey

Overall there was a statistically significant improvement in attitude towards gardening in the experimental group, *F* (3, 466) = 3.67, *p* = 0.012; Wilks' Lambda = .98, but not in the other two subscales of healthy dietary habits and attitudes towards science. The analysis also indicated that females within this group showed a significant improvement in their attitude towards science, gardening and the combined score of the three subscales, *F* (3, 466) = 3.67, *p* = 0.014; Wilks' Lambda = .98. There was no change in any of these scales for the control group.

Qualitative Findings - Student Interviews

Eight female students and fifteen male Grade 7 students were interviewed upon completion of the intervention in the experimental groups. They were asked about a range of issues, including what they felt they had learnt, how the project could be improved and the extent to which their parents had taken an interest in the project.

Some comments from the Grade 7 female students are summarised below (all have been given pseudonyms). Many of the girls mentioned that they had appreciated the change in their learning environment. For example Nasren commented:

> *I felt a change in the learning atmosphere. I learnt about how plants grow and my observation skills improved, so yes I would like it if the project continues.*

This sentiment was also expressed by Amal:

> *I liked the change in the learning environment, because for me learning outdoors increases my desire to learn, and I also liked how the project encourages the usage of natural resources in learning.*

While Muna mentioned that she enjoyed the group-work with her friends but also the sense of depending on herself throughout the while caring for her growing plants.

Fatima commented on a number of issues she found favorable, including the change of learning environment:

> *It was a great experience for me for many reasons: we first had a change of atmosphere from a boring classroom to a garden. I also liked planting different vegetables, which made me like eating them more. In addition, I learnt planting methods and I loved watching the plants grow. I'd love it if the project continues in every school because my brothers and sisters enjoyed working with me at home.*

Like Fatima, all of the girls interviewed claimed that they had engaged their families in the project mainly by taking some plants home and growing them there with the help of their parents.

All of the girls felt they had learnt a lot about plants and plant husbandry, and some claimed that they had changed their dietary habits. Hanan commented that she had learnt a lot of things about gardening, and her appetite for fruits and vegetables had increased. She claimed to love going to the garden and hoped that the project would continue.

Overall, as Nawal commented, the garden was a source of considerable motivation for the students:

> *I loved studying inside the garden. The ways we worked and did stuff in the garden were a big motivation to learn.*

These female students appeared to find that the school garden offered an entirely new learning environment compared to the one they had previously experienced in science classes. By its very nature, gardening is a hands-on activity that lends itself to working in groups, and this may have been quite a novel approach to learning science for these female students. Furthermore, the project was designed to engage with families, and it was encouraging

to note that all of those students interviewed had involved their families. Another encouraging finding was the claim by some participants that they were now eating more fruit and vegetables as a direct result of this gardening project.

The male Grade 7 students who were interviewed were also enthusiastic about the school garden project. As with the female students, the males claimed to enjoy the practical, hands-on approach that the garden offered. Ahmed commented:

> *The science classes this year have become very interesting and I am waiting it with eagerly because of their importance in our educational, practical and professional life. I hope to be an agricultural engineer in the future. I hope that the project will be implemented for all grades due to its benefit and fun we had at the same time.*

Mohammed expressed similar views about the nature of his experience:

> *The science lessons when we were taught through the project made me active because it combined theoretical and practical side and this in itself earns a lot of knowledge that you may not get it in the subject that lacks practical side. The project changed a lot of things in my life, especially in my diet and the benefits of agriculture in the health, environmental and economic fields.*

The issue of health and diet was a common theme emerging from the male interview data.

> *The school garden project changed a lot of my wrong food habits and I wish to continue in the project and be an integral part of the school curriculum because it teaches students a lot of knowledge about healthy food (Abdul- Aziz).*

This theme of health and healthy eating was mentioned by half of the cohort interviewed.

> *I become an expert in the manufacture of healthy meals at home and this is due to school garden project, which allowed me to learn by doing. I also became interested in the cultivation of crops such as tomatoes, cucumbers, carrots and peppers because of their great importance in my personal health and the health of my family members (Said).*

A number of the males also made the link between gardening and agriculture more generally. For example Farooq commented:

> *I started to be interest in agriculture...I want to work in an agricultural research centre. I learned from the project methods of plant reproduction. The project has contributed to higher achievement level to me and my colleagues. I would like to be added in the project, some knowledge about agricultural pests, the types of drugs (chemicals) used to combat them.*

The themes emerging from the interviews with male students were rather different than those from the females, and this may have reflected different teaching approaches with male and female students, as in Oman all secondary schools are single-sex. However, there appeared to be common enthusiasm for the project regardless of gender.

Teacher Interviews

Four Grade 7 science teachers (two females and two males) were also interviewed as to their impressions of the gardening project and the benefits or otherwise for their students. One female teacher felt that the project had a number of benefits, particularly for low-achieving students.

> *The project contributed in improving the level of students' achievements especially those low achiever students and those with low self-concept and self-esteem. In addition, the project improved students' skills in agriculture and their attitudes towards science.*

She went on to say that the project had helped to enhance the level of communication between students, teachers and parents, and in particular she believed that some of the students were displaying better communication skills as a result of having to explain their activities throughout the project. She also felt that if implemented on a long-term basis such projects had the potential to reduce dependency on imported foods and teach students how to develop small enterprises related to agriculture.

The second female teacher working at an all girls' secondary school spoke specifically about the affective and psychological benefits of developing and working with a school garden in the context of what is otherwise a very arid and barren environment.

The school garden project is one that enrich both the teachers and students especially…personally I learnt a great deal about planting methods, organic and industrial fertilizers, growing plants and combating insects and pests. In addition the project improves the curriculum of science in Grades 5-10 through adding more live practical experiments, which increases the students' drive to learn, as well as enriching lessons related to contemplating God's creations such as Islamic studies and Arabic. I was drawn to how my students loved the gardening lessons, and how much they enjoyed mixing soils and watching the plants grow. The project also helped create a positive atmosphere for both the teachers and students through working in a beautiful place filled with greenery. An example of such an effect was when the school psychological specialist referred girls who were suffering from depression and loneliness to spend some time in the garden, and the improvement in their psychological condition was evident. Most girls that were involved in the project went to the garden whenever they had free lessons, a testament to how much they enjoyed being there.

One of the male teachers said that the project helped to strengthen the relationships between students and teachers through changing the way of teaching and use of the school environment as a place of learning science. He was also happy that the school now had a garden that could be used to teach science in future and hoped it would encourage other teachers to use it with other classes in their teaching.

Like the female teacher, the second male teacher interviewed commented that the project had enhanced communication between students, teachers and the parents. He went on to comment:

This project had a major role in raising the enthusiasm and motivation of the students and for me personally to use farm tools as well as to provide the student with a safe environment and create an attractive learning environment for students. It also inspired the spirit of teamwork and created an attractive learning environment for the students.

Overall these teachers were delighted that the gardens would remain after the research project was over. One did, however, comment that to conduct science activities within the context of a garden was quite time-consuming and the amount of lesson time allocated for science was rather short.

DISCUSSION

This research project was underpinned by the overarching question: Can school gardens be an effective pedagogical resource in schools within the Sultanate of Oman? The following sub-questions informed this broader question:

- Does school gardening improve students' content knowledge in science?
- Does school gardening improve students' process skills in science?
- Does school gardening encourage students to consume more fruit and vegetables as part of their everyday diet?

This project was very much a pilot study, as prior to this research, school gardens were unknown in Oman. Consequently, the findings have been treated very tentatively. However, there are initial indications from this pilot that establishing school gardens may benefit students in terms of learning outcomes, and in particular the development of science process skills. There were also some indications from both the survey and interview data that the intervention did impact positively on some students' attitude towards gardening and agriculture.

However, perhaps the most encouraging finding, albeit with a small sample of students and teachers who were interviewed, was the apparent positive impact in the affective domain of students, who seemed to find the experience of teaching and learning within a school garden very satisfying. Thus overall, on the basis of this pilot, it appears that introducing gardens to school could be beneficial in the context of Oman.

While the quantitative data did provide some evidence of improved understanding of science concepts, this was not significantly different from that of the control group taught in a more traditional manner. However, in the area of science process skills, there did appear to be a greater gain for the experimental group than with the control group. This may have resulted from the opportunities afforded by the garden for more hands-on student centred activities and seems to be in keeping with at least some of the findings of Passy et al. (2011) who reported improved scientific skills amongst students who had undertaken a school garden project in the UK.

The attitudinal survey indicated that the gardening project provided students in the experimental group with a more positive view of agriculture and gardens. This is important, as traditionally, employment in agriculture has been viewed as rather menial in Oman. Hence, migrant workers largely undertake the limited work that exists in agriculture. However, it was rather disappointing that the project did not appear to improve attitudes towards

healthy eating. More time may be required to develop a more positive attitude in this area. Having said this, there was evidence from the qualitative findings that some students were considering issues of diet and health.

The interview data indicated that both male and female students really appreciated the change in the learning environment away from the classroom and towards a more practical approach. This appears to be consistent with the findings of Waliczek et al. (2001), who found that students in the USA who engaged in gardening projects developed better attitudes towards school. There was also a sense from the responses, which as Falk and Dierking (2000) and Paris (1997) reported, the students may have enjoyed more autonomy and independence of learning, in the less formal environment of a school garden.

Although only anecdotal, one teacher reported that she felt teaching and learning in the school garden was particularly beneficial for low-achieving students and it impacted positively on their self-esteem. This was very much in keeping with research reported by Hoffman et al. (2004) for students in the UK, suggesting that some benefits of school gardens may apply across cultural contexts. In fact, it was encouraging that in a conservative Islamic country such as Oman, one female teacher suggested that the use of a school garden for teaching was very much in tune with Islam. The same teacher reported that girls with depression were being encouraged to spend time in the garden.

So clearly there were a number of positive outcomes from this pilot study. This particular study focused only on the science curriculum, but as suggested by Morris et al. (2002) there would be scope for integrating the school garden with many other curricular areas. However, as Passy et al. (2011) caution, integrating school gardens into the curriculum requires time, energy, funding and effort. It also requires student and staff support, especially from the school principal, and it was notable in this study the impact that enthusiastic teachers made to the establishment and maintenance of a garden and ultimately the effect on teaching. School gardens require ongoing attention, particularly in a harsh arid environment like Oman, which has a predominantly desert climate, so identifying staff and students within a school who are willing to work on the garden, even after the 'novelty' of such a project has worn off, is crucial.

Establishing school gardens in Oman is quite costly as initially at least soil has to be purchased and because of the arid conditions and intense sunshine, crops generally need to be grown in raised beds and under shade cloth. Furthermore, although fresh water is generally available, much of this comes from reverse osmosis desalination, a costly and potentially environmentally damaging process producing large quantities of salt. If the Sultanate of Oman decides to pursue the establishment of school gardens, it may be worth conducting trials using hydroponics as an alternative cultivation method to circumvent some of these issues.

Finally, a further complication in Oman and other countries in the Gulf region has been the collapse in the price of oil in recent times. This is now putting severe restrictions on many projects, and could well jeopardise any plans to extend the introduction of school gardens to a larger number of schools. In our opinion this would be unfortunate, as despite the tentative nature of our findings they do suggest that school gardens have potential benefits for both teachers and students in Oman, and at the very least an extended trial appears to be merited.

ACKNOWLEDGEMENT

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The Study of University Students' Awareness and Attitude Towards Environmental Education in Northern Cyprus

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ABSTRACT

This research has been conducted to detect the attitude and behavior levels of university students in Northern Cyprus about environmental education The research population consists of the university students in Northern Cyprus, while the sample consists of 175 university students in Northern Cyprus in the same year. The "environmental awareness scale" and "environmental attitude scale" was administered to the participants as data collection tools. The answers that the students gave have been analyzed quantitatively. It has was found that female students have higher environmental attitudes and they are more sensitive to the environment than male students.

Keywords: environment, environmental awareness, environmental attitude, environmental education

INTRODUCTION

The environment can be described as the outer environment where all living things maintain their lifetime relationships. The environment consists of viable and non-viable factors. The viable factors of the environment are human beings, plants, animals and microorganisms. Non-viable factors are both natural and human-made resources and assets such as air, water soil, landforms, buildings and bridges (Başal, 2003).

The environment is the integration of physical, chemical and biotic factors that have influence on the lives of living organisms in a particular habitat. In summary, it includes all the factors that have effect on the life of organisms (Yücel, 2006).

The environment represents different meanings about whether or not to be a subject of human activities. Yücel separated the environment into two parts consisting of the physical and social environment. The environment in which living things sustain their lives and perceive physically their existence, features and characters is called the physical environment. The physical environment is divided into two, the natural environment (mountains, sea, lakes, etc.) and the artificial environment (city, town, dam, etc.). The environment, the formation of which human beings do not have any effect on is called the natural environment, while the one that has changed according to the needs of human beings is called the artificial environment (Yücel, 2006).

The environmental awareness is the reaction that an individual or society faces environmental problems with the acts and thoughts for the protection of the environment in parallel with the development of environmental problems against the problems affecting them. Environmental awareness has emotional and behavioral dimensions. In other words, environmental awareness consists of the thoughts including decisions, principles and interpretations about the environment, behaviors that are the transfer of such thoughts to life and several feelings regarding all these.

Environmental awareness is an important condition for studies preventing the environmental pollution and environmental friendly attitudes but it is not sufficient. All of society should be included. According to Wong (2010), people's environmental awareness is the perception representing the sum of the changes in environmental and socio-economic dimensions of a nation in a given space and time. The resolution of the problems is difficult unless individuals and families participate and wrong habits are changed. People who have

Contribution of this paper to the literature

- The levels of environmental attitude and behavior of the university students who were studying in Northern Cyprus were not at the expected level.
- Certain precautions are advised in the paper to improve the current level.
- There is statistically significant difference between the grade levels of the students and they are known to be environment friendly by their friends.

environmental awareness are the ones who select the least negative way and method to the environment while producing or consuming in daily life (Erkal et.al, 2001).

Environmental education is a way of teaching how to protect the environment which we live in, and its importance through systematic and scientific ways (Kabaş, 2004; Külköylüoğlu, 2000). As Özden (2008) notes formal environmental education should be started from preschool and continued up to university also, the lessons about environmental science and environmental issues should be thought from beginning elementary school up to university. Non-formal environmental education on the other hand involves all educational processes conducted outside of school. It is directed to all age groups, especially mature people who have finished their studies. (Wojcik, 2004).

Doğan (2000) makes an assessment about the environmental education to be an eternal process in which individuals and societies acquire awareness about sustainable development through knowledge, values, abilities and experiences, and obtain the determination to act in order to resolve the current and future environmental problems. Environmental education is the process to make the thoughts comprehensible and verify the values in order to develop important attitudes and abilities so as to understand and accept the relationship among environmental education, humans, culture and the biophysical environment. Another definition of environmental education is the helping process that other people to acquire appropriate behaviors and skills to understand and protect the relations and interactions between their cultural and biological environments (Kabaş, 2004).

The individuals that have had environmental education are supposed to have the properties that are indicated below under the natural, social, value and action content titles when compared to the individuals not involved in environmental education (Keleş, 2007).

In the light of the information mentioned above, it has been targeted in the research to determine the environmental education, attitude and behavior levels of the university students with help of a questionnaire and to increase the environmental awareness of the students through environmental education support.

MATERIAL AND METHODS

Model of the Research

In this section of the study descriptions about the model, sampling, data collection tool, implementation of data collection tool and data analysis of the research about "the investigation of the attitude and behavior levels of environmental education, university students studying in Northern Cyprus" are included.

Universe and Exemplary/Research Group

The universe of this research is formed by the university students in Northern Cyprus. As for the sample of this research, it included 175 university students studying in the 2014-2015 academic period.

Data Collection Tool and/or Techniques

In this study, the "Environmental Awareness Scale" and "Environmental Attitude Scale" were administered to the participants as data collection tools (Give the tool in the appendix). The data collection tool which was developed by the researcher was based on the literature (theses, articles, announcement, scientific research, and so on). The subject was investigated in order to initially create the main structure of the research, the objectives of the research and the conceptual structure and main framework of the data collection tool were then created.

Analysis of the Data

The answers that the students gave to the data collection tool have been analyzed in quantitatively. The information that was obtained from the questionnaires was analyzed using the SPSS 20.0 program. In determining whether university students in Northern Cyprus differed according to gender or not about the environment, environmental education and environmental awareness the unrelated t-test was used, while in determining

Table 1. The relation between the ages of the students and whether they received environmental course before (chi-square test)

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7,054[a]	1	,008		
Continuity Correction[b]	6,196	1	,013		
Likelihood Ratio	6,992	1	,008		
Fisher's Exact Test				,012	,007
Linear-by-Linear Association	7,013	1	,008		
N of Valid Cases	174				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 22,03 b. Computed only for a 2x2 table1.

Table 2. T-test results of environmental attitudes of the students according to the gender variant (n=173)

Gender	n	(x)	s	p
Female	100	2.6876	.3547	.001
Male	73	2.5051	.3801	

Table 3. The results of environmental attitudes of the students according to age (n=173)

Age	n	(x)	s	p
Female	102	2.5597	.3812	.040
Male	71	2.6793	.36462	

whether they differed according to the education of their parents an Anova, Chi-square test was used. In order to investigate the behaviors of the students with regard to their efficiency about environmental education the frequency and percentages have been used.

FINDINGS

The findings obtained as a result of the research are given in tables and explained in this section. Some comments are made by taking into consideration whether or not the attitudes and behaviors of the students towards the environment differed (see **Table 1**).

There is no relationship between age and whether an environmental course was taken before. There is a relationship between age and whether an environmental course was taken before. As p=0.008< α=0.05, H_0 is rejected. There is a relation between the ages of the students and whether they received environmental course or not before. Namely, their ages had an effect on getting environmental course (see **Table 2**).

There is no significant relationship between the gender and environmental attitudes of the students. There is a significant relationship between the gender and environmental attitudes of the students. As p=0.001 <α=0.05, H_0 is rejected. There is a significant relationship between the gender and environmental attitudes of the students. According to the independent exemplary t–test, there is a significant relationship between the gender and environmental attitudes of the students. Even though the environmental attitudes of both male and female students are found to be high in both groups, the scores of female students are found to be significantly higher than male students. Because the average of female students (2.6876) is found to be higher, it differs from male students significantly (see **Table 3**).

There is no significant relationship between the age and environmental attitudes of the students. There is a significant relationship between the age and environmental attitudes of the students. As p=0.04< α=0.05, H_0 is rejected. There is a significant relationship between the age and environmental attitudes of the students. This result means that there is a significant relationship between the age and environmental attitudes of the students. Even though the environmental attitudes of the students are found to be high in both groups, the scores of the 23 years and above students are found to be significantly higher than 22 years and below students. Because the average of 23 years and above students (2.6793) is found to be higher, it differs from 22 years and below students significantly (see **Table 4**).

Table 4. ANOVA Results with respect to the regional population where the environmentally conscious students live (n=167)

Population	n	(*x*)	s	p
below 500	5	3,0387	.37020	0,038<0,05
between 500-2000	6	2,9428	.56716	
between 2000-5000	14	2,8620	.27610	
between 5000-10000	13	2,5147	.65170	
between 10000-20000	18	2,9226	.28783	
between 20000-50000	22	2,7456	.37181	
over 50000	89	2,8773	.36546	

Table 5. The results that the students warn without any hesitation those who damage to the environment with respect to age (n=171)

Age	n	(*x*)	s	p
22 years and under	100	2.19	1.187	.049
23 years and above	71	2.58	1.359	

Table 6. The results that the students are known to be environment friendly by their friends with respect to gender (n=166)

Gender	n	(*x*)	s	p
Female	93	2.29	1.109	.024
Male	73	2.70	1.198	

Table 7. ANOVA results that the students are known to be environment friendly by their friends with respect to grade level (n=166)

Class Levels	n	(*x*)	s	p
1. Grade	35	1.97	.985	0.028<0.05
2. Grade	67	2.67	1.120	
3. Grade	40	2.58	1.174	
4. Grade	24	2.42	1.283	

It has been observed that there is a significant difference among the environmental consciousness scores of the students in relation to the regional population where they live. Gunduz et al. (2016) had similar findings about the environmental consciousness in Lefka region of Cyprus too. This finding can be interpreted that there is a significant relationship between the environmental consciousness and the population of region that students live. The environmental attitudes of the students show differences between those having a population of 5000-10000 in the region and those having a population over 50000. The environmental attitude of the region having the highest average which is over 50000 is higher than other regions (see **Table 5**).

There is no significant relationship between the age of the students and those damage to the environment that they warn without any hesitation. There is a significant relationship between the age of the students and those who damage to the environment that they warn without any hesitation. As p=0.049<α=0.05, H_0 is rejected. There is a significant relationship between the age of the students and those who damage the environment that they warn without any hesitation. There is a significant relationship between the age of the students and those who damage the environment that they warn without any hesitation. That the students who are 23 years and above, having the highest average warn those who damage the environment is higher than the students to be 22 years and below (see **Table 6**).

There is no significant relationship between the gender of the students and that they are known to be environment friendly by their friends. There is a significant relationship between the gender of the students and that they are known to be environmentally friendly by their friends. As p=0.024 < α=0.05, H_0 is rejected. There is a significant relationship between the gender of the students and that they are known to be environmentally friendly by their friends. There is a significant relationship between the gender of the students and that they are known to be environmentally friendly by their friends. There are differences between the environmental consciousness of male and female students. Male students with an average of 2.70 are known to be more sensitive to the environment by their friends than female students (see **Table 7**).

There is statistically significant difference between the grade levels of the students and that they are known to be environmentally friendly by their friends. This finding can be interpreted that there is a significant relationship between the environmental attitudes and grade levels of the students. There is a significant relationship with regard to being in 1 and 2 classes of the students to be known environment friendly by their friends. The students in class 2 with an average of 2.67 are known to be more sensitive to the environment by their friends than class 1 students.

DISCUSSION AND CONCLUSION

The following results are obtained as a consequence of this research:

There is a relationship between the ages of the students and whether or not they studied an environmental course before. According to the independent exemplary t-test results, while there is a significant difference of the attitudes of university students towards the environment, there has been no significant difference on their behaviors. Except this, a significant relationship between the gender of the students and that they are known to be environment friendly by their friends has been found. Even though the scores of environmental attitudes of both male and female students are found to be high in both groups, the scores of female students are found to be significantly higher than male students. The fact that similar results have been obtained in many studies that have been conducted with university students (Altın, 2001; Çabuk & Karacaoğlu, 2003; Erol, 2005; Yılmaz et al., 2002) indicates that increasing the environmental awareness among our students in our country should be carried out more effectively.

It has been observed that there is a significant difference among the environmental consciousness scores of the students in relation to the regional population where they live. This finding can be interpreted that there is a significant relationship between the environmental consciousness and the population of region that students live. The environmental attitudes of the students show differences between those having a population of 5000-10000 in the region and those having a population over 50000. The environmental attitude of the region having the highest average which is over 50000 is higher than other regions.

It has been observed that there is a significant difference statistically that the students warn those who damage the environment depending on the income of the family. This finding can be interpreted that there is a significant relationship between the incomes of the students' families and that they warn those who damage the environment with no hesitation. Atasoy (2005) and Kesicioğlu and Alisinanoğlu (2009) could not find out in their study a significant difference between the economic levels regarding attitudes towards the environment. There seems to be a similarity between their studies and this.

There is a statistically significant difference between the grade levels of the students and that they are known to be environmentally friendly by their friends. This finding can be interpreted that there is a significant relationship between the environmental attitudes and grade levels of the students. There is a significant relationship with regard to being in classes 1 and 2 of the students to be known environmentally friendly by their friends. The students In class 2 with an average of 2.67 are known to be more sensitive to the environment by their friends than class 1 students. Deniş and Genç (2007), Sağır et al. (2008), Çeken (2009) have detected in their studies that there is a significant difference between classes in terms of attitude towards the environment. The results of this study are parallel with the results of these studies.

As a consequence, we can come to a conclusion that the levels of environmental attitude and behavior of the university students who are studying in Northern Cyprus are not at the expected level. The following suggestions are included by examining the results of the research:

By taking into consideration the relationship between the attitudes and behaviors of the students towards the environment, precautions for increasing their success level should be taken. Among these precautions, the ones to increase the interest and motivation of the students should be considered. For example, a natural watching trip implementation to be carried out by being integrated with nature could be beneficial on this matter.

It has been indicated that the attitudes of the university students towards the environment are influenced by familial factors. For this reason, cooperation with families should be encouraged in environmental education studies, and the participation of families to these studies should be encouraged.

It can be foreseen that important steps can be taken not only in problems relating to the attitudes and behaviors towards the environment but also in resolving the complications and discrepancies that are encountered in the application of the principles and objectives indicated in the Constitutional Law and Basic Law of National Education.

Instead of focusing on the concern of the students with regard to future environmental problems, the importance of the individual studies should be pointed out for the resolution of the environmental problems, and the students should be encouraged in this direction.

Individual efforts should be considered to be important by explaining to the students that the environmental problems come out of several activities of people and so they will be terminated by several human activities.

In order to make the attitude and behavior of an individual towards the environment a lifestyle until university the education to be given should begin from the pre-school and should be sustainable and applicable to the environmental conditions where he/she lives.

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Utilizing Wikis and a LINE Messaging App in Flipped Classrooms

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ABSTRACT

The aim of this research is to identify students' perception of the utilization of wikis, LINE, and flipped teaching strategies in a Research Methodology course at a university in Taiwan. Q-methodology, a combination of qualitative and quantitative research, was employed for this study, and sixteen participants were asked to rank-order 30 statements related to the integration of wikis and LINE in a flipped classroom. Correlation, a centroid factor analysis, and judgmental rotation were used to identify the significant factors. The two factors that represented groups of participants with a similar perception were extracted and the results were as follows; (1) learners could be divided into those with a strong positive feeling about group-based activities and self-paced learning (Collaborative Achiever) and those who had a positive reaction to collaboration, but expressed concern about tension caused by competition (Collaborative Competitor), and (2) all the participants agreed that they were highly engaged and motivated when using Wikispaces and LINE in the flipped classroom based on the advantages of a timely and easy-to-use IT environment, self-regulated learning, virtual community companion, collaborative work, and the building and sharing of knowledge. The theoretical and practical implications of the results were discussed.

Keywords: flipped classroom, Q-methodology, Wikispaces, LINE, collaborative learning

INTRODUCTION

Many previous studies have focused on utilizing wikis for collaborative learning and student engagement in higher education (Chia & Pritchard, 2014; Lee & Bonk, 2014; Yueh et al., 2015), and there is also a growing interest in the use of m-learning in education (Kearney et al., 2015). Indeed, LINE (http://line.naver.jp/en/) is one of the most popular applications for messaging on smartphones and personal computers in Taiwan, with 17 million Taiwanese users in January 2017 and more than 218 million monthly active users worldwide. Ninety-one percent of Taiwanese between 12 and 65 years of age used LINE in the first half-year of 2016 (Yeh, 2017). Due to the personal and portable nature incorporated into learning, the Mobile Instant Messaging (MIM) app may have the potential to be employed as a compelling learning tool in higher education (Hsieh & Wu, 2013; Rambe & Bere, 2013; Van de Bogart & Wichadee, 2015; Wang et al., 2016).

Despite the popularity and extensive use of LINE by students, its usage as a virtual learning companion has not made significant inroads into mobile learning studies (Hsieh & Wu, 2013). Nonetheless, the pedagogical potential of MIM remains one of the least explored functionalities of smartphones in higher education institutions (Rambe & Bere, 2013; Van de Bogart & Wichadee, 2015). While a considerable volume of research has been undertaken on the utilization of wikis in teaching and learning practices (Yueh et al., 2015; Altanopoulou & Tselios, 2017), few investigations have been made of the use of both Wikis and LINE as collaborative tools to supplement a "flipped classroom." However, it seems critical to explore students' views during the initial application of a "flipped classroom" approach in order to understand how technologies can best be integrated into the learning process (Bhagat et al., 2016; L. Chen et al., 2015; S. C. Chen et al., 2015; Davies et al., 2013). Therefore, the purpose of this Q-study is to identify and categorize learners' perception of the use of wikis, LINE, and flipped teaching strategies in

Contribution of this paper to the literature

- This study identifies university students' perception of the use of wikis, LINE, and flipped teaching strategies in a Research Methodology course in Taiwan.
- Q-methodology, a combination of qualitative and quantitative research, was used for the study.
- Instructors need to be aware that there are distinctive sets of opinions (i.e. Factors I and II) in the flipped classroom; thus, there is a need to provide support on an individual level.

a Research Methodology course at a university in Taiwan. The following research questions will guide the overall study:

1. What are the learners' subjective opinions of this pedagogy?
2. What are the factors that represent groups of learners who share a similar pattern of thought?

The paper is organized as follows: (1) the theoretical and empirical background of the study is presented in the first part; (2) details of the methodological approach used to complete the research are provided in the second part; (3) the results are presented in the third part; and (4) the fourth part contains a discussion of those results, as well as some recommendations and implications for further research and practice.

LITERATURE REVIEW

Using the LINE Messaging Application in Education

Today, the proliferation of mobile technologies offers the opportunity to embed learning in higher education. Indeed, LINE has become the most favorite app of Taiwanese smartphone owners ahead of Facebook, YouTube, WeChat and Instagram, according to the survey results released from the Market Intelligence Center under the government-sponsored Institute for Information Industry (Chung & Huang, 2016). LINE enables users to exchange texts, images, videos, and audio material, as well as participate in free VoIP conversations and video conferences (see **Figure 1**). Van de Bogart and Wichadee (2015) suggest that smartphones with a LINE chat app may support teaching and learning in a database course. Shih et al. (2015) also found that college students demonstrated a positive attitude toward learning English vocabulary, particularly spelling, using the LINE app. The LINE chat app constantly updates choices of self-expressive sticker characters that can also be attached to a standalone message to convey a feeling or even an attitude. Teachers can interact with their students using the emoticons and stickers attached to text when using LINE as a way to bridge the generation gap. Stapa and Shaari (2012) suggest that some of the emoticons can be used to strengthen the text message, while others represent particular tones of voice such as happiness, sadness, fear, anger, disgust, and surprise. Students can also utilize the small emoticons and stickers in the LINE app as a substitute to express their feelings and respond to their friends in an everyday life situation (Van de Bogart & Wichadee, 2015).

Using Wikis in Higher Education

Leuf and Cunningham (2001), who invented the wiki concept, originally described it as "a freely expandable collection of interlinked webpages, a hypertext system for storing and modifying information – a database, where each page is easily edited by any use with a forms-capable Web browser client" (p.14). Recent rapid advances in wiki technologies have already been utilized successfully in higher education to promote students' writing skills (Wheeler & Wheeler, 2009), enhance their critical thinking and contextual application (West & West, 2009), impact knowledge management processes, fulfill students' satisfaction (Biasutti & EL-Deghaidy, 2012), and facilitate group learning (Altanopoulou et al., 2015). Most of the application of wikis in education is related to the collaborative approach to learning (Yueh et al., 2015). Wikis enhance creativity and freedom of expression, although there are some challenges for students. The openness of wikis may sometimes make it prone to vandalism and cause the posting of untrue information. In addition, learners may tend to only read the information to which they contributed, and may be defensive in taking personal credit for their particular work within groups. Furthermore, students may dislike group work and feel intimidated by online learning and collaboration (Wheeler et al., 2008). Abdekhodaee et al. (2017) found that peer feedback improved learners' work; however, much of it was too brief to be constructive and was offered too late to be useful in guiding their work. One challenge of using wiki is that the non-peer reviewed content is usually posted prior to its publication and there is a risk that it may contain inaccurate or false information (Kolski et al., 2015). Snodgrass (2011) suggests that collaborative learning using a wiki is potentially more successful when combined with face-to-face activities and assessments.
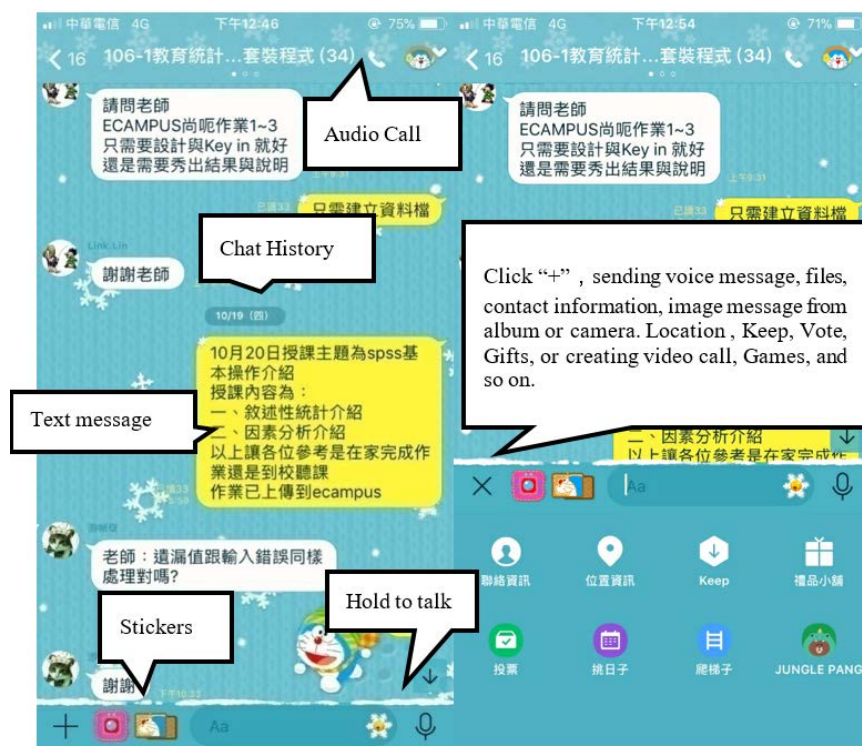
Figure 1. Features of LINE

Implementing the Flipped Classroom for Teaching and Learning

A growing awareness has been directed toward implementing the flipped classroom approach in assorted educational institutions (Aşıksoy & Özdamlı, 2016; Karabulut-Ilgu et al., 2017; Lee, 2017; Zainuddin & Halili, 2016). Previous researchers have reported that the flipped classroom approach fosters academic performance, enhances interaction (Hung, 2015), improves class attendance (Chen et al., 2014), and cultivates a positive attitude toward the course in which it is applied (S. C. Chen et al., 2015). Bhagat et al. (2016) note that the flipped classroom approach could help low achievers because they will receive more attention from teachers. Contrary to these positive findings, L. Chen et al. (2015) claim that some students may not have internet access to view the videos at home. Milman (2012) elaborates that poor quality of video lectures usually becomes an unexceptional problem in flipped classroom practice. Kim et al. (2014) found no evidence that flipped learning improved students' grades. Chen et al. (2014) also reported that some students resisted this approach initially because they did not have time to watch video lectures prior to classes. Consequently, some skipped the pre-class activities and came to class unprepared. Notwithstanding, potential negative effects have been found in this approach in higher educational institutions, with Liou et al. (2016) arguing that videos in flipped classroom are not inherently interactive and there is a need to integrate other technologies to advance the flipped classroom model.

METHODOLOGY

Trainer and Research Participants

The research was conducted during a sixteen-week flipped course at a continuing education center in a university in Taipei. Sixteen graduate students attended this required course. The first author, who had experience of implementing a flipped classroom, was the instructor, the curriculum designer, and the moderator in the individual and focus-group interviews. All the participants had college degrees and web-based learning experience, and many of them knew each other and the moderator.

Description of the Course

The wiki and LINE messaging application was implemented in a Research Methodology course, a required component of the master's program in the Department of Technology Management. The course contents included the following: (1) an introduction to a variety of quantitative and qualitative research methods, (2) planning,
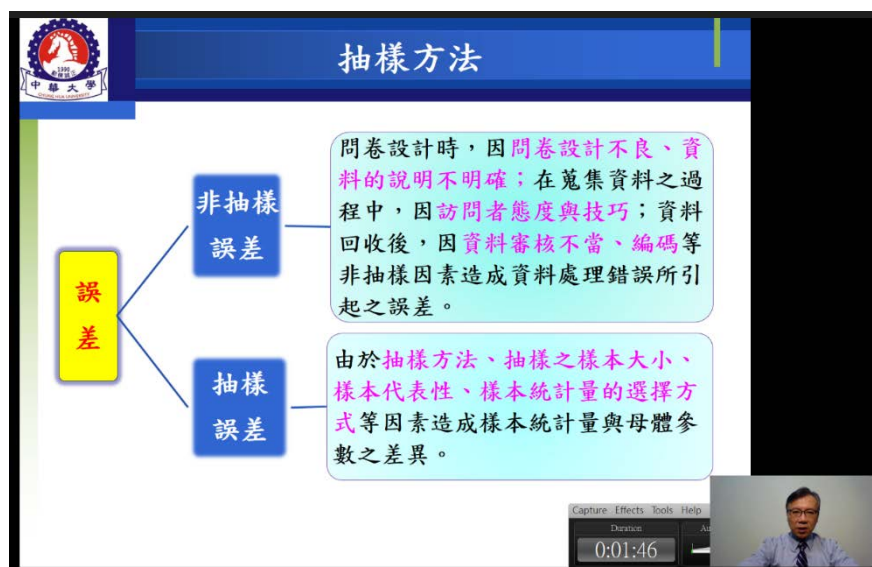
Figure 2. Sample screencast with Camtasia software

designing, and choosing appropriate research method(s), (3) collecting, analyzing, interpreting, and reporting data, and (4) utilizing the Statistical Package for Social Sciences (SPSS) to manage and analyze data. The participants were assessed based on 12 individual written assignments and five sessions of group-based case studies that incorporated the use of Wikispaces.

Instructional Strategies in the Flipped Classroom

Each team consisted of two to four trainees, who were assigned segmented missions (i.e., group problem-solving, decision-making assignments and peer reviews).Formal groups were organized in this training program. The course was designed as follows:

1. Text-based lecture notes and pre-recorded multimedia micro-lectures (i.e., two to three micro-lectures, six to seven minutes in length) were assigned to each class. The lecture was recorded with Camtasia Studio 8 screen capture software (see **Figure 2**). These video clips were presented in the Wikispaces Classroom.

2. The training sessions were moved from inside to outside the classroom. The students used the time outside to view pre-recorded multimedia lectures and read lecture notes prior to attending the class.

3. Individual students were required to answer some group/individual questions in order to assess their fundamental knowledge of the lesson material right before each class.

4. The amount of class time spent on lecturing was reduced, allowing the students more time for structured team-based problem-solving and feedback. They were assigned to work in teams of two to four. At the beginning of each class, the team members compared their responses to their individual/group assessments and agreed a team response. The teacher then reviewed any common misconceptions and summarized the key concepts. Finally, the small groups completed team-based short essay questions or case studies with higher-level application problems.

5. The teacher provided assistance, clarification and feedback when needed.

In summary, since it was necessary for the students to focus on more complex and long-term problems in the physical classroom, they were officially organized and monitored by their teacher. Consequently, the peer groups gathered to develop and contribute to one another's mastery of various course topics by discussing the materials and supporting their group members.

Implementation of Wikispaces Classroom and LINE

Wikispaces Classroom (i.e., a social writing platform for education) was selected for this course from the many available wiki software packages. All the students were required to create their own account and participate in the individual/group tasks during the course. The training program, which consisted of three 1-hour sessions each week, was conducted in a traditional classroom; however, the virtual collaborative activities were undertaken via the Wikispaces (www.wikispaces.com). The students attended a one-hour briefing session about the Wiki at the beginning of the semester. Wikispaces was used regularly to deliver news, upload assignments, and share learning
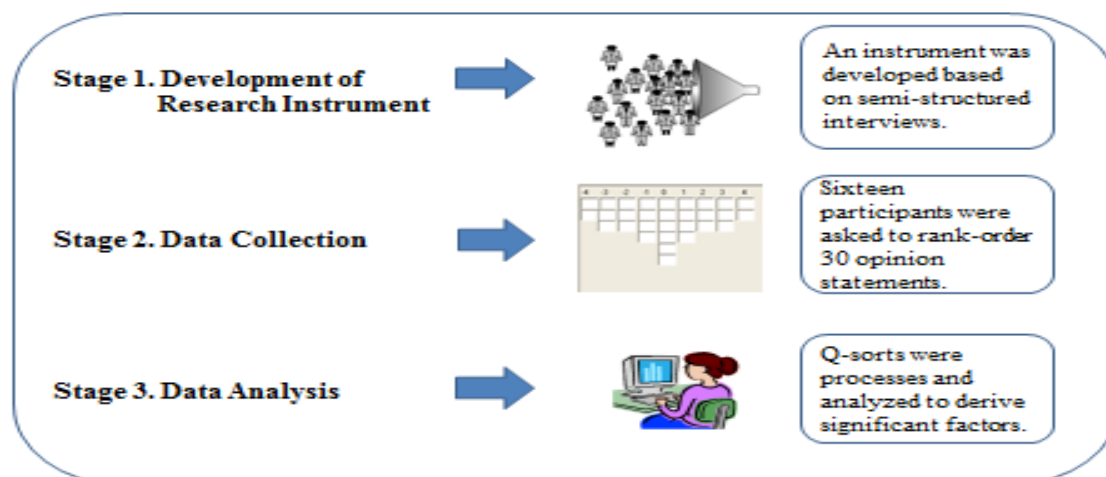
Figure 3. Steps of Q-methodology

video clips and materials. The trainer facilitated further discussions on the Wikispaces homepage, and the students were encouraged to use Wikispaces to discuss and answer queries. Overall, the basic features of a Wikispaces Classroom are as follows: (1) provides a page-editing function, (2) tracks and logs the editing processes, (3) organizes group work, (4) supports online discussion and feedback, (5) creates rich and appealing pages using widgets, and (6) provides adjustable permission to keep the content safe and secure.

Participation in Wikispaces on a weekly basis was mandatory, but LINE was used in this course on a voluntary basis. Learners could use LINE as a platform to form their own virtual learning companion in order to exchange text messages, graphics, video and audio media, make free VoIP calls, and hold free audio/video conferences. This is a technology that provides an informal learning environment, and students can use it for chronologically-structured contributions. In contrast, Wikispaces Classroom offers both formal and informal learning settings and allows users to develop content-specific websites. Participants summarize their learning using online collaboration tools, and instructors provide feedback to increase the cooperation in both virtual and physical classrooms. Wikispaces Classroom and LINE were both used in this study to enhance collaborative learning in the virtual learning community (VLC).

Measuring Subjectivity

Q-methodology was used in this study in order to ascertain the subjective viewpoints of a few people by asking them many questions, rather than exploring the reaction of a large number of people to fewer questions. The objective of Q-methodology is neither to uncover cause nor to generalize demographic prevalence of variables to a large population. Hence, a small sample size is quite common and acceptable when utilizing Q-methodology (Brown, 1993; Brown, 1996; Stellefson et al., 2012). The three steps of Q-methodology are as follows: (1) Development of the research instrument: to create a set of statements to be sorted, (2) Data collection: to sort those statements along a continuum of preferences (i.e., from agree to disagree) by each participant, and (3) Data analysis: to analyze and interpret the data (see **Figure 3**).

Data Collection

Having completed the training program, 16 learners participated in a Q-study led by the researcher. Semi-structured interviews were conducted with all the students one week after the end of the training program in order to ascertain their perspective of the topic. The research instrument was based on a representative sample of 30 statements containing key ideas from the interviews. Those 30 statements, which represented the final Q-set, were selected through a content analysis that characterized aspects of technology, content, and teacher/students. It is imperative to note that Q-statements (i.e., the opinion statements of the research instrument) in Q-methodology are selected as cautiously as the participant selection is conducted in any other scientific method (Brown, 1996). A pilot test was conducted with two volunteers who participated in the first interview, with only minor changes needing to be made to clarify some Q-statements. The Q-set (viz. Q-methodology questionnaire) was then distributed to all learners to study the basis of their assessment of this innovative pedagogy. Without bias, and treating both disagreement and agreement issues alike, the participants were asked to rank-order 30 statements into nine categories within the response grid, ranging from Most Disagreeable (–4) to Most Agreeable (+4). In other words,

Viewpoints are modeled in Q-sort.
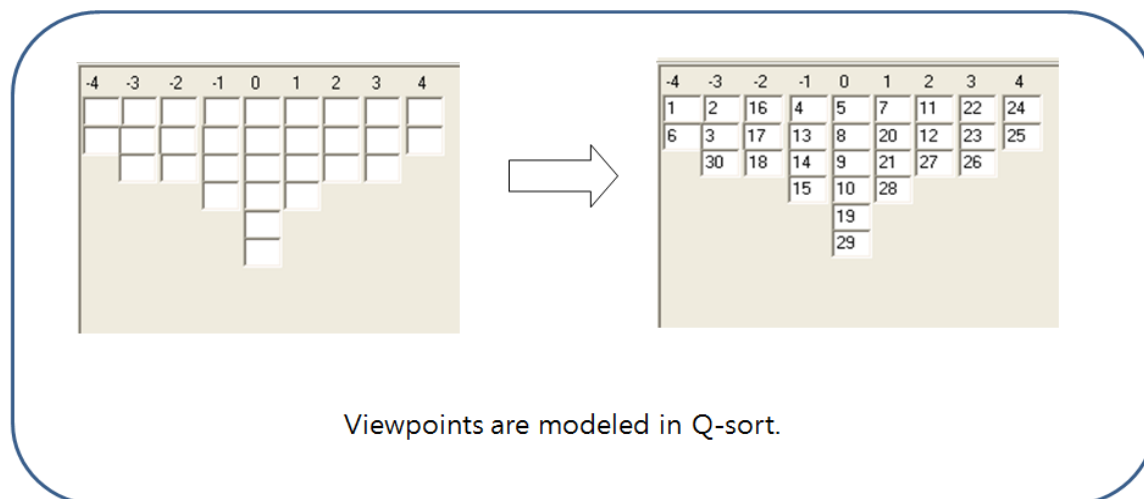
Figure 4. Q-sorting

the participants constructed their viewpoints in Q-sorts on the sorting answer sheet (see **Figure 4**) (L. Chen et al., 2015).

Data Analysis

PQMethod (version 2.11) statistical software was used for the data analysis. Data and Q-sorts were entered into the program as they were being collected, thus producing different piles of statement numbers. Unlike the Likert survey technique, the statements related to one another are examined in Q-methodology. Various factor rotation and statistical procedure methods can be applied to safeguard factor reliability in Q-methodology. Correlation, a centroid factor analysis, and judgmental rotation (i.e., hand rotation) were employed to derive the significant factors in this study. The relevant factors were selected and defined for a final analysis. Interested readers are referred to Brown (1993), Brown (1996), Watts and Stenner (2012) for further theoretical concerns and guidelines.

RESULTS

The participants' factor/opinion types (see **Table 2** and **3**) were revealed using the PQMethod software. Factors that represented groups of students with a similar perception were extracted in order to reveal various patterns of thoughts expressed in their subjective views. Two factor types were identified: (1) Factor I: Collaborative Achiever, and (2) Factor II: Collaborative Competitor (see **Table 1**). The sixteen trainees' Q-sorts were divided into these two factors. All the Q-sorts were found to be statistically significant, i.e., the loadings on these two factors were more than 0.36.

Table 1. Factor loadings by participant and opinion type (*)

ID	Factor A	Factor B
1	59	
2	56	
5	52	
6	48	
7	68	
8	82	
9	53	
10	52	
11	80	
14	86	
15	67	
3		66
4		56
12		73
13		66
16		53

(*) only significant loadings are shown (p<.01); decimals omitted

Factor I: Collaborative Achiever

Group I was the largest factor group extracted. It comprised 11 participants, representing 68.75% of the P-sample. This group consisted of 7 females and 4 males. Two were aged between 31 and 35, four between 36 and 40, and three between 41 and 45. One of them was aged between 46 and 50, and one between 56 and 60.

The individuals in this group preferred reduced seat time in the physical classroom (Statement 11, +1). They watched these video clips repeatedly when questions arose (Statement 30, +4). They also liked those learning materials being posted based on their own progress (Statement 18, +3) and enjoyed the customized learning processes (Statement 23, +4). These individuals suggested that the instructors should continue to use this approach (Statement 16, +3).

On the other hand, they were not under a lot of pressure when they compared their work with that of others and realized they had made mistakes in the online environment (Statement 3, -3). They did not appear to be concerned about the comprehensiveness of the online assignment (Statement 4, -3). At the same time, they did not think their classmates came to class without completely watching these pre-class materials (Statement 21, -3). Factor I participants perceived much benefit and few drawbacks in the application of LINE and Wiki technology in the flipped classroom. They were neither concerned about asking questions in the virtual space (Statement 10, -4) nor about others copying their work (Statement 9, -4); however, they found the course load to be quite heavy (see **Table 2**).

These distinguishing statements helped us to define and clarify the uniqueness of each factor, since the factor scores were used to further represent the characteristics of each cluster (see **Table 2** and **3**), with the first factor describing *collaborative achiever* (see **Table 2**) and the second factor describing *collaborative competitor* (see **Table 3**). These two specific factors were named based on comparing and contrasting the two sets of distinguishing statements (see **Table 2** and **3**).

Table 2. Statement scores by factors/opinion types

No.	Statements	Factors (*)	
		I	II
3	When comparing answers with classmates and realizing that I was mistaken in the online environment, I was quite anxious.	-3	1
4	I was concerned about the comprehensiveness of the assignment if I submitted my assignment too fast online.	-3	0
9	Some lazy students just copy others' work from Wikispaces.	-4	-1
10	Some students are afraid to ask questions in case they appear to be stupid in the eyes of their peers in the virtual space.	-4	3
11	The seat time in the "physical classroom" should be reduced if universities adopt this teaching method in future.	1	0
16	I hope my professor will continue to use this novel approach to teach the Research Methodology course.	3	1
18	I like the idea that the teaching materials were listed on the website and learners could preview/review them based on their progress.	3	0
21	Some students did not finish watching the video clips and just looked at handouts ahead of class.	-3	-2
23	Learning is customized based on individuals' needs and the teaching contents can be modified on a weekly basis. Lecturers can be sure of the quality of teaching from students' work posted on the virtual context.	4	0
29	The course load was very intense and hefty.	3	-4
30	I watched the video clips repeatedly when I was unsure how to complete the assignment.	4	-1

Table 3. Statement scores by factors/opinion types

No.	Statements	Factors (*)	
		I	II
2	Learners can compare observe others' online work, thereby accelerating the competition among classmates.	-2	3
5	I feel quite reluctant to post my unique ideas on the discussion board first because everyone can read and copy my answers.	-2	4
8	Team members discuss and generate ideas that enable the VLC to interact and collaborate. I can offer my support and build my self-competency.	2	3
10	Some students are afraid to ask questions in case they appear to be stupid in the eyes of their peers in the virtual space.	-4	3
15	The teacher categorized and posted weekly teaching materials online based on the curriculum, which made me quite comfortable to manage and record changes.	2	4
17	This teaching method may not be suitable for all types of learners since computer literacy and technological competence is required.	-1	-3
20	I would recommend that the department adopts this teaching method for each course.	-2	-3
25	The teaching video lasted for about 6-7 minutes. I think the length of the video clips are too long.	0	-3
28	Students may be tempted to fast forward the video if it is too longwinded.	-1	-4
29	The course load was very intense and hefty.	3	-4

Factor II: Collaborative Competitor

Group II was composed of five participants, representing 31.25% of the P-sample. This group consisted of 2 females and 3 males, four of whom were aged between 31 and 35 and one was less than 30 years old. The individuals in this group also recognized that this teaching approach had many benefits. They did not appear to be concerned about the heavy course load (Statement 29, -4); on the other hand, they were concerned about asking questions in the virtual space (Statement 10, +3) and reluctant to post their ideas on the board first (Statement 5, +4). They were very much aware of the competition among the group members (Statement 2, +3).

On the other hand, they strongly favored this method because it keeps a good record of their learning (Statement 15, +4), provides personal support, and advances collaboration and interaction (Statement 8, +3). They believed that this approach may be suitable for all types of students (Statement 17, -3). In contrast, the individuals in this group did not recommend adopting this approach for every course (Statement 20, -3). They considered that the duration of the video clips was not too long (Statement 25, -3), and students would probably not be tempted to fast forward them (Statement 28, -4) (see **Table 3**).

Consensus Statements between Factors I & II

The consensus statements between these two groups of trainees were statements 1, 8, 13, 14, 17, 19, 20, 21, and 22 (see **Table 4**). Both groups agreed that this method enhanced interaction and collaboration, fostered discussion,

Table 4. Consensus statements between Factor I and Factor II

No.	Statements	Factors (*)	
		I	II
1	This pedagogy enables individuals or groups to discuss the course content or any issues.	2	1
8	Team members discuss and generate ideas that enable the VLC to interact and collaborate. I can offer my personal support and build my self-competency.	2	3
13	This teaching method enhances my learning effectiveness.	1	2
14	This pedagogy motivates me to do better.	1	2
17	This teaching method may not be suitable for all types of learners since computer literacy and technological competence are required.	-1	-3
19	If problems were encountered during the preview of the video clips, we usually discussed them in the physical and virtual contexts.	1	2
20	I would recommend this teaching method for every course in our department.	-2	-3
21	Some students did not finish watching the video clips and just looked at the handouts ahead of the class.	-3	-2
22	The interface of the Wikispaces Classroom is all in English and is too complex, which makes it hard to begin.	-1	-1

increased motivation, and improved learning effectiveness. They discussed the pre-class materials both in and out of the class time if questions arose. These two groups thought that their classmates finished watching the whole video clips prior to the beginning of the class. They also believed that this approach is suitable for all types of learners. Both groups found the Wikispaces to be not too complex to begin with; however, these individuals did not believe that every course could adopt this method.

DISCUSSION AND CONCLUSION

Discussion

The results of this research revealed several important issues, the first of which is that the learners' opinions could be divided between those who showed strong positive feelings about group-based activities and self-paced learning (i.e. Factor 1: Collaborative Achiever) and those who had a positive reaction toward collaboration, but expressed concern about tension caused by competition (i.e. Factor 2: Collaborative Competitor). Though Factor 1 students considered that the course load was very heavy, they still maintained a positive attitude toward it. On the other hand, Factor II students did not think that the workload was hefty, but they were reluctant to post their answers and perceived their performance as a contest in a competitive learning environment. More research is needed to determine whether competition in the classroom is motivating or destructive. The findings of this research are in line with those of Chen et al. (2014) and Shih and Tsai (2017), who found that learners' workloads were heavier due to homework outside the classroom. This may pose a challenge to employing flipped classrooms. Consistent with Mayer's (2014) cognitive theory of multimedia learning, this study divided the long video into a serious of short video clips and used a six-minute guideline of video production. In addition, this study is in line with previous research, which recommends that 20-25 minutes for all combined video segments would be a bearable workload for most students in a flipped classroom (Lo et al., 2017). It is recommended that learning materials may be divided into various levels (i.e. required pre-class materials for all students and optional learning materials for higher achievers) and learners can adopt them to learn based on their abilities.

Secondly, the participants of this study said that the course materials were well-organized and presented and the quality of the instructional design was high. Nevertheless, all the participants agreed that they were highly engaged and motivated in the physical classroom, the asynchronous environment (i.e. Wikispaces) and the asynchronous/ synchronous environment (viz. LINE). Consistent with Hung (2015), all the participants agreed that this teaching method had improved their learning effectiveness. The analysis of this study goes beyond the findings of Liou et al. (2016), which initially suggests that there is a need to integrate other technologies for the advancement of the flipped classroom model. This implies that the students were particularly attracted to the advantages of a timely and easy-to-use IT environment, self-regulated learning, virtual community companion, collaborative work, and the ability to build and share knowledge provided in Wikispaces and LINE that were added in the current flip learning context.

Thirdly, while Chen et al. (2014) and L. Chen et al. (2015) maintain that some Chinese students still find it difficult to adopt the flipped learning approach because of their former passive learning habits from the traditional classroom, the findings of this research present a very different picture of this pedagogy. These adult learners strongly believed that this approach could enhance students' intrinsic motivation. It motivated them to seek additional information, encouraged continuous dialogue and collaborative interactions among colleagues, and fostered a feeling of autonomy and personal affinity rather than relying on humdrum grades to spark

enthusiasm. Previous researchers claimed that learners cannot immediately ask questions for clarification during video lectures in flipped classrooms (Schultz et al., 2014). In contrast, the findings of this study revealed that the Chinese students engaged in active learning in both the in-class and out-of-class contexts that took place before, during, and after lessons.

Fourthly, Baepler et al. (2014) claimed that when instructors provide an active learning classroom, seat time can be cut by two thirds and the same outcomes can be attained. Similar to this argument, the findings of this research suggest that Factor I participants believed that in-class seat time could be reduced in a flipped learning context. Further research should investigate if students' seat time can be reduced while achieving the same outcomes.

Fifthly, a particularly interesting aspect that emerged was that the Factor II participants described tension between the collaborative and competitive nature of the VLC. The public nature of the Wikispaces and Line enables learners to be easily compared. Factor II students did not wish to initiate the posting of answers in front or their peers. Due to the different tendencies between Chinese learners and their Western counterparts in online education, Factor II participants were too timid to ask questions and publish their work online for fear of "losing face." In fact, the Confucian-heritage culture and the concept of "face" still has a huge impact on Chinese students' learning (Wang & Greenwood, 2015). "Having face" means that one has a good social standing or a good reputation and protecting one's face is another source of psychological motivation. This collaborative approach may be challenging for students who are not accustomed to open discussions and expressing insights as the feedback is displayed online publicly and it can lead to either loss or gain of face. Thus, to convey a better impression and seek positive peer feedback becomes one of the ways learners can protect their face. Teachers should be mindful to such 'restraints' on Chinese learners' behavior and provide more encouragement. Clear instructions and sufficient preparation time should be provided to allow students to think about those virtual discussion topics. Further research is needed to validate whether learners prefer a "safe" learning context and a sense of anonymity in VLC.

Conclusion

Apart from the limitations of the study, it is concluded that instructors need to be aware that there are distinctive sets of opinions (i.e. Factor I and II) in the flipped classroom, just as there are learners with diverse needs and backgrounds in traditional classroom settings. The aspects of Factor I and II participants deserve urgent attention and understanding. Evidently, social media like wikis and Line are not a fad, since they continue to play an emergent role in individuals' lives (Doss et al., 2016). With their combined strengths of formal and informal learning, unique features that optimize the benefits while constraining the limitations of each of them, it is concluded that Wikispaces and LINE are likely to form an effective approach for adult learners in the context of flipped classrooms.

Limitations of the Study

Although several pedagogical implications can be drawn from this study, some limitations must also be acknowledged. Firstly, it is important that the generalization of the preliminary findings should not be interpreted by the numerical distribution, but rather the validity and implications of the opinion clusters this Q-study conveyed. Secondly, the pre-class videos were provided in this required Research Methodology course; thus, it should be considered whether these findings are course subject-specific. Further research at broader levels (i.e. program, discipline) may assist researchers to understand the overall impact of this pedagogy. Thirdly, since this study was mainly focused on graduate students, a further investigation is needed of the way in which age and maturity influence learners' reaction to the course and academic performance. Fourthly, the vast majority of the studies included in this research examined the flipped classroom approach within one semester. Therefore, further longitudinal studies are necessary to provide a more in-depth understanding of this new teaching approach. As with any study, this study has some limitations that need to be considered when interpreting the findings.

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Preservice Science Teachers' Instructional Design Competence: Characteristics and Correlations

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ABSTRACT

Underpinned by a holistic, dynamic, and process-oriented view of teacher competences, this study provides an analytic hierarchy system of instructional design competence (IDC) for evaluating teachers' IDC based on the mental model of instructional design. Additionally, this study quantitatively explores the IDC characteristics and correlations of 118 preservice science teachers at Shanxi Normal University in China, who learned the ADTRE (analyzing, designing, teaching, revising, and evaluating/improving) instructional model, based on reflection and feedback. Using lesson planning (LP) scoring rubrics, we analyzed 113 lesson plans from 56 participants majoring in biological science and 57 in biological technology. We present the ADTRE model and discuss relationships between preservice science teachers' academic achievement and IDC. Major findings include a positive correlation between preservice science teachers' IDC scores and their course grades in Advanced Mathematics and Cell Biology and concept mapping skills. There was a negative correlation between preservice science teachers' IDC and course grades in Principles of Genetic Engineering and Technology, and no significant correlations existed between IDC and course grades for teacher education courses. Our findings reveal the nature of preservice science teachers' IDC, a potential for improvement in university teacher education curricula, and a need for further research.

Keywords: ADTRE instruction model, instructional design, instructional design competence, preservice science teacher education

INTRODUCTION

Instructional Design Competence (IDC) is an essential component of teachers' professional competence and expertise, and its importance has increasingly been acknowledged in worldwide research and policy (Tuinamuana, 2011). Official documents for teachers' professional development, especially teachers' professional standards over the last two decades, indicate an increased emphasis on the importance of teachers' IDC in England (DfE, 2011; Page, 2015), France and Germany (Page, 2015), the United States (Anagnostopoulos, Sykes, McCrory, Cannata, & Frank, 2010; NBPTS, 2001), Australia (AITSL, 2011), China (Liu & Liu, 2017; MOE, 2011), and other countries (Tuinamuana, 2011). Given the close alignment between the teaching profession and teacher education programs, there is an increased emphasis on preservice teachers' competence in instructional design and lesson planning (John, 2006).

Instructional Design (ID) theories were not introduced into Mainland China until the 1980s (Hannah, Bridge, & Mu, 1983; Zeng, 1985). Although its principles have been incorporated into secondary and primary science teaching practices during a new round of curriculum reform (Bi & Lu, 2000; Wang, 2001; Yang, 2002; Zhang, 2001), there has been minimal impact in science teaching practices (Jiang & Lin, 2007; Shi, Song, Fang, & Yu, 2005). However, some ID textbooks for preservice science education were translated from English to Chinese (Dick, Carey, & Carey, 2004; Gagné, 1992, 1999; Gagne, Wager, Golas, & Keller, 2000; Seels & Richey, 1999) and photocopied (Dick, Carey, &

Contribution of this paper to the literature

- Provides an analytic hierarchy system of IDC for evaluating preservice science teachers' IDC based on the mental model of the ID model's nature.
- Quantitatively explores the effects of an ADTRE instructional model based on reflection and feedback in teacher education.
- Reveals the real state of preservice science teachers' IDC, which has the potential to significantly improve in university teacher education; secondly, reveals several relationships between preservice science teachers' academic achievement and IDC: significant positive correlation, no significant correlation, and significant negative correlation, which suggests a weakness in university teacher education curricula and a need for further research.

Carey, 2002) and produced (Sheng, 2005; Wu, 1994; Zhang, Zhu, & Hu, 1990) during this period. Chen (2002) and Zhang, Jin, and Chen (2004) investigated the characteristics and influential factors of primary school teachers' classroom IDC, and Zhang (2009) explored primary science teachers' IDC through analyzing their lesson planning cases. Nevertheless, there have been no empirical studies on the characteristics and correlations of IDC for K-12 preservice science teachers.

Regarding preservice teacher preparation, research increasingly demonstrates that it is an important, yet challenging task to provide preservice teachers with opportunities to develop instructional design and planning skills before they begin their professional teaching careers (Doyle & Holm, 1998; Klein, 1991; Koehler, 2015; Ruys, Keer, & Aelterman, 2012). There are many strategies, approaches, methods, frameworks and models to achieve this objective, but developing IDC through instructional design provides an excellent opportunity for preservice science teachers because instructional design (ID) serves as a central intellectual process for developing IDC.

Many models have been used to teach ID (Branch & Gustafson, 2002). Magliaro and Shambough (2006) found that learners of ID do not always use the models given to them, but they actively and independently reconstruct models in graduate ID courses. Isman, Abanmy, Hussein and Al Saadany (2012) found that the new ADDIE (analysis, design, development, implementation, evaluation) model was strongly effective in achieving research aims, particularly for developing students' teaching skills in an undergraduate teacher education course. Nonetheless, an examination of preservice science teachers' IDC has not yet been reported. Sugar (2014) argued that ID practices do not occur in isolation. Rather, ID practices are supported by numerous elements, including preservice science teachers' beliefs (Laplante, 1996) and teaching efficacy (Cantrell, Young, & Moore, 2003), pedagogical content knowledge (PCK) (Angeli & Valanides, 2005), and knowledge of instructional planning such as cognitive demand of tasks (Bümen, 2007). Hashweh (1987) traced biology and physics teachers' subject-matter knowledge and its effect on instructional planning and teaching. Hashweh (1987) found that the teachers' prior subject-matter knowledge affected their instructional design and teaching. For instance, science teachers with detailed knowledge of their disciplines were more likely to incorporate explanatory knowledge representations, in the form of analogies and examples, into their design and enactment.

While university science courses play an important role in preservice science teachers' knowledge of content, university education courses also contribute towards the development of preservice science teachers' instructional design competence. Given that preservice science teachers take courses generally classified into foundational, major, and teacher professional education courses during their college studies, how does college academic achievement in these courses affect IDC? Weber (2015) examined how pre-service teachers in undergraduate preparatory programs learn instructional design competencies and proposed a recommended sequence to improve the practice of instructional design for online learning in teacher education programs. Yet, an examination of correlations between preservice science teachers' IDC and their academic performance has not yet been reported in the literature. Thus, the purpose of the study reported in this article is to answer the following questions: (1) What are characteristics of preservice science teachers' IDC? and (2) What is the relationship between preservice science teachers' academic achievement and their IDC? This study seeks to enrich the ID literature given that there are few IDC quantitative studies. This study's findings can also provide valuable insight for preservice science teacher education and contribute to preservice, in-service, and college teachers' IDC development.

CONCEPTUAL FRAMEWORK

The research on ADTRE (analyzing, designing, teaching, revising and evaluating/improving) based on reflection and feedback, ID models, and the analytic hierarchy system of IDC, form the foundation for our research.

ADTRE

What is the nature of ID models? In general, instructional design models, as described in the instructional system design literature, provide principles and procedures for ID and offer frameworks for guiding the design and development of successful learning activities and environments in almost all types of training and development programs. Yet, ID models can easily lead to a false characterization of ID as simply copying techniques as opposed to a rather complex intellectual process. John (2006) presented an ID model, which mimics the natural decision-making of an experienced practitioner in that it is not a fixed process but can fit all situations.

According to the functional definition of Rouse and Morris (1986), ID models are the mechanisms by which designers describe the purpose and form of a system, explain its function and its current state, and predict what a system might do. In fact, ID is an individual's conceptual construction and mental model (Magliaro & Shambough, 2006; Rouse & Morris, 1986). It represents how designers systematically understand a particular domain and the actions they would bring to the complex and novel instructional task and instructional situations, based on their cultural heritage, prior experiences, worldviews, and methodology.

Why construct ADTRE ID models? According to Magliaro and Shambough (2006), one of ID models' great features is continuous change depending on learning and teaching needs. John (2006) argued that published ID models, especially the dominant models of preservice teacher education require re-consideration and revision because of their linearity. The ADDIE model (analysis, design, development, implementation, and evaluation) is most frequently represented as the ID process and is generally viewed as a valuable framework for developing all types of training and development programs because of its individual and collaborative instructional development structure (Mayfield, 2011). However, the model needs revision due to its restricted approach towards learning to teach. For preservice teachers, developing ID expertise with their own style and characteristics requires learning how to use knowledge in action and spending time on teaching practice.

What knowledge is required for ID model development? Shulman (1986, 1987) stated that teaching expertise should be described and evaluated in terms of PCK, which involves relating subject matter knowledge and contexts to pedagogical knowledge. Similarly, according to other research studies of PCK (Cochran, DeRuiter, & King, 1993; Boz & Boz, 2008; Park & Oliver, 2008), ID is a creative, problem-solving process that designers integrate and understand when enacting PCK. Regarding teaching enactment, as McDonald, Kazemi and Kavanagh (2013) pointed out, the university is only one of the three settings for teacher education (the other two are P-12 classrooms and hybrid spaces). Teaching enactment practiced by preservice science teachers is an approximation of practice, or sheltered practice, where teacher educators and preservice science teachers formally and systematically ask questions and collaboratively revise plans.

ID improvement is often revised iteratively through the complementary and ongoing readjustment from reflection and feedback. As Danielewicz (2001) described, preservice science teachers' reflexivity involves their active analysis of past situations, events, and products of instructional design through critique and revision for the explicit purpose of changing thought or behavior. Feedback is essential to learning, and recent research suggests that the most effective feedback is immediate rather than delayed (Scheeler, McKinnon, & Stout, 2012). With immediate feedback, the supervisor is able to advise the teacher against performing an inadequate technique by informing the teacher of what to do, and the teacher can then perform the appropriate technique during the subsequent learning trial in the same lesson. Thus, teaching enactment, reflection, and feedback should also be included and emphasized in ID models.

What is the ADTRE model? Figure 1 offers a nonlinear, circular, and interactional model in that it emphasizes the importance of reflection and feedback as vital processes for the construction of the product (the lesson plan). The ADTRE model is conceptually defined as a visual mental model and provides an iterative decision-making process for preservice science teachers to apply in complex and diverse future teaching situations. The five phases of ADTRE are analyzing, designing, teaching, revising, and evaluating or improving. They look like leaves or petals grounded in the stem—reflection and feedback—which continuously provide critical design thoughts. In the analyzing phase, instructional tasks are determined as a result of textbook and related curriculum material analysis and learner analysis. In the designing phase, decisions are made based on the following components: content selecting, objectives making, methods selecting, media and resources selecting, and events arranging. The teaching practice phase involves teaching enactment. After the revising and evaluating phases, design is improved.
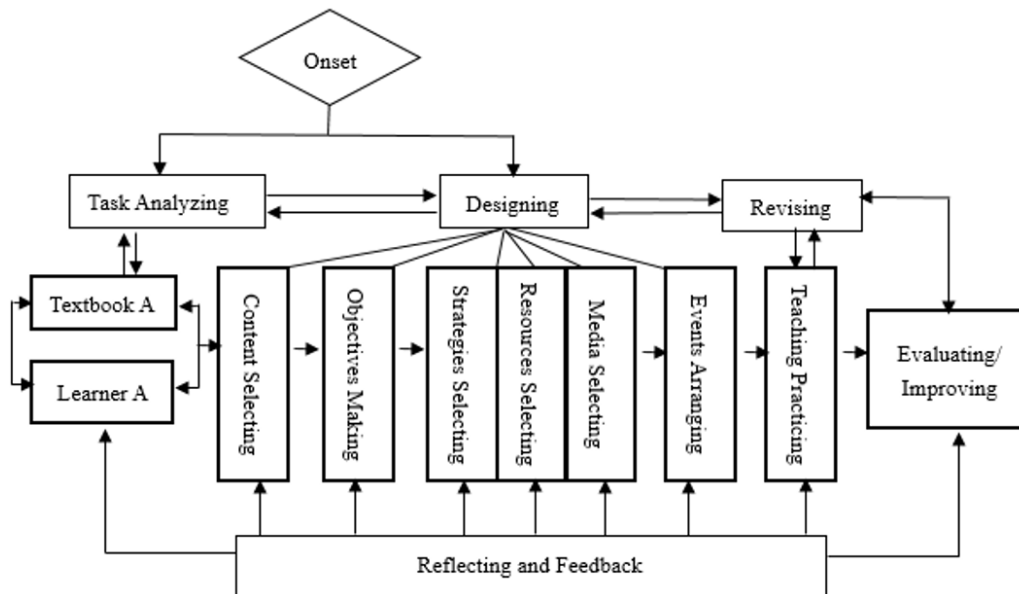
Figure 1. The ADTRE Model Based on Reflecting and Feedback

The ADTRE instructional design model integrates the advantages of the existing ID models, such as ADDIE, but it still has its own characteristics. First, the ADTRE model inherits the systemic feature of traditional ID models. Through constant and meaningful reflection and feedback, ADTRE can be not only regulated but also kept at dynamic equilibrium for a dissipative system. In terms of its use in teacher training, especially in preservice science teacher training, if we view this model as an open system rather than a closed system, like a thermodynamic system, it exists within a larger system of an external environment (an "instructional and learning environment") with which it interacts. It extracts "energy"—thinking and support from teacher educators and their peers—to construct instructional planning. It also extracts "matter"—reading and analyzing textbooks and curriculum materials and creating appropriate scripts that can be taught.

In addition, reflecting certainly plays the most important role in the ADTRE model. Every time, from a rough, fuzzy sense and awareness, with reflective behavior—and after the analysis of materials, learners, teaching objectives, content, methods, and assessments—instructional design attains the most optimal, reasonable, and effective planning. There are also a number of trade-offs, adjustments, and improvements. Reflection is not a reaction, which is a physiological, instinctive response that only leads subjects to act repeatedly and habitually. On the contrary, with reflective thinking, students continuously and critically examine their behaviors and thoughts and then construct new thoughts and behaviors beyond the original ones. Feedback is equally important in instructional design, since the result of instructional design (lesson planning or teaching) conversely affects teachers' design processes, with negative feedback that deviates from the original system goal. Instructional planning generally begins with the initial consideration of goal, content, process, and method. Therefore, feedback can achieve this optimization with authenticity and motivation without time delays.

The ADTRE model mimics the optimization of decision-making as a result of reflection and feedback. Rasmussen (1983) pointed out that three different types of decision-making exist and co-exist in a single case: skill-based, rule-based, and knowledge-based decision-making. The best ID involves all three types while designers or students utilize their IDC, ID models, and PCK for optimal design production.

How to teach with the ADTRE model in science teacher education? Reigeluth (2013), as cited in Gray et al. (2015) claimed that the traditional instructional models have been criticized because they failed to capture the complexity of the professional ID process. Lecturing on ID phases and providing the conceptual model for graduate student instruction (Magliaro & Shambaugh, 2006) is not sufficient. If we want to consider undergraduate students as ID professionals, teaching pedagogy should be modified so that learning ID involves unique ID activities and tasks aligned with particular subject areas. Accordingly, in order to improve preservice science teachers' IDC, instructional design models should be integrated into college instruction and IDC training practice.

The Analytic Hierarchy System of IDC

What is the nature of competence? Klein and Jun (2014) argued that competencies describe the critical ways in which proficiency is demonstrated. However, many researchers (Klein & Richey, 2005; Parry, 1998; Richey, Fields,

& Foxon, 2001) claimed that there are a set of related skills, knowledge, and attitudes that enable an individual to effectively perform a given occupation or job. In this study, competence, as described by Klein and Jun (2014), is applied. Competence is a critical way in which proficiency is demonstrated and a system in which multiple skills and abilities in a hierarchy can be measured through individual performance.

Several related conceptions and terms for IDC (instructional design competence) used in the literature are: *instructional design competencies* (Bowman, 2015; Cheng, 2014; Klein & Jun, 2014; Richey et al., 2001), *instructional design skills* (Brill, 2016; Isman et al., 2012; Koehler, 2015; McElvany et al., 2012; Nativio, 2014), *pedagogical design capacity* (Aydeniz & Dogan, 2016; Beyer, 2009; Beyer & Davis, 2012; Forbes, 2009; Forbes & Davis, 2010; Knight-Bardsley & McNeill, 2016; Ross, 2014) and *lesson planning skills* (John, 2006; Koehler, 2015; Klein, 1991). These various academic terms represent IDC as a hierarchy and mental ability of human beings.

Instructional design competences (skills) describe a special mental ability of ID. *Pedagogical design capacity* primarily focuses on the performance of a special or particular IDC, such as an instructional method design skill. As decision-making of mental skills rather than separated procedures or ways, IDC can be considered as the choice, on some basis or criteria, between one alternative among a set of alternatives and involves several pedagogical design capacities.

Lesson planning (LP) skills must be mastered technique among the professional skills for teacher preparation programs (Martin, 1994). In teacher education professional literature and daily teaching practice, LP include curriculum or course and unit planning (John, 2006; Karges-Bone, 2000; Savage, 2015; Skowron, 2006). LP is not only a design behavior or performance, but it is also a design result or written document with special templates, models, or illustrations and graphics.

LP has been defined by Savage (2015) as the process of thinking about one's thoughts and writing down a plan for the teaching and learning of a specific group of students, in a specific place, at a specific time. Essentially, LP is viewed as mimicking the natural decision-making process (John, 2006; Squires, 1999), which requires teachers' experiences, beliefs, knowledge, and especially PCK to explore, reflect, and make decisions. Writing the lesson plan is considered a key competence for not only preservice science teachers, interns, and novice teachers but also experienced teachers (John, 2006; Karges-Bone, 2000; Savage, 2015; Skowron, 2006). Western/American and Chinese LP researchers and education practitioners share many similar understandings in terms of conceptions, types, functions, procedures, and templates (John, 2006; Karges-Bone, 2000; Liu, 2003; Savage, 2015; Skowron, 2006; Zhang, 2013).

The decision-making procedure of LP can be illustrated with an analytic hierarchy process (Saaty & Vargas, 2001; Xia & Wang, 2015). That is, referring to classical instructional design theory (Gagné, Wager, Golas, & Keller, 2005; Kemp, 1971; Kemp, Morrison, & Ross, 1998; Dick, Carey, & Carey, 1996), lesson planning theories (Jefferies, 1966; Karges-Bone, 2000; Savage, 2015), and other previous research (He, Liu, Zheng, & Jia, 2016), IDC is considered a hierarchical system including multiple abilities: Textbook and Related Curriculum Material Analyzing (TA), Learner Analyzing (LA), Objective Making (OM), Content Selecting (CS), Strategies, Resources and Media Selecting (SRMS), Events Arranging (EA) and Reflecting and Feedback and Teaching Practice and Evaluation/Improvement (RFTEI). These abilities (i.e., TAA, LAA, OMA, CSA, SRMS, EA, RFTEI) are related to each other and form an integrated system (Dick et al., 1996; Gagné et al, 2005; He et al., 2016; Jefferies, 1966; Karges-Bone, 2000; Kemp, 1971; Kemp et al., 1998; Savage, 2015), which constitute the second level of the IDC system, also known as a criterion level. The bottommost level is the case level, also referred to as the lesson planning level, which includes designers' and students' ID products or lesson plans that apply IDC. The IDC system is conveyed in **Figure 2**.
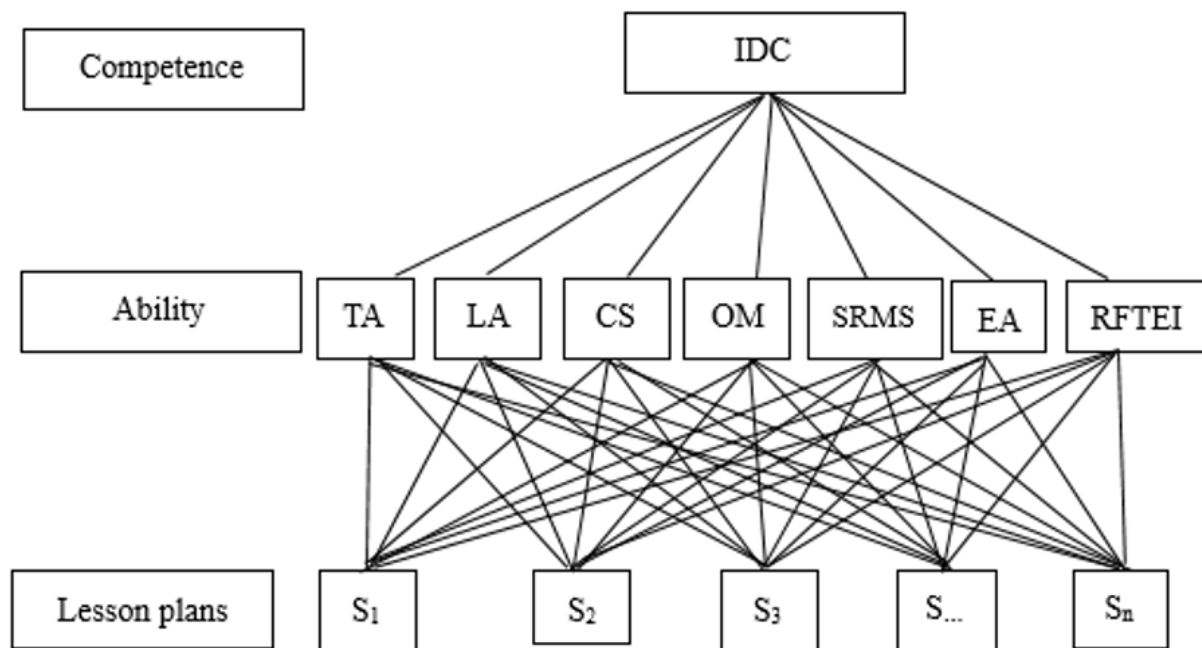
Figure 2. The System of Instructional Design Competences

It is worth noting that each ability in the second level of the IDC System can be divided into several skills, which constitute the sub-criteria level. The definition and indicators of each skill of IDC ability are delineated in **Table 1**. What needs special emphasis is that TA plays a very important role in instructional design planning, since it provides the foundation for the other design steps. The key part of the TA skill is the ability to organize and understand science content knowledge, which is also an important component of PCK, and can be presented by concept mapping (Ball & McDiarmid, 1990; Somers, 2009). The ability of RFTEI involves several skills, including reflection and feedback, teaching practice, and evaluation and improvement. The goal of fostering preservice science teachers' RFTEI ability is to develop IDC as part of teaching skills and construct a lesson plan that documents preservice science teachers' design thoughts and reveals their IDC. In the instructional process of the ADTRE instructional model, there are numerous opportunities for preservice science teachers to demonstrate ongoing reflection and feedback, teaching practices, and evaluation or improvement (RFTEI), from examination of their thoughts and actions. Since each ability is complex (Hatton & Snith, 1995; Gagné et al., 2005; McDonald et al., 2013), there is a need to develop assessment rubrics (Gagné et al., 2005), which has not been the focus of this article.

Table 1. The Definition and Indicators of IDC Skills

Ability	Definition		Skill Indicators
TA	The Textbook Analyzing ability involves teachers' critiquing and understanding of the textbook and curriculum materials, and making selection of the appropriate content, not only topics, but also components of the subject to be taught, including deep understanding of the ideas in textbooks (Randahl, 2016).		a. Naming the topic that can be taught within 10 minutes and summarizing the content of the topic b. Eliciting the connection of the related chapters and sections c. Understanding the instructional content systematically, logically and hierarchically (Shulman,1986). d. Identifying the structure of the and textbooks and the intention of the textbook's authors e. Keeping track of requests of the science curriculum standards (He et al., 2016)
LA	Learner Analyzing (LA) refers to analyzing learner interests and abilities, and identifying those dimensions of common learner characteristics that carry different implications for instruction.		a. Describing students' thinking traits or learning interests b. Describing students' prior conceptions or prior learning knowledge c. Knowing or evaluating students' learning difficulties d. Knowing how to investigate students' pre-conceptions
OM	The Objectives Making ability encompasses the writing of appropriate, quality, and concise learning objectives.		a. Numbers of learning objectives b. Numbers of well-written learning objectives c. Number of learning objectives with vague verbs d. Writing three-dimensional learning objectives
CS	The Content Selecting ability is based on Textbook Analyzing and Learner Analyzing; it involves identifying the key conceptions (knowledge, method, principle), in addition to identifying conceptions that are difficult-to-understand for students.		a. Identifying the key concepts (knowledge, method, principle) b. Identifying student learning difficulties
SRMS	Strategies, Resources, and Media Selection consists of three decisions:(a) What kind of strategies (methods or approaches) should be employed while teaching? (b) What resources (or materials) are needed in order to accomplish the goals?), and (c) How can the key knowledge and difficulties be addressed by integrating multimedia technology into teaching?		a. Chosen strategies fit the instructional content b. Resources or media are suitable for the instructional content c. Selected methods and media are helpful for highlighting key instructional content d. Chosen methods and media help address the difficult instructional content e. Designed instructional phases are distinct
EA	Events Arranging refers to designing four instructional stages that closely align with the instructional content	Introduction	a. Having creative, new, and unusual thinking b. Effectively focusing on a topic that is simply and explicitly written c. Effectively drawing from students' daily lives, social experiences, and unique interests
		New Content Learning	a. Promoting teaching with questions designed for triggering students' critical thinking skills b. Constructive interactions between teacher and student (Molinari et al., 2013) c. Presenting teachers' content logically and clearly (He et al., 2016) d. Making important content prominent e. Addressing difficult content f. Making scientifically accurate conceptions g. Integrating interdisciplinary education
		Summarizing, Assessment, and Feedback	a. Summarizing instructional content b. Helping students construct new meaning from lessons c. Stressing key instructional content d. Stressing difficult instructional content e. Designing questions and issues for assessment that are related to the instructional content f. Designing an outline of the instructional content and displaying it on the blackboard
		Assigning Homework	a. Homework is connected to current content and supports future lesson content well b. Homework reinforces and strengthens students' learning c. Homework helps students apply and transfer new knowledge

How is IDC studied? IDC is a field of research on competences such as curriculum materials analysis and adaptation (Beyer, 2009; Davis, Beyer, Forbes, & Stevens, 2011), objective making (Bümen, 2007), strategies selecting (Beyer & Davis, 2009), argumentation (Knight-Bardsley & McNiell, 2015), curriculum design (Beyer & Davis, 2012), classroom discussion (Ross, 2014), inquiry (Forbes, 2009; Forbes & Davis, 2010), formative assessment (Aydeniz & Dogan, 2016), and reflection (Saribas & Ceyhan, 2015). These research areas, however, involve different aspects of IDC, and not enough attention in the past has been paid to the relations among them.

In **Figure 2**, LP is located at the bottom, which is the final, authentic component that represents IDC. LP can be a joyful, creative process (Karges-Bone, 2000; Savage, 2015), an art, science, and school-wide mission (Karges-Bone, 2000). Though, as an ID product, a LP document embodies thought with the quantity and quality of thinking and is viewed as analogous to natural decision-making (John, 2006; Squires,1999). Researchers (Kemp, 1971) and teacher education practitioners demonstrated that daily LP and classroom teaching could be further deconstructed into several smaller sections (subject area, unit, topic). According to Bloom's taxonomy, topics of any content area can be classified into several interconnected, smaller topics. The subtopics can be factual, conceptual, procedural, or metacognitive topics or principles (Anderson et al., 2001; Clark & Lyons, 2010). Zheng, Fu, He and Zheng (2014) proposed the CPUP model (Class Systems, Plate Systems, Unit Systems and Primitive Systems), a four-level hierarchy system model, based on the Von system science theory and observational data.

On the other hand, as a teacher training strategy, microteaching has been employed since the early 1960's (Allen & Ryan, 1969; Amobi, 2005; DeLorenzo, 1975; Remesh, 2013) and is widely accepted as one of the most important methods for providing on-campus clinical experiences for preservice teachers. Fostering preservice science teachers' IDC is easier when a whole lesson is divided into several smaller sections. Therefore, in this study we adopted 10-minute lesson planning, which is also called micro-lesson or mini-lesson because it involves planning a 10-minute lesson as opposed to a traditional 45-minute lesson.

If IDC is an interactive, hierarchical process, a system of how preservice science teachers understand ID, then it seems valuable to study preservice science teachers' characteristics and their correlations. IDC analysis not only affords instructors a concrete understanding of preservice science teachers' IDC, but it also provides them with the knowledge to create a more relevant and effective IDC. At the university level, analysis of IDC provides insight on curriculum design and reform.

METHOLODOGY

Research Setting and Participants

Participants included 118 students at Shanxi Normal University in China, who were enrolled in a semester-long, upper-level Bachelor's course called, *Middle and High School Biological General Teaching Methods*. Using the convenience sampling method (Gall, Borg, & Gall, 2002), these students were selected because they received the same instruction on the ADTRE model; these students studied ID 3 hours each week for 6 weeks. Out of the 118 participants, 59 students majored in biological science (Class 1 from the two biological science classes), and 59 students majored in biological technology (Class 2 from the one biological technology class). Students participated in this course during the fall semester of their junior year, from September 2015 to January 2016. For all participants, this course was their first formal study of ID, which prepares them for their teaching practicum during the spring semester of their junior year or the fall semester of their senior year, when they teach in rural schools in Shanxi Province. After ADTRE Model instruction, each preservice science teacher prepared lesson plans, and by the end of the methods course, 113 lesson plans (56 from biological science students and 57 from biological technology students) were created for analysis.

Course Description and College Instruction on the ADTRE Model

Prior to ADTRE Instructional Model instruction, preservice science teachers watched and discussed videos of biology teaching and conducted classroom observations of teaching in secondary biology classrooms (grades 7-12). They also learned about ID theories and were introduced to several ID models, such as the ADDIE model and those of Dick et al. (1996), Gagné et al. (2005), and Kemp et al. (1998). Preservice science teachers were then asked to select a topic in sequence that they were interested in from the same high school biology textbook. Using the ADTRE Instructional Model, they designed 10-minute-lesson plans, with guidance from the teacher educator and their peers in collaborative learning groups. While writing the lesson plans, they learned several abilities, which include the following: analyzing the textbook and learner characteristics, writing objectives, selecting teaching content, organizing the classroom for instruction, and choosing teaching strategies, resources, and media.

During the teaching practice phase, preservice science teachers rehearsed their plans while their preservice science teacher peers acted as students and captured videos of their lesson enactments with their cell phones. Then,

Table 2. ADTRE Instructional Model

Instructor Teaching Stages	The Instructional Intention	Preservice science teachers' learning steps		
A Analyzing & Learning: video watching and theory learning	1. Reflection on prior knowledge and teaching experiences 2. Motivating intention 3. Introducing ID theory	◆ Watch and analyze video of teaching ◆ Field observing (observation) of secondary (grades 7-12) biology teaching ◆ Learning about and preparing ID knowledge ◆ Reflection on learning and teaching		
D Designing and abilities training: using ADTRE ID model to design and write a lesson plan	1. Applying ID theory 2. Collaborative planning 3. Abilities training 4. Developing mastery (Ambrose, Bridges, DiPetro, Lovett, & Norman, 2010)	A TA & LA	**R** Reflecting, feedback, and revising instruction document	
		D OM, CS, EA & SRMS		
		T Microteaching & Rehearsal in group		
		E Self-evaluation and improvement		
T Teaching Practice: rehearsal of plans, as other preservice science teachers and teacher educator "play" students	1. Observing teaching performance 2. Collecting abilities training feedback 3. Providing individual guidance 4. Revising instructional strategies for IDC development	◆ Gaining feedback from teacher educator and other high school expert teachers ◆ Reflecting on what they have learned and revising plans for future enactments and job interviews ◆ Reflecting and improving IDC	**R** Reflecting, feedback, and improving IDC	
E Evaluating/ improvement: teaching skills test that high school expert teachers completed	1. Evaluating revised lesson plans 2. Discussing questions about teacher abilities training 3. Evaluating teaching skills 4. Developing IDC			

with their group members, they collaboratively analyzed videos of their lessons and improved their plans. Finally, they returned to the whole class and practiced their teaching based on their improved lesson plans, while the teacher educator and their classmates role-played students. After teaching the revised lesson, each preservice science teacher received feedback and individual guidance from their professor and peers, which they used when they reflected on their lesson plans and IDC. In general, for each major, the teaching practice phase took 590 minutes, since there were 59 preservice teachers who practiced their 10-minute-lessons individually. In other words, for each 1 hour class, 4 preservice teachers practiced their teaching for a total of about 40 minutes, and there were about 20 minutes for the teacher educator's comments (for details, see **Table 2**). At the end of semester, all preservice science teachers took part in a university teaching skill test that high school expert teachers evaluated. Reflection and feedback, improving instruction, and IDC were central components for both teacher educators and preservice science teachers throughout the course. The details of our instructional intent and students' learning steps are also displayed in **Table 2**.

Scoring Rubric Development

We scored preservice science teachers' IDC based on their lesson plans, according to a rubric. To develop the rubric based on the IDC definition and skill indicators, we used the research literature (Dick et al., 1996; Gagné et al, 2005; He et al., 2016; Jefferies, 1966; Karges-Bone, 2000; Kemp, 1971; Kemp et al., 1998; Mäntylä & Nousiainen, 2014; Savage, 2015) and focus group discussions. We developed a LP analytic rubric by detailing the IDC skill indicators. The LP rubric preparation process and scoring criteria were informed by Bümen (2007) and Klein's (1991) work as well as He et al.' s (2016) instrument. Two science education professors and one expert high school biology teacher worked together to create the criteria for the rubric.

We also followed McClure, Sonak and Suen's (1999) concept mapping skill assessment to grade the skill of "understanding the instructional content systematically, logically, and hierarchically," which is part of TA. This skill includes organizing and understanding science content knowledge. We used concept mapping because research has shown that concept maps can indicate the organization and understanding of science content knowledge in a graphic, visual manner (Novak & Gowin, 1984). Concept mapping can also be used as an assessment tool (Mok, Lung, Cheng, Cheung, & Ng, 2006). Furthermore, Somers (2009) reported that concept mapping can be a strong tool for preservice teachers to organize and understand subject matter knowledge and strengthen understanding of pedagogy through reflection. Thus, we utilized a concept mapping skill assessment to evaluate preservice science teachers' IDC. Due to space limitations, we direct you to the paper written by McClure et al. (1999), which details the reliability and validity of concept mapping as a measurement instrument. In addition, we examined the initiation-response-feedback (IRF) pattern (Molinari, Mameli, & Gnisci, 2013) to grade the skill of promoting teaching with questions designed for activating students' critical thinking. Then, we tested

Table 3. Spearman's Rank Correlation Coefficient of the Two Raters for the Rubric Components

IDC	TAA	LAA	OMA	CSA	SRMSA	EAA=.939**			
						Intro.	NCL	SAF	AH
.964**	.896**	.991**	.940**	.964**	.920**	1.00**	.908**	.994**	978**

** p<.01

the rubric draft on 10 preservice science teachers' lesson plans and obtained feedback from 2 science teacher education professors and 2 expert biology teachers. With this pilot test, we re-examined the performance levels and definitions of each criterion until the rubric reached its final and acceptable state.

The scoring rubric for teachers' IDC is located in the **Appendix**. For each category of teachers' ability, a group of subcategories, which referred to teachers' skill indicators, were defined. For example, the ability of learner analyzing (LA) contained four indicator skills, which included describing students' thinking traits or learning interests, describing students' prior conceptions or prior learning knowledge, knowing or evaluating students' learning difficulties, and knowing how to investigate students' pre-conceptions. The content of teachers' lesson plans, according to the four skills, were assessed by the researchers and a score (none -0, exact -1, and more exact -2) was assigned to each skill. The overall score of LA was computed by adding the scores of the four skills. However, the other dimensions of IDC did not share exactly the same scheme of scoring due to the complexity of skills. For example, the score of the first skill of events arranging (EA), which referred to having creative, new, and unusual thinking, was defined as creative thinking (2 marks), just review (1 mark), and none (0 marks). The total scores of teachers' abilities were then used in the further analyses.

Data Analysis

Pre-service science teachers' instructional design competence was evaluated through scoring teachers' 10-minute lesson plans. We believe the 10-minute lesson includes full components of lesson teaching. As the saying goes, small as the sparrow is, it possesses all its internal organs, the instructional design competence required for a 10-minute lesson is not less than that required for a 40-45-minute lesson, which generally includes three or four 10-minute lessons. On the contrary, effective instructional design competence is required to design and implement a shorter lesson plan as opposed to a longer and more traditional lesson plan. Often, it is more difficult to design micro-lessons or mini-lessons, such as those used in the flipped classroom (Bergmann & Sams, 2012) and Khan Academy experiences (Khan, 2012). For the past ten years, our university, as well as other normal universities in China, has adopted 10-minute-lesson planning as an effective practice.

Some people might consider lesson content as a factor that might impact instructional design competence results. However, it is difficult for preservice science teachers to design lesson plans while they are still learning and practicing instructional design. The difficulty still lies in how to best present content to students, which requires preservice science teachers to have expert instructional design competence, which they do not yet have (Hammerness et al., 2005). However, as Hevern (2009) pointed out, Bruner (1960, 1977) argued that any subject could be taught to any child at any stage of development, as long as it is presented in the proper manner. Thus, the difficulty of the teaching content is negligible in the face of teachers' IDC. Furthermore, our analysis framework displays IDC as systematic rather than isolated, which refers to a design capability for any teaching task rather than a single task.

Reliability and validity is fundamental for any research. Credibility and content validity were achieved by using the Analytic Hierarchy System of IDC as the conceptual framework to guide the study. The content validity for the scoring rubric is based on significant western/American and Chinese theories and instructional design practices, as **Scoring Rubric Development** noted. In addition, in this study, the content validity for the scoring rubric has been achieved through focus group discussion between the two raters who have extensive experience in lesson plan design. Reliability was enhanced by providing the definition and skill indicators of each instructional design ability as well as an acceptable level of inter-rater reliability on the total IDC and six instructional design abilities.

We employed two raters in this study. One was a science education professor who has more than 20 years of teaching experience and teacher education experience, and the other one was a biology master's degree student with 3 years of biology teaching experience. Both individuals had extensive expertise and knowledge on lesson planning and biology education. The two raters are qualified in designing lesson plans since both have participated in professional instructional design training before they became teachers. The student has been directed by the science professor for one year on research in biology teaching. Additionally, the student took part in this research project from its inception and has participated in every step of the study since then. In order to guarantee the reliability of the results, two raters (the researchers) fully and deeply discussed every biology teaching content designed by the preservice science teachers and reached a consensus on the assessment. The result of inter-rater reliability was calculated with Spearman's rank correlation coefficient, which showed an acceptable level. **Table 3** presents the coefficients.

Table 4. Descriptive Statistics Results of Preservice Science Teachers' IDC (N=113)

	Minimum	Maximum	Mean	Std. Deviation	Students' Number (Percent)of ">" or "=" Mean			
					Class 1	Class 2	Total	%
TAA	1	85	34.01	16.62	23	31	54	47.79
LAA	0	6	2.54	1.38	29	27	56	49.56
OMA	4	26	11.98	4.80	19	39	58	51.33
CSA	0	12	5.33	2.41	21	30	51	45.13
SRMSA	2	12	8.00	2.48	35	34	69	61.06
EAA	16	62	32.67	10.10	24	28	52	46.02
IDC	37	167	94.53	23.83	25	24	56	49.56

Note: Class 1, majors in biological science, and Class 2, majors in biological technology. The following is the same

Two raters scored 113 students' lesson plans; the science education professor scored TAA, LAA, OMA, and part of EAA, while the other rater scored CSA, SRMSA, and part of EAA. The scoring served as the source of IDC data for descriptive statistics analysis. In addition, in order to study the relationship between IDC and students' academic performance, we collected and examined five semesters of these preservice science teachers' academic performance, which included general courses, required courses, and teacher education courses. In total, there were 17 courses including College English, Advanced Mathematics, Inorganic Chemistry, Organic Chemistry, Genetics, Biochemistry, Cell Biology, Microbiology, Ecology, Education, Educational Psychology, and Middle and High School's Biological General Teaching Methods.

Preservice science teachers' academic performance can be revealed in various ways, from an information era ePortfolio (JISC, 2014) to a more traditional professional knowledge test (Paulick, Grosschedl, Harms, & Moller, 2016). Subject examination scores are therefore only one method used in determining academic performance. We chose subject examination scores to study the relationship between students' academic performance and IDC because subject examinations assess preservice science teachers' PCK, which is a key prerequisite for ID mental activity and IDC development. It is unfortunate that, at present, many universities in developing countries use only subject examination scores and lack diverse academic achievement assessment methods. Shanxi Normal University is no exception. Lastly, we wanted to explore the extent to which these courses contributed to students' IDC, in that findings could provide empirical evidence for teacher education curriculum reform.

RESULTS

Descriptive Statistics of Preservice Science Teachers' IDC

The overall mean for the IDC scores was 94.53 (SD=23.83). Means (with standard deviations in parentheses) for each IDC ability were: TAA 34.01(16.62), LAA 2.54 (1.38), OMA 11.98 (4.80), CSA 5.33 (2.41), SRMSA 32.67 (10.10), and EAA 32.67 (23.83), respectively. The descriptive statistics results of preservice science teachers' IDC are shown in **Table 4**.

IDC Comparison between the Majors

In order to compare any significant difference in preservice science teachers' IDC between different majors, independent samples t-tests were done. The results showed that the differences between the two majors' overall IDC mean scores were not statistically significant at the 0.05 level (p =0.08). However, Class 2 (majors in biological technology) and Class 1 (majors in biological science) had statistically significant different mean scores on OMA and CSA (p <0.05). There were no statistically significant different mean scores on TAA, LAA, SRMSRA, and EAA (p >0.05). **Table 5** presents the results.

Table 5. Descriptive Statistics for Different Preservice Science Teacher Majors' IDC Tests and Independent Samples t-test for Equality of IDC Means

		n	**Mean**	**SD**	**SEM**	*t*	*df*	*p*(2-tailed)
TAA	1	56	32.89	18.45	2.47	-0.706	111	0.482
	2	57	35.11	14.69	1.95			
LAA	1	56	2.43	1.48	1.00	-0.847	111	0.399
	2	57	2.65	1.29	0.17			
OMA	1	56	10.66	4.70	0.63	-3.003	111	0.003
	2	57	13.28	4.57	0.61			
CSA	1	56	4.88	2.76	0.37	-2.001	98.25	0.048
	2	57	5.77	1.93	0.26			
SRMSA	1	56	8.21	2.47	0.33	0.910	111	0.365
	2	57	7.79	2.49	0.33			
EAA	1	56	31.54	9.11	1.22	-1.189	111	0.237
	2	57	33.79	10.95	1.45			
IDC	1	56	90.61	22.88	3.06	-1.751	111	0.083
	2	57	98.39	24.32	3.22			

Table 6. Relationship Between General and Foundational Courses and IDC

		General Courses		**Foundational Courses**		
		IDC	**English**	**Advanced Math**	**Inorganic Chemistry**	**Organic Chemistry**
IDC	Pearson Correlation	1	-0.045	.191*	0.066	0.080
	Sig. (2-tailed)		0.635	0.043	0.490	0.397
	N	113	113	113	113	113

*. Correlation is significant at the 0.05 level (2-tailed)

Table 7. Relationship Between Required and Major Courses and IDC (N=113)

		IDC	**Botany**	**Zoology**	**Genetics**	**Biochemistry**	**Cell Biology**	**Micro biology**	**Ecology**	**Molecular Biology**	**Principles of Genetic Engineering**
IDC	Pearson Correlation	1	0.058	0.006	0.058	-0.052	.244**	0.082	0.071	-0.082	-.216*
	Sig. (2-tailed)		0.540	0.948	0.543	0.584	0.009	0.390	0.452	0.387	0.021

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

Relationship between the Preservice Science Teachers' Academic Achievement and IDC

In order to determine if there was any relationship between the preservice science teachers' academic achievement and IDC, correlations analysis was done. The results indicated that there was a statistically significant correlation between students' overall IDC scores and their grades in Advanced Mathematics (enrolled during the freshman year, fall semester) (p<.05) (r=.191, *p* <0.05). There was no statistically significant correlation between students' overall IDC scores and grades in any of other courses. **Table 6** presents the findings.

The correlation between student overall IDC scores and student grades in the required and major courses shows that there was a statistically significant correlation between IDC scores and grades in Cell Biology (enrolled in sophomore year, spring semester) (r=.244, p <0.01). There was a statistically significant negative correlation between IDC scores and grades in Principles of Genetic Engineering and Technology (enrolled in junior year, fall semester) (r = -0.216, p <0.05). There was no statistically significant correlation between IDC scores and grades in other courses (i.e., Botany, Zoology, Genetics, Biochemistry, Microbiology, Ecology, and Molecular Biology). **Table 7** presents the results.

As for the correlation between IDC scores and teacher education courses, there were no statistically significant correlations between IDC and the teacher education courses (including Education, Educational Psychology, Biology Teaching Methods, and Teaching Skills Training courses), although there were significant correlations between IDC and concept mapping skills (see **Tables 8** and **9**).

Table 8. Relationship Between Teacher Education Courses and IDC (N=113)

		IDC	Education	Biology Teaching Method	Teaching Skills Training	Educational Psychology
IDC	Pearson Correlation	1	-0.037	-0.016	0.114	0.071
	Sig. (2-tailed)		0.695	0.870	0.229	0.456
	N	113	113	113	113	113

Table 9. Relationship Between Concept Mapping Skills and IDC (N=113)

		IDC	Concept Mapping Skills
IDC	Pearson Correlation	1	.242**
	Sig. (2-tailed)		0.010
	N	113	113
Concept Mapping Skills	Pearson Correlation	.242**	1
	Sig. (2-tailed)	0.010	
	N	113	113

**. Correlation is significant at the 0.01 level (2-tailed)

DISCUSSION

Research substantiates the primary role that teachers play in student learning and academic success (Akiba, LeTendre, & Scribner, 2007; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Tatar, Tuysuz, Tosun, & İlhan, 2016). According to Stronge (2013), in order to "improve the quality of our schools and positively affect the lives of our students, we must change the quality of our teaching" (p. 3). Globalization of the teacher professional standards and competencies has led to an increased emphasis on fostering teachers' qualities (UNESCO, 2014). However, as Aydin et al. (2013) pointed out, "preservice teachers have the potential to pursue lifelong professional growth as they progress throughout their career[s]" (p. 904). Thus, the quality of preservice teachers requires attention and should be a key focus for university teacher education programs.

Caena (2014) pointed out that, increasingly, research and policy support a holistic, dynamic, and process-oriented view of teacher competences. Underpinned by this competency perspective, this study provided an analytic hierarchy system of IDC for evaluating teachers' IDC based on the mental model and nature of ID. This study also quantitatively explored the effects of an ADTRE instructional model based on reflection and feedback for 118 preservice science teachers, majoring in biological science or biological technology, at Shanxi Normal University in China. We collected 113 lesson plans from these students and analyzed them according to scoring rubrics. Specifically, we explored particular characteristics of preservice science teachers' IDC, whether or not there were differences in IDC between the two majors, and the relationship between preservice science teachers' academic achievement in different courses and their IDC. This study is aligned with the current reform efforts regarding the significance of IDC and confirms the studies that discuss how preservice teachers can be successful in acquiring and applying instructional design skills (Klein, 1991; Neale et al., as cited in Klein, 1991).

Characteristics of Preservice Science Teachers' IDC

About 50% of participants in this study attained the IDC mean. IDC components with the greatest numbers of students who attained the mean, from high to low were: SRMSA, OMA, LAA, TAA, EAA, and CSA. A little more than 60% of students demonstrated competence in selecting teaching strategies and resources and media, and a little more than 50% of the students were more easily able to write objectives. Students had slightly more difficulty with determining learner characteristics and analyzing textbooks and curriculum materials. Fewer students, about 46% and 45% respectively, had difficulty with arranging instructional events and selecting content for lessons. The above findings suggest that there is significant room for preservice science teachers to improve in their IDC.

We posit that the IDC components where students had more difficulty require more teaching experience and support. Fully understanding student needs, arranging instructional events, and selecting instructional content based on analysis of curriculum materials, are skills that are more difficult for novice teachers. On the other hand, writing objectives and determining materials needed for lessons can more easily be taught and require less teaching experience to develop. Abd-El-Khalick's (2006) study, which investigated two preservice and two experienced secondary biology teachers' global and specific subject matter structures and the relationship between these structures and their teaching practices, reveal differences between novice and expert teaching. Experienced teachers paid more attention to their students' needs and emphasized fewer details and more integrative content. Preservice teachers relied more heavily on the textbooks when teaching, having more difficulty selecting overarching themes that connected biology content. Therefore, it is possible that some of the IDC components require more expertise for competence than others, which might explain the differences in the individual IDC component results.

Regarding the differences in IDC based on major, both Class 1 (biological science majors) and Class 2 (biological technology majors) had statistically significantly mean scores on OMA and CSA (p <0.05). There were no statistically significant mean scores between the two majors in the other IDC components and overall IDC scores. After all, students with different majors are in different classes, and it is possible that differences in the course curricula, or other factors, like the class culture or learning environment, could have contributed to the abovementioned differences in these preservice science teachers' IDC. However, reasons for this finding need to be explored more deeply.

Relationships between Preservice Science Teachers' Academic Achievement and Their IDC

Considering the relationship between the preservice science teachers' academic achievement and IDC, this study revealed a positively significant correlation between Advanced Mathematics and Cell Biology courses and IDC. Learning in these two courses emphasized the competences of comprehension and reasoning, and transformation and reflection, which were foundational components of teaching reform (Shulman, 1987). Shulman (1987) pointed out: "Teaching begins with an act of reason, continues with a process of reasoning, culminates in performances of imparting, eliciting, involving, or enticing, and is then thought about some more until the process can begin again" (p. 13). Thus, we believe that this finding is particularly valuable because it provides strong evidence for Shulman's (1987) idea about teaching that emphasizes comprehension, reasoning, transformation, and reflection. As Shulman (1987) stated, "This emphasis is justified" even though "research and policy have so blatantly ignored those aspects of teaching in the past" (p. 13). Unfortunately, even with teacher education backgrounds, we did not consider this circumstance of teaching. If we took instructional topics into consideration, we would find that nearly forty percent of the teaching topics belonged to the field of cell biology, and perhaps the preservice science teachers reviewed cell biology knowledge during instructional design. Whatever the reason, we should carefully and judiciously draw a conclusion from this finding that the reasonable thinking competence and subject matter knowledge learned in Advanced Mathematics and Cell Biology benefitted preservice science teachers' development of IDC.

There was also a significant correlation between IDC and concept mapping skills. Martin (1994) found that preservice teachers' usage of concept mapping led to lesson plans "which exhibit continuity, which are well-integrated, and which are logically sequenced" (p. 27). He argued that concept mapping is helpful for preservice teachers when developing lesson plans, especially because preservice teachers can quickly learn concept mapping skills. Conversely, there was a significant negative correlation between IDC and Principles of Genetic Engineering and Technology. This finding could be a result of limited learning time, where students were both learning material for this course and developing IDC in the same semester.

The findings were not significant for the correlations between other major and general courses and IDC. If abiding by the definition of teacher competences (Deakin Crick, 2008), IDC is viewed as a complex combination of knowledge, skills, understanding, values, attitudes and desire, leading to effective, situated actions in an instructional design mental activity. Major and general courses should be the primary origin of preservice teachers' IDC. Possible reasons for our result are that pre-service science teachers are left with fragmented knowledge because traditional teacher education is often inefficient in creating the required coherence in learned subject content. Thus, creative university teaching methods are required in order to facilitate consolidation of preservice science teachers' knowledge, including subject matter knowledge (Mäntylä & Nousiainen, 2014).

Additionally, there was no significant correlation between teacher education courses, such as Education, Educational Psychology, Teaching Skills Training, and Biology Teaching Methods. This outcome seems to support the results of previous studies that had revealed the unfortunate truth of teacher education. Several studies reported that teacher education programs are not adequately informed by knowledge or research on teachers' professional learning (RAND Reading Study Group, as cited in Aydin et al. 2013; U.S. Department of Education, 2008). Furthermore, this result also suggests the weakness in our university teachers' education curriculum and teaching methods, which needs to be explored more deeply.

These results suggest that other variables, perhaps relating to the preservice teachers themselves, could affect IDC. Hardre and Kollmann (2013) examined differences in individual characteristics that they believed could influence preservice teachers' IDC. They found that the differences that seemed to impact preservice teachers' IDC included matters of choice, some that developed over time, and others that were based on attitude or personality (Hardre & Kollmann, 2013). For instance, some preservice teachers chose content that they were more familiar with, which granted them more time, energy, and attention towards learning ID content and principles; they would not need to divide their time between mastering content and ID. Hardre & Kollmann (2013) also suggested that preservice teachers who were less likely to expand beyond their comfort zones developed IDC more slowly. Preservice teachers who were more metacognitive, reflective, and self-regulative tended to be more successful in

ID. Thus, differences in individual characteristics could contribute to these disparities among particular IDC components.

RECOMMENDATIONS

Due to its complexity, there seems to be increasing convergence towards a definition, structure, and application of IDC. This study provides an analytic framework for evaluating preservice science teachers' IDC based on the mental model of instructional design and offers one of many possibilities. The analytic hierarchy system of IDC needs to be studied continually and improved to validate and explain the true nature of IDC. Furthermore, another limitation of this study is that preservice science teachers' RFTEI ability, because of its complexity, was not determined. In addition, this study assessed IDC based on the lesson plans of biological science and biological technology majors' lesson plans. Future studies could explore other methods for assessing IDC. They could also focus on other areas of science, such as chemistry, physics, and earth science, as well as different levels of participants, such as in-service, college and university teachers. Additional research can extend over a longer period in order to examine how IDC develops over time, and study novice and expert teachers' IDC. Similar to the Hardre & Kollmann (2013) study, other factors that contribute to IDC should also be examined.

ACKNOWLEDGEMENTS

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APPENDIX

The Rubric Criteria of IDC

Ability	Definition	Skill Indicators	Operational definition		Score
TA	The Textbook Analyzing ability involves teachers' critiquing and understanding of the textbook and curriculum materials, and making selection of the appropriate content, not only topics, but also components of the subject to be taught, including deep understanding of the ideas in textbooks (Randahl, 2016).	a. Naming the topic that can be taught within 10 minutes and summarizing the content of the topic	Topic and time are suited		1
			Topic and time are not suited		0
		b. Eliciting the connection of the related chapters and sections	Not any connection		0
			Writing the name of the previous chapter and the posterior		2
			Writing the relationships among the previous, the current teaching content and the posterior		2
			Describing critically		2
		c. Understanding the instructional content systematically, logically and hierarchically (Shulman,1986). (referring to concept map assessment, McClure et al, 1999)	T04	Total	add together T0401-T0404
			T0401	Propositions (if valid)	numberX1
			T0402	Hierarchies (if valid)	numberX5
			T0403	Cross-links (if valid)	numberX10
			T0404	Examples (if valid)	numberX1
		d. Identifying the structure of the and textbooks and the intention of the textbook's authors	None		0
			Recognizing the structure		1
			Analyzing the structure		1
			Indicating the textbook structure' teaching meaning and the intention of the textbook's authors		1
		e. Keeping track of requests of the science curriculum standards (He et al., 2016)	Quoting and discussing		2
			Just quoting		1
			None		0
LA	Learner Analyzing (LA) refers to analyzing learner interests and abilities, and identifying those dimensions of common learner characteristics that carry different implications for instruction.	a. Describing students' thinking traits or learning interests	More exact		2
			Exact		1
			None		0
		b. Describing students' prior conceptions or prior learning knowledge	More exact		2
			Exact		1
			None		0
		c. Knowing or evaluating students' learning difficulties	More exact		2
			Exact		1
			None		0
		d. Knowing how to investigate students' pre-conceptions	The Way is more appropriate		2
			Just putting forward the way		1
			None		0
OM	The Objectives Making ability encompasses the writing of appropriate, quality, and concise learning objectives.	a. Numbers of learning objectives			1/each
		b. Numbers of well-written learning objectives	Behavioral verb (referring to the curriculum standard) +learning content		1/each
		c. Number of learning objectives with vague verbs	Non-behavioral verb, for example, cultivate, understand, master etc.; the objective that could not be achieved in a lesson, such as curriculum goal like "cultivate students' scientific literacy"		-1/each
		d. Writing three-dimensional learning objectives	Three dimensions		3
			Two dimensions		2
			One dimension		1
CS	The Content Selecting ability is based on Textbook Analyzing and Learner Analyzing; it involves identifying the key conceptions (knowledge, method, principle), in addition to identifying conceptions that are difficult-to-understand for students.	a. Identifying the key concepts (knowledge, method, principle)	The concepts selected are indeed the key conceptions		2/each
			The concepts selected are not key conceptions		1/each
			None		0
		b. Identifying student learning difficulties	The content selected are indeed difficulty for student to understand		2/each
			The concepts selected are not difficulty for student to understand		1/each
			None		0
SRMS	Strategies, Resources, and Media Selection consists of three decisions:(a) What kind of strategies (methods or approaches) should be employed while teaching? (b) What resources (or materials) are needed in order to accomplish the goals?), and (c) How can the key knowledge and difficulties be addressed by integrating multimedia technology into teaching?	a. Chosen strategies fit the instructional content	The strategy is more helpful for student understand		2
			The strategy is helpful for student understand		1
			Not applying strategy		0
		b. Resources or media are suitable for the instructional content	The resources or media are more helpful for student understand		2
			The resources or media are helpful for student understand		1
			Not applying resources or media		0
		c. Selected methods and media are helpful for highlighting key instructional content	Methods and media more suit key content learning		2
			Methods and media suit key content learning		1
			Methods and media don't suit key content learning		0
		d. Chosen methods and media help address the difficult instructional content	Methods and media are more helpful for reducing the grade of difficulty		2
			Methods and media are helpful for reducing the grade of difficulty		1
			Methods and media are not helpful for reducing the grade of difficulty		0
		e. Designed instructional phases are distinct	Including four phases (see EA)		4
			Including three phases		3
			Including two phases		2
			Including one phase		1

Ability	Definition	Skill Indicators	Operational definition	Score
EA	Events Arranging refers to designing four instructional stages that closely align with the instructional content	**Introduction**		
		a. Having creative, new, and unusual thinking	Creative thinking	2
			Just review	1
			None	0
		b. Effectively focusing on a topic that is simply and explicitly written	Highly relevant to the teaching topics, simply and clearly	4
			Lowly relevant to the teaching topics, vaguely or repetitively	2
			Irrelevant to the teaching topics	0
		c. Effectively drawing from students' daily lives, social experiences, and unique interests	Connecting more appropriately	2
			Connecting appropriately	1
			None	0
		New Content Learning		
		a. Promoting teaching with questions designed for triggering students' critical thinking skills	More observably	2
			Observably	1
			None	0
		b. Constructive interactions between teacher and student (Molinari et al., 2013)	Total	
			IRF	1/each
			IR1R2R3Rn…F	1/each
			IR1F R2 F 2 Rn…F	1/each
			IR0 (or teacher speaks to himself)	1/each
			I00	1/each
			Other for example, "Do you understand?" etc, or including questions for organizing instruction and not academic learning	-1/each
		c. Presenting teachers' content logically and clearly (He et al., 2016)	Clear and logical	2
			Not clear or not logical	1
			Neither clear nor logical	0
		d. Making important content prominent	More explanation	2
			Explanation	1
			None explanation	0
		e. Addressing difficult content	Utilizing different methods to make the difficulty easy to understand, such as metaphor, modeling, visualizing, etc.	2
			Just retelling the content	1
			None explanation	0
		f. Making scientifically accurate conceptions	Errorless	1
			Error	0
		g. Integrating interdisciplinary education	Implying	1
			None	0
		Summarizing, Assessment, and Feedback		
		a. Summarizing instructional content	Comprehensively	2
			Not comprehensively	1
			None	0
		b. Helping students construct new meaning from lessons	More helpful	2
			Helpful	1
			None	0
		c. Stressing key instructional content	Indicating key instructional content in detail	2
			Just indicating which is key	1
			Not indicating key content	0
		d. Stressing difficult instructional content	Indicating difficult instructional content in detail	2
			Just indicating which is difficult	1
			Not indicating difficulty	0
		e. Designing questions and issues for assessment that are related to the instructional content	Taking a special test to measure students' learning result	3
			Waking up students' memory through review	2
			Restating instruction content	1
			No assessment	0
		f. Designing an outline of the instructional content and displaying it on the blackboard	Outline displaying on the blackboard is more concise	2
			Outline displaying on the blackboard is concise	1
			No outline displaying on the blackboard	0
		Assigning Homework		
		a. Homework is connected to current content and supports future lesson content well	More helpful	2
			Helpful	1
			None	0
		b. Homework reinforces and strengthens students' learning	More helpful	2
			Helpful	1
			None	0
		c. Homework helps students apply and transfer new knowledge	More helpful	2
			Helpful	1
			None	0

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Analysis of the Factors for the Successful E-Learning Services Adoption from Education Providers' and Students' Perspectives: A case study of Private Universities in Northern Iraq

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ABSTRACT

Electronic learning (e-learning) adoption has always been a challenge for developing countries which is often stunted by the facilitating conditions as well as the resistance of both the professionals and students. Two-step research methodology is applied in private Universities of Northern Iraq by utilizing a hypothesized model of technology acceptance model (TAM). First, the readiness factors were investigated through University staff by analysing 516 participants. As the second research objective, the intention of students is explored with 256 valid respondents in these Universities. Data were obtained from seven private Universities' staff and students via a paper based quantitative survey. Respondents were selected based on the convenience sampling method, where researchers visited Universities during the semester with permission of their administration bodies. The findings reveal that the lowest value was for human resource readiness factor. Cultural acceptance, both from education providers' and students' perspective, is quite crucial in order to have a sustainable e-learning applications. From a technical point of view, our findings also confirm the importance of the technological readiness and the main TAM constructs of perceived ease of use (PEOU) and perceived usefulness (PU). Therefore, management of the Universities need to ensure that selected systems adequately address these issues.

Keywords: e-learning, readiness, technology acceptance model, developing countries, adoption

INTRODUCTION

The rapid growth in Information and Communication Technology (ICT) and the power of Internet has continued to make strong impact on the service delivery models of today's global digital environment, such as: e-learning, e-government, e-commerce, e-health, e-business, e-banking, etc. World education sector has also evolved significantly by electronic learning (e-learning) which utilizes various technologies to improve the quality of content (Sulčič & Lesjak, 2009). E-learning is defined as the use of communication technologies and information in education sectors in order to be able to offer services in order to enhance academic outcome (Baris, 2015). In today's digital world of globalization, education which involves teaching and learning is regarded as an important element for achieving competitive advantage. In order to gain competitive grounds, both individuals and institutions are becoming more knowledge-intensive, which enables them to focus more on acquiring and maintaining knowledge in order to gain significant advantage. ICT upgrades educational standards, to put it differently, by means of technological devices so that students can be more successful in learning. Developing new technologies in universities create more efficient learning atmosphere and learning environment (Baris, 2015). The field includes delivery methods and approaches diverging services from education sector to students. As the technology changes rapidly, new possibility in learning increases. The aim of e-learning in education sectors is to increase the efficiency of teaching and enhance students' learning. E-learning is the centrepiece of information systems-supported improvements to digitize the services distribution and the development of education sector taking place through all stages. Electronic learning uses the Internet and the World Wide Web for both information distribution and

Contribution of this paper to the literature

- Contribution both to theory and practice to implement effective e-learning systems for the private universities in Northern Iraq and other developing countries that are at the same level of development.
- Identification of the factors and barriers towards a sustainable e-learning implementation from education providers' perspective.
- Measurement of behavioral intentions for e-learning applications by using technology acceptance model (TAM) within the student community.

services distribution (Shareef et al., 2011). There are many advantages of using e-learning in education sectors. The quality of education can be improved in several ways by implementing e-learning, one of them is learning course materials anytime and anywhere, therefore students will have the ability to access their learning materials easily. Moreover, it provides motivation resulting in active learning. E-learning involving broadcasting technologies, computers, the internet, videos, slides, etc, provide visual and audio learning atmosphere, resulting in effective participation process.
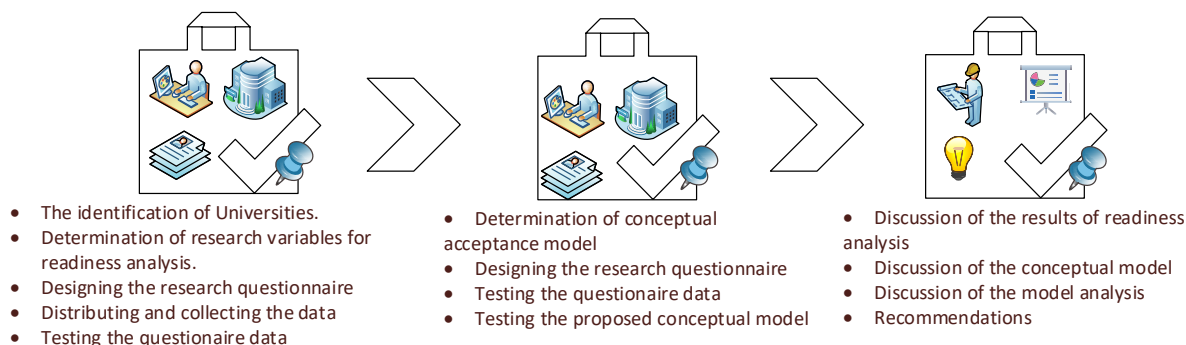
Institutions who are interested in deploying e-learning implementations have different cultures and also different facilitating conditions (Kaur, 2004). Therefore, it is a crucial first step research objective to identify the barriers in order to realize a sustainable e-learning implementation (Rohayani et al., 2015). It was realized from the previous studies that e-learning implementations without proper planning have difficulties to succeed (Borotis & Poulymenakou, 2004). In accordance, the adoption of e-learning can be initiated by measuring the readiness of e–learning (Clark & Mayer, 2016).

While considering the great potential of ICT, it should be noted that its effectiveness greatly depends on the degree of acceptance and use within the target population (Teo & Noyes, 2014). From the previous studies, users' perception and knowledge for a recently proposed technology have shown to affect acceptance and usage (Tarhini et al., 2015; Wong et al., 2015). Technology Acceptance Model (TAM) is one of the most well-known and used models to empirically explore the determinants of technology acceptance (Davis, 1989). It is a challenging research objective both to realize the barriers and identify users' intention in order to motivate a sustainable e-learning implementation.

With the above mentioned issues in mind, two-step research study was conducted to realize the determinants of e-learning technology readiness as well as to identify the factors of influencing consumer's acceptance in private Universities of Northern Iraq. First, e-learning readiness assessment was applied to realise the knowledge of the state for current related technologies, requirements and barriers from the service providers which would enhance sustainable implementation of strategies for e-learning technologies. The first part of the study mainly focused on the private Universities staffs' perspective, because they are the key stakeholders who could decide the level of technology for the specific region and also able to decide what or which e-learning applications would be appropriate to consider. As a second research objective, TAM assessment was tested to determine whether the students' intention and knowledge are enough to use an e-learning technology. In this research, two factors, Perceived usefulness (PU) and Perceived ease of use (PEOU), were discussed that will have impact on consumer's acceptance of electronic learning. PU is the degree to which an individual believes that the term of technology, under exploration, will improve her/his efficiency or outcome (Davis, 1989). On the other hand, PEOU is the degree to which an individual believes that using a technology will be easy, clear and simple. The researcher used two independent variables (PU and PEOU) to measure the dependent variables which are factors influencing consumers' acceptance.

MODEL DEVELOPMENT

Two-step research methodology is applied in this study as can be seen in **Figure 1** to realize a sustainable and future proof e-learning adoption strategy for the region.

- The identification of Universities.
- Determination of research variables for readiness analysis.
- Designing the research questionnaire
- Distributing and collecting the data
- Testing the questionaire data

- Determination of conceptual acceptance model
- Designing the research questionnaire
- Testing the questionaire data
- Testing the proposed conceptual model

- Discussion of the results of readiness analysis
- Discussion of the conceptual model
- Discussion of the model analysis
- Recommendations

Figure 1. Proposed research methodology

Table 1. Definition for the readiness factors

Readiness	Definition
Technological	This refers to the observable and measurable technical competencies involving users' capabilities with the software and hardware technologies that are required for e-learning deployment
Human resource	This refers to the readiness of the professional service providers in terms of knowledge, experience and interest in e-learning technology
Content	This refers to the readiness of e-learning content to the lecturers, their satisfaction with the content, and assess if they need training on eLearning content development
Educational	This refers to issues such as content analysis, audience analysis, goal analysis, design, methods and strategies which assess the principles and methods of instruction (i.e., teaching and learning)
Leadership	This refers to the government and institutions management's leadership dimensions that address the continuation, updating, and upkeep of the learning environment
Cultural	This refers to the enculturation of e-learning in terms of Internet use and networked technologies to disseminate information, communication, interaction and teaching

Despite the well-known potential benefits of using e-learning applications, there are some potential barriers that need to be overcome so as to cross the line in implementing the e-learning system (Rohayani et al., 2015).

It was revealed by Kuldip Kaur and Zuraini Wati that policy makers have to take a preliminary role for e-learning applications as information systems deployments (Kaur & Abas, 2004). On the other hand, Sadik has found out from his study in an Egyptian University that knowledge, skills and experience are the key factors in the acceptance and implementation of e-learning technologies (Sadik, 2007). Policy, technology, financial, human resource and infrastructure have been considered in order to measure students' e-learning readiness (Saekow & Samson, 2011). Another research work by Oketch et al. (2014) considered technology, cultural and content as factor to assess e-learning readiness in University of Nairobi, Kenya. It was found out by the study that technology and cultural factors are important for e-learning adoption while the content is not so important (Oketch et al., 2014). The factors that are considered in the first part of the research study are presented in **Table 1**. The problems listed below seems to be the general problem affecting e-learning implementation in private universities in Northern Iraq.

In accordance to the definitions presented in **Table 1**, a conceptual model for e-learning readiness is introduced as illustrated in **Figure 2**.
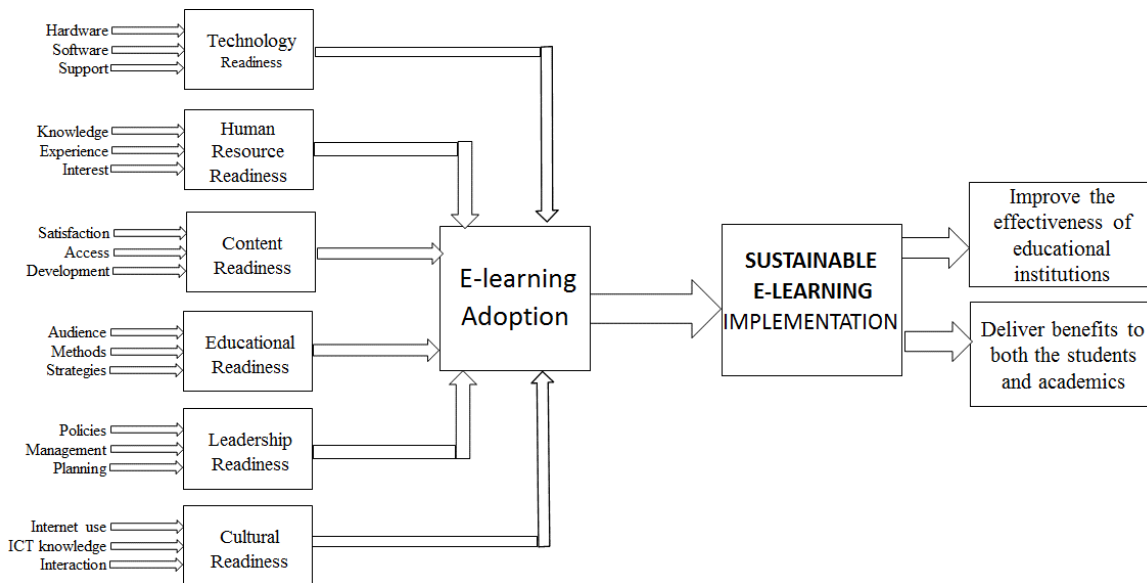
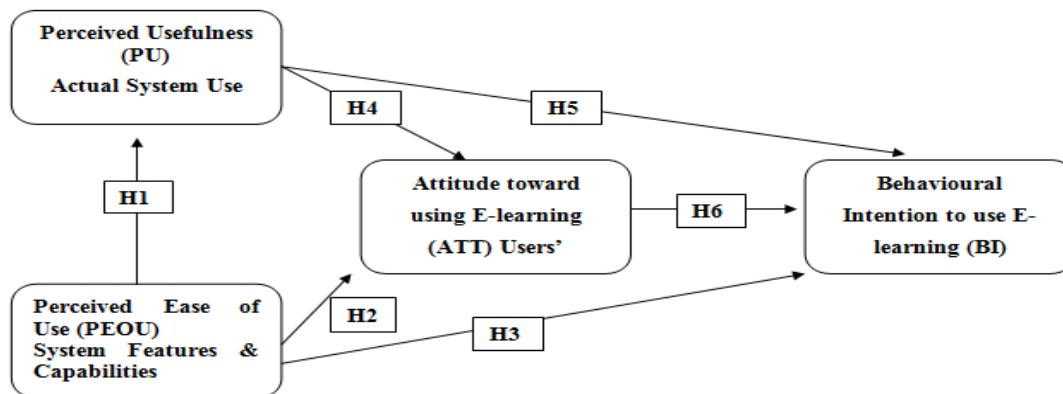**Figure 2.** The conceptual model of e-learning readiness

Figure 3. Proposed theoretical TAM research model

As mentioned earlier, TAM is used as an information-theoretic model for the second-step of the research study. It enables researchers to make statements about possible acceptance or rejection of a new technology by a designated user group. With a growing demand for technology and the starting computerization, difficulties increase in system integration. As a consequence, the acceptance of specific technologies by their designated operators became a field of research to diminish the effects of possible rejection. Davis (1989) adjusted the Theory of Planned Behaviour by adding a technical scope, with the intention to give recommended procedure for the search of acceptance of technical products. His aim was to identify and neutralize reasons of rejection for these technical items. There are several studies in the literature that have successfully extended TAM applications for e-learning technology (Alshare et al., 2011; Hu & Hui, 2012; Sharma & Chandel, 2013; Sharma et al., 2014). TAM has also been used to measure e-learning acceptance in developing countries, such as Jordan (Abbad et al., 2009; Al-Adwan & Smedley, 2013). In most developing countries, traditional styles of pedagogy are utilized in education, due to a lack of financial resources and appropriately trained staff (Baroud & Abouchedid, 2010; Dagher & BouJaoude, 2011).

It was highlighted by the TAM that perceived usefulness and perceived ease of use has a direct effect on attitudes towards using a new technology (Chen et al., 2011). Attitude is another important factor which is defined as the degree to which the user is interested in specific systems. It has a direct effect on the intention to use those specific systems in the future (Davis et al., 1989). It should also be noted that behavioural intention is affected by perceived ease of use and perceived usefulness (Johnston et al., 2015). Furthermore, examples of the external variables were given in the new model by Venkatesh and Davis (2000) as TAM2, such as "job relevance", "output quality" and the "results demonstrability" (Nyoro et al., 2015). In this study about e-learning, the factor of design is of special interest, as it gives evidence of the dependency between system design and system use. The link between these two parameters is the behavioural intention influenced by PU and PEOU, as there is no direct dependency. Proposed theoretical model for the second part of the research study is presented in **Figure 3**.

Access and ease of technology are realized as one of the most important factors that contribute to the sustainable implementation of e-learning systems (AbuSneineh & Zairi, 2010). Therefore, perceived ease of use (PEOU) is considered as a direct determinant of attitude towards using technology (ATT) in many research studies (Park, 2009; Chang et al., 2012). In addition to this, PEOU has an indirect effect on behavioral intention to use technology through increased perceived usefulness (PU) (Sek et al., 2010; Lee et al., 2011). It was also investigated that increased PEOU leads to greater perception of usefulness (Venkatesh and Davis, 2000). Therefore,

H1: Perceptions of ease of use an e-learning should lead to increased perceptions of usefulness in e-learning.

H2: Perceived ease of use of an e-learning will lead to an increasingly positive attitude toward e-learning.

H3: Perceived ease of use of an e-learning will lead to increases behavioural intention to use e-learning.

PU was theorized as direct determinant of ATT and indirectly results in more positive for behavioural intention to use technology (Teo et al, 2014). Therefore,

H4: Perceived usefulness of an e-learning will lead to an increasingly positive attitude toward e-learning.

H5: Perceived usefulness of an e-learning will lead to increases behavioural intention to use e-learning.

ATT is defined as the individuals respond to a recently proposed technology. It was clearly revealed from the previous studies that positive attitude towards a new technology is required in order to realize a successful implementation (Huang and Liaw, 2005). Therefore, ATT has been hypothesized as a direct determinant of behavioural intention to use (ITU) (Alharbi & Drew, 2014).

H6: Positive attitude toward an e-learning will lead to increases behavioural intention to use e-learning.

METHODOLOGY

Methodology for the First-step of the Research Study

Quantitative research method is applied for the first-step of the research methodology to find the readiness factors including (technological readiness, human resource readiness, content readiness, educational readiness, leadership readiness, and cultural readiness) in implementing e-learning. The questionnaire items were adopted from the studies of (Aydin & Tasci, 2005; Lašáková et al., 2017), which consists of survey questions asking the participants to express their opinions on their knowledge, perception, and experiences with e-learning technology applications. Currently there are seven private universities in the Erbil city. The questionnaire was distributed randomly among 700 academic and administrative staffs (education providers) of private universities. The participants of the present study were 516 participants from different private universities in Kurdistan region of Iraq. The questionnaire included 16 items of technological readiness, 15 items on human resource readiness, 19 items on students' readiness, 15 items on content readiness, 15 items on educational readiness, 15 items on leadership readiness, 16 items on cultural readiness and 20 items on e-learning implementation. All items were evaluated by using five point Likert scale ranging from 1=Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree to 5= Strongly Agree. After the completion of data gathering, all data were examined by SPSS to find out readiness factor level of e-learning implementation.

Methodology for the Second-step of the Research Study

Quantitative method was also applied for the second-step of the research methodology with a questionnaire regarding factors influencing students' acceptance of implementing electronic learning in private universities in Northern Iraq. The survey was used to collect data by the form of a questionnaire related to participants' perceptions and opinions regarding the factors influencing the students' acceptance of e-learning. 270 questionnaires were distributed and 256 were received in which 14 questionnaires were missing. The questionnaire was validated from pervious researchers and adapted from (Tarhini et al., 2015).

RESULTS

Results for the First-step of the Research Study

The demographic data was analysed to determine the characteristics of the academic and the administrative staff of the Universities, and the result in shown in **Table 2**.

Table 2. Summary of demographic data of the academic and administrative respondents

	Items	Frequency	Percent
Gender	Male	318	61.6
	Female	198	38.4
Age	20-29	134	26.0
	30-39	160	31.0
	40-49	138	26.7
	50 and above	84	16.3
Level of education	Bachelor	80	15.5
	Master	174	33.7
	PhD	262	50.8
Position	Staff	76	14.7
	Assistant lecturer	78	15.1
	Lecturer	116	22.5
	Assistant professor	114	22.1
	Associate professor	76	14.7
	Professor	56	10.9

Table 3. Correlation Analysis for the first-step of the research study

Correlations		
Items	**Pearson Correlation**	**E-learning implementation**
Technological readiness	Pearson Correlation	.915**
	Sig. (2-tailed)	.000
	N	516
Human resource readiness	Pearson Correlation	.769**
	Sig. (2-tailed)	.000
	N	516
	Sig. (2-tailed)	.000
	N	516
Content readiness	Pearson Correlation	.885**
	Sig. (2-tailed)	.000
	N	516
Educational readiness	Pearson Correlation	.764**
	Sig. (2-tailed)	.000
	N	516
Leadership readiness	Pearson Correlation	.876**
	Sig. (2-tailed)	.000
	N	516
Cultural readiness	Pearson Correlation	.826**
	Sig. (2-tailed)	.000
	N	516

** Correlation is significant at $p < 0.01$ level (2-tailed)

Table 2 shows that majority of the respondents' are male which is an expected characteristics in most developing countries. The table shows age, level of education and position of the participants. The surveyed participants are the professionals who are expected to improve the effectiveness of educational institutions by utilizing e-learning technologies. The reliability of the constructs was checked by Cronbach's alpha. Cronbach's alpha measures how well a set of items measures a single unidirectional latent construct. Different reliability values were considered satisfactory by different researchers. For instance, it should be at least 0.7 according to DeVellis (2003) and Robinson et al. (1991) or 0.6 is considered satisfactory while a value of 0.8 or higher is preferred according to Nunnally (1970). Given that all constructs had composite reliability scores above 0.7, this suggests that the constructs had adequate reliability. The correlation analysis of the factors is presented in **Table 3**.

As can be seen in **Table 3**, the correlation analysis for the study indicates that all the items have a significant correlation (the value of r**> 0.76, p<0.01) with e-learning implementation in which linear correlation is strong between all readiness items and e-learning implementation. Multiple regression analysis is depicted in **Table 4**.

Table 4. Multiple Regression Analysis

Independent variable	Coefficients (β)	t-value	P-value
Technological readiness	.737	51.319	.000
Human resource readiness	.556	27.259	.000
Content readiness	.698	43.121	.000
Educational readiness	.629	26.857	.000
Leadership readiness	.684	41.167	.000
Cultural readiness	.627	33.193	.000
R^2	.0731		
F value	1786.337		.000

Dependent Variable: E-learning implementation

Table 5. Summary of demographic data of the participated students

	Items	Frequency	Percent
Gender	Male	158	61.7
	Female	98	38.3
Age	18-19	44	17.2
	20-21	54	21.1
	22-23	60	23.4
	24 and above	98	38.3

Multiple regression analysis was employed in order to find out the predictive relationship between each independent variable and dependent variable. In this section, the relationship between seven independent variables and e-learning implementation as dependent variable was found. As can be seen in **Table 4**, technological readiness factor has significantly predicted e-learning implementation (β = .737, p<.001). Content (β = .698, p<.001), educational (β = .629, p<.001), leadership (β = .684, p<.001) and cultural (β = .627, p<.001) readiness factors have a strong influence on e-learning implementation. Majority of the participants have indicated that technology (both hardware and software) and content are either available or the management (leadership readiness) has intention to take necessary actions to implement e-learning applications in private Universities of Northern Iraq. Professionals recognize that large-scale course redesign for e-learning initiative involves a strong collaboration among the teachers, IT personnel, and administrators in the planning as well as the implementation. Technical and funding support from the management are available to implement e-learning applications. For the educational readiness, the institution has the capability to transfer the learning content online. Professionals are also aware that organizational (cultural) change is going to occur after e-learning implementation process which eventually change daily routine in University environment.

On the other hand, human resource readiness factor has the lowest value (β = .556, p<.001). Therefore, it indicates that human resource readiness have positive influence for e-learning implementation but not as strong as other readiness factors. It was found out from the research study that all the education providers are well-aware of the e-learning technology and willing to use such applications. However, majority of the participants thought that it would have been better for the institutions to establish mechanisms which maintain high levels of employee morale and motivation among them in order to use such e-learning applications. There should be a management initiative to have training programs for professionals.

Results for the Second-step of the Research Study

The demographic data was first analysed to determine the characteristics of the participated students, and the result in shown in **Table 5**.

Table 5 depicts that majority of the respondents' age are above 24 which is positive indication in terms of higher education for a developing country. The surveyed participants are the first target group who are going to benefit from the advantages of e-learning technology. For the second-step of the research methodology, reliability test is also applied in order to find out whether all items used to analyse the current study are reliable or not. The results are depicted in **Table 6**. In terms of Perceived Usefulness factor, the Cronbach's Alpha = .829 for 11 items, since (.829>.6) therefore 11 questions of perceived usefulness were reliable. In terms of Perceived Ease of Use as independent factor, the Cronbach's Alpha = .872 for 8 items, since (.872>.6) therefore 8 questions of perceived ease of use were reliable. In terms of Behavioural Intention to Use E-learning factor, the Cronbach's Alpha = .862 for 3 items, since (.862>.6) therefore 3 questions of behavioural intention to use e-learning were reliable, and in terms of Attitudes towards using e-learning factor, the Cronbach's Alpha = .798 for 3 items, since (.798>.6) therefore 3 questions of Attitudes towards using e-learning were reliable (Hair et al. 2010).

Table 6. Reliability statistics of the TAM variables

Dimensions	Cronbach's Alpha	Number of items
Perceived usefulness (PU)	.829	11
Perceived ease of use (PEOU)	.872	8
Behavioral intention to use	.862	3
Attitudes towards using e-learning	.798	3
Total	.840	25

Table 7. Correlation analysis

		BI	PEOU	PU	ATTITUDE
BI	Pearson Correlation	1	.729**	.673**	.821**
	Sig. (2-tailed)		.000	.000	.000
	N	256	256	256	256
PEOU	Pearson Correlation	.729**	1	.662**	.564**
	Sig. (2-tailed)	.000		.000	.000
	N	256	256	256	256
PU	Pearson Correlation	.673**	.662**	1	.412**
	Sig. (2-tailed)	.000	.000		.000
	N	256	256	256	256
ATTITUDE	Pearson Correlation	.821**	.564**	.412**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	256	256	256	256

**. Correlation is significant at the 0.01 level (2-tailed)

Table 8. The relationship between PU and PEOU

Dependent Variable: Perceived Ease of Use						
	B	Std. Error	Beta	t	P	Decision
(Constant)	.821	.151		5.423	.000	
PEOU	.797	.037	.803	21.465	.000	Supported
Model F	460.765					
R^2	.645					

P<0.05

Table 7 shows the correlation analysis between variables and all the factors exhibited significant relationships. It could be stated that apart from the relationship between PU and ATTITUDE constructs, the results show that all the other constructs' have correlations above 0.5. All the factors exhibited positive relationships with attitude towards using e-learning.

The hypothesis testing

The relationships between constructs were tested after supporting the validity and reliability of the measurement model. Structural equation modelling (SEM) was used to test all hypothesized relationships amongst constructs as can be seen from the sections below.

A multiple regression analysis was conducted to test the first Hypothesis (H1), perceived usefulness (PU) as an independent variable and perceived ease of use (PEOU) as dependent variable (**Table 8**).

The value of R^2 is .645, which indicates that 65% of the variables have been explained. According to (Anderson & Gerbing, 1988) this is a large effect. PU has a strong influence on PEOU (β=.803) in which this analysis gave support to Hypotheses 1. The value of F = 460.765>0.01 this means there is positive relationship between variables. The value B for perceived ease of use PEOU = .797 (.797>0.01) which indicates that increases in perceptions of ease of use an e-learning should lead to increased perceptions of usefulness in e-learning.

Hypothesis 2 was supported as PEOU (β=.564) was found to positive influence on the attitude towards using e-learning (ATT) at the .05% level as shown in **Table 9**.

Table 9. The relationship between PEOU and ATTITUDE

	Dependent Variable: ATTITUDE					
	B	**Std. Error**	**Beta**	**T**	**P**	**Decision**
(Constant)	.879	.213		4.132	.000	
PEOU	.780	.054	.564	14.364	.000	Supported
Model F	206.313					
R^2	.564					

P<0.05

Table 10. The relationship between PEOU and BI

	Dependent Variable : BI					
	B	**Std. Error**	**Beta**	**T**	**P**	**Decision**
(Constant)	.728	.140		5.211	.000	
PEOU	.799	.036	.729	22.415	.000	Supported
Model F	502.445					
R^2	.729					

P<0.05

Table 11. The relationship between PU and ATTITUDE

	Dependent Variable :ATTITUDE					
	B	**Std. Error**	**Beta**	**T**	**P**	**Decision**
(Constant)	.471	.174		2.703	.000	
PU	.907	.043	.800	21.236	.000	Supported
Model F	450.963					
R^2	.800[a]					

P<0.05

Table 12. The relationship between PU and BI

	Dependent Variable :BI					
	B	**Std. Error**	**Beta**	**T**	**P**	**Decision**
(Constant)	.766	.148		5.171	.000	
PU	.900	.036	.841	24.771	.000	Supported
Model F	613.620					
R^2	.841					

P<0.05

As can be seen from the results of single regression analysis, the value of F = 206.313>0.01 which states a positive relationship between variables. The value of R^2 = .564 means that 56% of the variables have been explained, and the value B for perceived ease of use PEOU = .780 (.780>0.01) which indicates that increases in the perceived ease of use of an e-learning will lead to an increasingly positive attitude toward e-learning.

As proposed by the TAM, PEOU and behavioural intention towards using e-learning (BI) explained a significant percentage of variance in attitude, R^2 =.729 (**Table 10**). PEOU had a strong significant effect on BI (β= .729) which supports third research hypothesis.

The value of F= 502.44>0.01 refers that there is positive relationship between variables and the value B for perceived ease of use PEOU= .799 (.799>0.01) which indicates that increases in the perceived ease of use of an e-learning will lead to increases behavioural intention to use e-learning.

Hypotheses 4 focus on the impact of perceived usefulness on attitude. Similar to the other studies on TAM (Davis, 1989), perceived usefulness has a positive direct effect on attitude (β = 0.75, $p < 0.05$) as depicted in **Table 11**. Therefore, H4 is supported.

Hypotheses 5 & 6 investigate the relationship of PU and ATT to BI. Perceived usefulness has a positive direct effect on behavioural intention (β= 0.841, $p < 0.05$), and attitude towards e-learning (β = 0.821, $p < 0.05$) as can be seen from **Table 12** and **13** accordingly. Therefore H5 and H6 are also supported.

Table 13. The relationship between Attitude and BI

	B	Std. Error	Beta	T	p	Decision
Dependent Variable : BI						
(Constant)	1.289	.086		15.059	.000	
ATTITUDE	.651	.022	.821	30.223	.000	Supported
Model F	913.415					
R²	.821					

P<0.05

DISCUSSIONS AND RECOMMENDATIONS

The demonstration of a two-step research methodology is important in order to understand the perceptions of both education providers and students in Northern Iraq. Quantitative research approach is conducted for the first part of the research study in order to identify the barriers for implementing e-learning technology from University staffs' perspective. It was found out that technological readiness factor has significantly predicted e-learning implementation (β = .737, p<.001). Content (β = .698, p<.001), educational (β = .629, p<.001), leadership (β = .684, p<.001) and cultural (β = .627, p<.001) readiness factors have also a strong influence on e-learning implementation but not as strong as technological readiness. Majority of the participants have indicated that technology (both hardware and software) and content are either available or the management (leadership readiness) has intention to take necessary actions to implement e-learning applications in private Universities of Northern Iraq. Technical and funding support from the management are available to implement e-learning applications. On the other hand, human resource readiness factor has the lowest value (β = .556, p<.001). Hence, it describes that human resource readiness have positive influence for e-learning implementation but as strong as other readiness factors. It was revealed from the research study that all the education providers are well-aware of the e-learning technology and willing to use such applications.

Quantities research approach is again conducted for the second part of the research. TAM model reveals an additional contribution by clarifying the specific pattern of cultural responses from students. Hypotheses 1, 2 & 3 states that *"PEOU will positively influence perceived usefulness in e-learning", "PEOU will positively influence attitude towards e-learning"* and *"PEOU will positively influence behavioral intention to use EMR"* respectively. All hypotheses were accepted; PEOU is one of the most important factors especially in the early stages of new technology use. It was found out from the previous studies that a new technology could be accepted without major resistances if an individual is familiar with the proposed technology (Marchewka & Liu, 2007).

Hypotheses 4 & 5 states that *"perceived usefulness will positively influence attitude towards e-learning",* and *"perceived usefulness will positively influence behavioral intention to use e-learning"* respectively. Both hypotheses were accepted; it was found that when users perceive the relative advantages of new technology, they are more likely to adopt it. Previous literature shows that perceived usefulness is significant for TAM studies, by adversely influencing both attitude and intention to use new technology (Teo et al., 2014).

Finally, the sixth hypothesis (H6) states that *"attitude towards e-learning will positively influence behavioral intention to use e-learning"*. This hypothesis was accepted; it was found that the attitude, belief, and willingness of students' have a significant influence on their decision and intention to use e-learning systems. This result corresponds to the findings of other researchers (Alharbi & Drew, 2014).

Based on the findings from our research discussed above, we identified the major barriers to the adoption and implementation of e-learning technology applications in a developing country, which we categorized into five principal areas; they include: (1) Technology infrastructure barriers, related to hardware, software, and networking; (2) Human resource barriers, related to attitude, willingness, and belief to use e-learning; (3) Educational Content barriers, related to knowledge, experience and strategy of using ICT tools and applications; (4) Administrative barriers, related to organizational and management policies; and (5) Cultural barriers, related to society's technology use.

Limitations and Future Research

We acknowledged that the study is limited by geographical scaling, since it was conducted in seven private Universities. We believed that the results of the study would have been better and more generalized if we were able to visit other cities and more Universities by using stratified sampling. Another relevant factor that we acknowledge as a limitation is that the study focused on academic & administrative staff of Universities and students, without considering the opinion of government officials. Further research could investigate the opinions of the government officials, especially in the area of policies and grants to support e-learning technologies.

CONCLUSION

Many developing countries have implemented e-learning applications to deliver services and information to the students through the Internet. As the population grows, several developing countries try to facilitate sophisticated web sites by providing many features to perform in better way to help students, other governments, businesses, and other web visitors. It is very essential to understand and recognize the importance of successfully implementing e-learning projects. Although most of e-learning implementation projects fail either partially or totally due to the resistance from the users, some e-learning implementation projects are successful. The findings of this study make a significant contribution both to theory and practice to implement sustainable e-learning systems for the private Universities in Northern Iraq and other developing countries that are at the same level of development. From the theoretical point of view, the first contribution is to identify the factors for a sustainable e-learning application from education providers' perspective. Second significant contribution of this work is the measurement of perception for e-learning applications by using TAM within the student community in private Universities. Six hypotheses, from the TAM, were supported and it was found out that all the TAM constructs are positively correlated between each other. PEOU has a significant effect on BI (β>.729) but has .564 correlation on ATTITUDE. The reason for the difference is that students never had the chance to use an e-learning application. It was also realized from Shroff et al. (p.610, 2011) that "*user's positive feelings toward the ease of use of technology are associated with sustained use of the technology*". Davis (Davis, 1989) point out that PU is influenced by PEOU which was also the finding of the research study. It was demonstrated that the most significant relationship among the variables is between BI and ATTITUDE (β>.8). This may be due to the fact that students are well-aware of the advantages and willing to adopt e-learning systems.

Cultural acceptance, both from education providers' and students' perspective, is quite crucial in order to have a sustainable e-learning application. Our work also contributes to the growing body of evidence with regard to the impact of behavioural intentions of both education providers and students in Northern Iraq which elucidates the impact of individual level on technology acceptance. From a practical point of view, our findings also confirm the importance of the technological readiness and the main TAM constructs of PEOU and PU. Therefore, management of the Universities and the policy makers need to ensure that selected systems adequately address these issues. Our results also confirmed the importance of content and leadership readiness for e-learning implementation. This emphasizes the need to consider implementation strategies both from the Universities and policy makers in order to implement a sustainable e-learning system.

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