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Considering Material Development Dimension of Educational Technologies: Determining Competencies and Pre-Service Teachers' Skills in Turkey

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The purpose of this study is to develop a list of competencies for the undergraduate level new educational technology course considering material development dimension in Turkey. Also, it was investigated to what extent pre-service teachers in Turkey gained these competencies. A total of 2,460 usable surveys were analyzed. It was found that male and female students received similar scores with similar standard deviations. The results also showed that students' competency levels in the elementary teaching programs were significantly higher than those in the other teaching programs, except the preschool teaching programs. On the other hand, students' competency levels in the elementary mathematics teaching programs were significantly less than students' competency levels in the other teaching programs.

Keywords: Educational Technology, Technology Competencies, Material Development

INTRODUCTION

Technology has a significant impact on our society, and has become a permanent part of our schools and classrooms. In this new era, teachers should have at least minimal educational technology proficiencies. However, due to rapid changes in technology, educational researchers have been challenged to answer a critical question: What are the educational technology knowledge and skills teachers should have? In order to answer this critical question it is important to examine research studies that have been conducted to determine different dimensions of educational technology competencies that teachers/instructors should possess.

Educational technology knowledge and skills have been perceived differently in different studies. From one perspective, it is generally considered that some computer and hardware skills teachers should have are educational technology skills, such as (1) creating, naming, saving, retrieving and revising documents, and using print options, (2) setting up and operating a VCR and monitor/TV, (3) applying strategies for identifying and solving routine hardware and software problems that occur during everyday use, (4) evaluating software and technology for instructional use, (5) creating spreadsheets to manage information, (6) creating databases to manage information, (7) setting up and operating a presentation system that works with a computer, (8) producing electronic slides/overheads and (9) developing web pages and/or sites for instructional use and relating information to parents (Ku, Hopper, & Igoe, 2001).

A study by Tsao (1998) investigated secondary vocational teachers' educational technology competency needs. The results showed that secondary vocational teachers rated educational technology skills important or very important that are related to using some hardware and computer software such as using an overhead projector, using word processing and spreadsheet

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software, using an operating system, downloading programs through the internet and creating multimedia presentations.

Instructional Technology Passport System (ITPS), developed by Technology Learning Circle (TLC) group of Illinois State University, was designed to ensure that graduating teacher candidates are able to use instructional technology in effective ways in compliance with national, state and institutional standards. Instructional technology competencies of the ITPS include the ability to use technology to work effectively and equitably with students challenged by a variety of physical disabilities, understanding basic computer terminology, concepts, and operation, the ability to use varieties of instructional media effectively (DVD/CD player, digital still camera, etc.), the ability to create and edit the content of web pages and the ability to use presentation authoring tools, idea development software and desktop publishing (Braun et al., 2002).

A different study by Scheffler and Jogan (1998) investigated what computer competencies public school teachers needed. In this study, using the Delphi technique and survey method, 67 computer competencies rated important or very important by teachers were identified. Most of these competencies were related to hard computer skills such as using a computer keyboard and operating computer hardware and software to troubleshoot minor problems. However, limited attention was also given to pedagogical skills, including using software to facilitate instruction and evaluating the effectiveness of computer-supported instruction.

As an educational technology skill, Hofer and Whitaker (2002) particularly emphasized using a variety of software programs in instruction. They proposed educational technology competencies with two dimensions. In one dimension, the competencies were classified as practical, innovative and future, in the other dimension, standard driven, depth/creativity and transforming education. Between these two dimensions, teachers should learn to use certain software programs for word processing, drill and practice activities, preparing and using multimedia presentations, designing web pages, collaborating on the internet, creating electronic portfolios, designing WebQuest, conducting internet searches, designing concept maps, performing inquiries with mind tools and creating digital videos, animations and 3D modeling.

The definition and focus of educational technology have changed over the years. In a recent definition, educational technology was regarded more as pedagogical skills to solve learning or performance problems, rather than being able to use hardware such as computers and projection machines (Reiser & Dempsey, 2002). Supporting this view, it is important to see in the recently identified teacher technology competencies that there has been more emphasis on the skills related to instructional uses of technology than to the skills related to hardware and software operation. Hence, teacher technology proficiency should be considered multi-dimensional, and the question "What must teachers know about using technology in the classroom?" should be answered in the context of different sets of knowledge and skills that effective teachers possess (Gooler, Kautzer, & Knuth, 2000).

For instance, besides the two categories that are prerequisite technical skills and technical skills underlining the use of all computer and related technologies, Moore et al. (1999) suggested two additional major educational technology competency categories that included pedagogical skills for teachers: instructional uses of technology applications to improve learning and professional activities, and behaviors teachers must use in an information-age classroom. Similarly, Albee (2003) concluded that educational technology competencies should include, besides technical skills, pedagogical skills such as evaluating and selecting software, developing instructional activities with computer software programs, integrating computer technology into teaching, and awareness of technology's ethical and legal issues.

Putting more emphasis on the skills related to instructional uses of technology rather than skills related to hardware and software operations, the most comprehensive approach to determining educational technology competencies may be seen in the NETS-T (National Education Technology Standards for Teachers) Project of the ISTE (International Society for Technology in Education). This project classified technology competencies under six categories: (a) technology operations and concepts, (b) planning and designing learning environments and experiences, (c) teaching, learning and curriculum, (d) assessment and evaluation, (e) productivity and professional practice and (f) social, ethical, legal and human issues (Gooler, Kautzer, & Knuth, 2000). This comprehensive approach can also be seen in cross-cultural/international settings (Schiller, 2002; Laanpere, 2001).

The Higher Education Council of Turkey restructured its teacher education programs in 1998. Under the new program all pre-service teachers in their third year were required to take a new educational technology course named Educational Technologies and Material Development. It may be perceived that the content of the new technology course may be similar to other contemporary educational technology courses. However, it additionally considers a new dimension in educational technology: material development.

The description of the new course in the program manual reads as follows: "Features of several educational technologies, their use and place in the teaching process, developing teaching materials (work

sheets, transparencies, slides, videos and computer-based course materials) by using educational technologies and evaluating them." No further explanations or competencies were provided for the course.

The purpose of this study is to develop a list of competencies, agreed upon by educational technology experts, for the new educational technology course considering material development dimension. Also, it will be investigated to what extent pre-service teachers in Turkey gain these competencies.

This research study has three objectives:

1. Determining educational technologies and material development competencies
2. Determining to what extent pre-service teachers in Turkey possess these competencies
3. Investigating the differences in pre-service teachers' possessing these competencies by gender and teaching programs

METHOD

Survey Instrument Development

A 46-item practical educational technology and material development competency survey instrument was developed by the researchers and sent to 2,600 pre-service elementary teachers in Turkey.

After reviewing related textbooks and documents, an initial list of 217 general educational technologies and material development competencies was developed and categorized into eight sections: (1) general concepts and definitions in educational technologies, (2) educational technologies and communication, (3) designing materials for instruction, (4) distance education, (5) using computers in education, (6) education and the internet, (7) planning educational technologies, (8) learning theories and (9) evaluation. A three-round process was planned to evaluate and refine the initial list. The evaluation was performed by a group of educational technology experts.

Members of the expert group were selected among university professors in the educational technology departments of colleges of education in Turkey. Each holds a Ph.D. degree in the educational technology field. A total of 15 experts were contacted via phone; 10 of them agreed to participate in the three-round evaluation process.

In the first-round evaluation, the list of 217 competencies was sent to the experts. They were requested to examine competencies and recommend additions, deletions, categorizations and rewordings. They were also requested to rate the importance of each competency using a 5-point Likert scale: (1) not important, (2) somewhat important, (3) moderately important, (4) important and (5) very important.

After the first-round evaluation, the second competency list was created based on the experts' ratings and recommendations. This competency list included 239 items receiving a mean rating of 3 or higher (moderately important, important or very important) plus new competencies suggested by the experts. Also, wordings of some items were changed. The second competency list was sent to the experts for the second-round evaluation.

In the second-round evaluation, the experts re-rated each competency, but they made no recommendations for any additions, deletions, categorizations or rewordings. Because the content of the second competency list was not changed in the second-round evaluation the third round-evaluation was not performed.

The final competency survey, with 227 items, was created from those competencies receiving a mean rating of 3 or higher (moderately important, important or very important) in the second-round evaluation. Based on ratings by the experts, calculation of Cronbach's alpha reliability coefficient of the final survey is 0.97.

The final competency survey had a large number of items and was to be administered to a large number of pre-service teachers. This caused a concern about pre-service teachers' possible unwillingness to participate in the study, reluctance in responding to the survey items and difficulties in administrating the survey. Therefore, the 227-item educational technology and material development competency survey was reduced to a new 46-item practical educational technology and material development competency survey.

The new survey was intended to collect information on pre-service teachers' practical or application-based educational technology and material development competency levels. Application-based competencies are defined as the ability to use previously learned information and skills in new situations to achieve a goal. Some of the application-based competencies in the new survey are: being able to prepare simple learning materials that are original and economical, using readily available resources and environmental conditions, being able to properly use flipcharts in lessons, being able to properly use overhead projectors in instruction and being able to teach a lesson using instructional techniques appropriate for the skill/subject to be taught.

Knowledge-based competencies, on the other hand, are those that emphasize remembering or recalling rules, facts, terms, trends and sequences. Some of the knowledge-based competencies that were not included in the new survey are being able to define technology, being able to explain historical development of technologies used in education, being able to explain the benefits of using instructional materials in the classroom

and being able to explain why learning environments should be arranged.

Pre-service teachers rated their practical educational technology and material development competencies using a 5-point Likert scale: (1) I do not know enough of this competency to respond, (2) I don't have this competency, (3) I am not sure, (4) I have this competency and (5) I definitely have this competency.

Population and Participants of the Study

The population of this study was senior elementary education students from all of the 61 colleges of education in Turkey that had elementary education departments, training teachers for grades between first and eighth. A typical elementary education department of a college of education in Turkey has five teaching programs: elementary, social science, elementary mathematics, science and preschool. The elementary teaching programs train teachers for basic education for grades between first and fifth. The other teaching programs, except preschool, train teachers for a specific subject area education, i.e., mathematics, social science or science, for grades between sixth and eighth.

According to data retrieved from the Higher Education Council's website, there were approximately 16,685 senior elementary education students in Turkish colleges of education when the data was collected in 2006. Distributions of students by the teaching programs was as follows: 7,715 students in the elementary teaching programs, 2,700 students in the social science teaching programs, 2,080 students in the elementary mathematics teaching programs, 2,505 students in the science teaching programs and 1,685 students in the preschool teaching programs. A total of 2,600 survey questionnaires, corresponding to 15.6% of the total senior elementary education students, were sent to 13 randomly-selected colleges of education that have an elementary education department.

Data Collection and Analysis

The students' responses were collected by mail. Before the mailing, a contact person was chosen from each of the 13 colleges. They were informed about the research study and requested to help administer the survey in their institutions. Then a packet was mailed to the contact people that included survey questionnaires, optical answer sheets, a stamped self-addressed envelope and instructions on administering the survey.

Descriptive statistics were used to summarize the means and standard deviations of 46 competencies. Also, t-test and Analyses of Variance (ANOVA) were employed to determine whether significant differences existed in students' competency levels by gender and by teaching program, respectively. The alpha level was set at .05.

RESULTS

A total of 2,460 usable surveys, corresponding to 94.6% of the total participants and 14.7% of the total population, were returned. The calculated alpha reliability of the survey was .95.

The data revealed that students received a mean score of 177.04 (23.9) on the overall survey. More specifically, students received a mean score between 2 and 2.99 on three competencies, between 3 and 3.99 on 25 competencies and between 4 and 5 on 18 competencies.

The practical educational technology and material development competency survey was originally written and administrated in Turkish. Hence, it was not shown in a table format that illustrated descriptive data for each item.

Those three competencies receiving maximum mean scores were related to using search engines (such as Google or Yahoo) on the internet, using overhead projection machines and using models and real materials to teach. On the other hand, three competencies receiving minimum mean scores were related to planning or implementing distance education over the internet or other means.

The means and standard deviations by gender and by teaching program are presented in Table 1 and Table 2, respectively. Over half (56%) of the respondents were female. Male ($M = 176.7$, $SD = 23.5$) and female ($M = 177.3$, $SD = 24.3$) students received similar mean scores with similar standard deviations.

Students' mean scores by teaching program are summarized in Table 2. As can be seen , students in the elementary teaching programs ($M = 181.5$, $SD = 22.1$) received the maximum and those in the mathematics teaching programs ($M = 170.1$, $SD = 21.8$) received the minimum mean score.

Results of t-test analysis showed that male and female students' mean scores were not significantly different ($p > .05$) (see Table 3).

As illustrated in Table 4, a statistically significant difference existed in students' scores by the teaching programs, which means that at least the mean score of students in one teaching program was significantly greater or lesser then the mean score of students in another teaching program(s).

Table 1. *Descriptive statistics results by gender*

Gender	N (%)	Mean	SD
Male	1084 (44%)	176.7	23.5
Female	1376 (56%)	177.3	24.3

Table 2. Descriptive statistics results by teaching programs

Teaching Program	N (%)	Mean	SD
Elementary teaching	617 (25.0%)	181.5	22.1
Preschool teaching	383 (15.6%)	179.2	26.5
Social Science teaching	585 (23.7%)	177.2	23.4
Science teaching	444 (18.0%)	175.5	25.3
Mathematics teaching	431 (17.7%)	170.1	21.8

Table 3. t-test summary table for students' competency scores

Groups	N	Mean	SD	df	T	p
Male	1084	176.7	23.5	2458	.65	.52
Female	1376	177.3	24.3			

Table 4.ANOVA results for students' competency levels by teaching programs

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	69298.0	12	5774.8	10.5	.00
Within Groups	1343704.7	2447	549.1		
Total	1413002.8	2459			

Table 5. The Tukey-HSD analysis results for multiple comparisons of teaching programs

Teaching Programs	(1)		(2)		(3)		(4)		(5)	
	MD	*p*	MD	*p*	MD	*p*	MD	*p*	MD	*p*
(1) Elementary teaching			2.3	.57	4.3	.01*	6.0	.00*	11.4	.00*
(2) Preschool teaching					2.0	.69	3.7	.16	9.1	.00*
(3) Social Science teaching							1.7	.78	7.1	.00*
(4) Science teaching									5.4	.01*
(5) Mathematics teaching										

MD: Mean difference, * statistically significant.

The Tukey-HSD multiple comparison procedure was used to ascertain which pairs of the teaching programs differed significantly. It was found that students' competency levels in the elementary teaching programs were significantly higher than those in the other teaching programs, except the preschool teaching programs. On the other hand, students' competency levels in the elementary mathematics teaching programs were significantly less than students' competency levels in the other teaching programs. The Tukey-HSD multiple comparison results are summarized in Table 5.

DISCUSSION

Some computer skills and being able to use these skills in instruction are commonly considered educational technology competencies (Kotrlik, Harrison, & Redmann, 2000). However, the educational technology definition by Reiser and Dempsey (2002) points out that the purpose of educational technology is to improve students' learning performances in instructional settings, regardless of using specific means. Computers or any other particular technologies are not specifically mentioned in the definition to achieve this

purpose. Therefore, any means or being able to use these means to improve learning performance, such as custom-made instructional materials (Ingram, 1996), can be considered within the realm of education technology competencies.

The questionnaire items rated as moderately important, important or very important by the experts and used in this study supported this view. Only 13 items out of 46 included computer-related skills, such as being able to create multimedia presentations by using computer technology or software. The other items included non-computer-related skills, such as preparing overhead projection slides and knowledge maps. This illustrates to a reasonable degree that educational technology competencies should include skills related to material development.

The results of this study showed that male and female students' educational technology and material development skills are comparable. No significant difference was detected between their skills. However, in other similar research studies, it was not unusual to see that male students had better educational technology skills than female students. One possible reason might be that the survey instrument used in this study had relatively fewer items related to computer skills.

In general, males are considered more technology-, especially computer-, savvy than females (Whitely, 1997; Busch, 1995). Therefore, studies taking particular computer-related educational technology competencies into account may show significant differences in favor of males. Yet this study included only 13 computer-related competencies out of 46. The other competencies consisted of different skills. Thus, a non-significant difference between male and female students' competency levels can be expected.

Pre-service teachers in elementary teaching programs rated their skills significantly higher than those in the other teaching programs, except preschool teaching programs. On the other hand, pre-service teachers in mathematics teaching programs rated their skills significantly lower than the other pre-service teachers.

Considering that different teaching programs use different curricula to train pre-service teachers for different student age groups, these results appear to be logical. According to Piaget, until 11 years of age, children are in the concrete operations stage where they have difficulties in understanding abstract concepts (Driscoll, 1994). To know or understand a concept, children in this stage have to act on it, modify it or transform it, but looking at it or copying it will not be enough to learn it. On the other hand, children between 11 and 15 years of age are in the formal operations stage where they can use reasoning and understand abstract concepts without utilizing concrete objects.

Pre-service teachers in elementary teaching programs are trained to teach elementary school students between ages 7 and 11 that are in the concrete operations stage. Therefore, it is possible that the curricula of elementary teaching programs, especially the courses related to teaching and learning, may emphasize the importance of using technology and instructional materials to facilitate learning of abstract concepts. Thus, students in these programs might already have high motivations and positive attitudes towards using technology and materials in instruction. This might better help them gain skills in the educational technology and material development course.

Pre-service teachers in preschool teaching programs, trained to teach children ages between 3 and 6 that are also in the concrete operations stage, received the second-highest mean score, although it is not significantly different from the mean score of those in social science teaching programs, which is the third-highest mean rating. This may also be a reason to consider the effects of the curricula of teaching programs on pre-service teachers' educational technology and material development competency levels.

Even stronger evidence for the effects of the curricula of teaching programs comes from the result that pre-service teachers in mathematics teaching programs rated their skills significantly lower than the other pre-service teachers. Pre-service teachers in mathematics teaching programs in Turkey are trained to teach mathematics to elementary education students with ages between 12 and 15 that are in the formal operations stage. These students are able to understand abstract mathematical concepts without tangible representations. Furthermore, mathematics usually includes abstract topics and concepts that may be difficult to teach in tangible ways. Therefore, it is possible that the curricula of elementary teaching programs do not emphasize the importance of using technology and materials to facilitate learning, so pre-service teachers in these programs might already have low motivation and attitudes toward using technology and instructional materials in the classroom. This might negatively affect mathematics pre-service teachers' learning performances in the educational technologies and material development course.

The results of this study were based on data obtained from a large number of samples randomly selected from among all of the senior pre-service elementary education teachers in the colleges of education in Turkey. Therefore, the results can be generalized throughout Turkey.

It must be realized that contents of educational technology courses for pre- and in-service teachers should be revised to include material development competencies. Knowledge of these competencies may enable them to be effective in the classroom teaching.

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