Effects of Multimedia Information Technology Integrated Multi-Sensory Instruction on Students' Learning Motivation and Outcome

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Under the waves of the Internet and the trend of era, information technology is a door connecting to the world to generate the multiplier effect of learning. Students' learning should not be regarded as the tool to cope with school examinations. The frequent contact with computers, networks, and relevant information allow students enjoying the colorful life. Some knowledge is broad on the Internet or TV media that the attraction of learning environments and teaching materials for students' interests to achieve the teaching effect becomes a primary issue.

With the design of experiments, the quasi-experimental research is preceded in this study. Total 92 students in two classes in Fuzhou No.1 High School in Fujian are preceded the designed teaching program of multi-sensory instruction in math for 4 months. The results show significant correlations between 1.learning motivation and learning outcomes, 2.multi-sensory instruction and learning motivation, and 3.multi-sensory instruction and learning outcomes. This study expects to understand the effects of multimedia information technology integrated multi-sensory instruction on students' learning motivation and outcomes as well as provide reference for teachers applying information technology integrated instruction and the promotion of relevant education units.

Keywords: Multimedia, information technology, multi-sensory instruction, learning motivation, learning outcome

INTRODUCTION

Living in current societies full of information media, which progresses from radio media and TV information communication to computer information network, it is

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the age of knowledge explosion when sent-down youth, salaried people, students in various levels, and even the elderly could apply various information media. Information technology education has been promoted in past years to make multimedia information technology integrated instruction become the diverse presentation of instruction on campus. It is an important issue for modern school development that teachers could apply multimedia and information equipment to teaching activities. The factors in multimedia information technology integrated instruction, inducing students' learning motivation and interests, are therefore worth understanding.

There are so many sources for students contact with computers, the Internet, and relevant information that the life becomes colorful. Some knowledge on the Internet or TV media is so broad that the attraction of learning environments and teaching materials for students' interests is a critical issue to achieve the teaching effect.

Learning psychologists usually suggest that teaching materials should be presented with various methods so that students with different learning styles could acquire knowledge through distinct senses. Although most people show mixed learning styles, various learning strategies would be used according to different conditions. Nevertheless, people still have the particularly effective learning methods; some of them prefer visual learning, another are good at auditory learning, and the others favor to kinesthetic learning. In this case, it is essential to precede multi-sensory instruction in order to satisfy more learning styles and enhance students' learning outcomes.

State of the literature

- Some knowledge is broad on the Internet or TV media that the attraction of learning environments and teaching materials for students' interests to achieve the teaching effect becomes a primary issue.
- It is an important issue for modern school development that teachers could apply multimedia and information equipment to teaching activities. The factors in multimedia information technology integrated instruction, inducing students' learning motivation and interests, are therefore worth understanding.
- It is essential to precede multi-sensory instruction in order to satisfy more learning styles and enhance students' learning outcomes.

Contribution of this paper to the literature

- Multimedia information technology integrated multi-sensory instruction emphasizes on inducing students' senses with various teaching activities in order to enhance the learning effect.
- Teachers have to continuously encourage students' behaviors for a long time so that students generate learning interests and establish confidence in learning.
- During the instruction, teachers utilize students' dominant senses for learning, and construct multimedia learning environments.
- to eliminate defects in traditional instruction and enhance the learning effect.

Current research focused more on teachers, while little studies intended to understand the effects of information technology integrated instruction on students' learning motivation and outcomes to further realized the advantages and shortcomings of information technology integrated instruction from the aspect of students as well as what kind of teaching methods could better attract students and induce the learning motivation and outcomes. This study therefore intends to understand the effects of multimedia information technology integrated multi-sensory instruction on students' learning motivation and outcomes and provide reference for teachers applying information technology integrated instruction and the promotion of relevant education units.

LITERATURE REVIEW

Multimedia information technology integrated learning

Cardillo (2010) defined multimedia information technology integrated learning as words and pictures. The former referred to verbal form, containing printed words and spoken words; and, the latter referred to pictorial form, including static pictures (illustrations, coordinate graphs, diagrams, photos, maps) and dynamic pictures

(animation, films). Multimedia learning referred to learning with words and pictures that multimedia information technology integrated learning could be called dual-code learning or dual-channel learning, i.e. the presentation of multimedia was to present information with words and pictures. The multimedia information technology integrated instruction information or the presentation of multimedia instruction aimed to assist in learning with the presentation of words and pictures (Geoffrey et al., 2012). The theories and points of view related to multimedia information technology integrated learning proposed by Orit Ben-Zvi, Assaraf & Orion (2010) are proposed to discuss the methods applying multi-sensory instruction to deal with multimedia information and the teaching design.

Deriving theories from multimedia information technology integrated learning, Kim (2011) emphasized three processes of selecting, organizing, and integrating words and pictures for all learning. Selection referred to selecting relative and important information from word and non-word information to be stored in the working memory, organizing such selected word and non-word information for establishing the structure to form two logic situated models, and finally integrating and combining such organized situated models (Varma & Linn, 2012). Since the three processes occurred in the limited working memory, the learning effect would be effectively promoted when a multimedia system could be utilized for designing the process for helping learners be good at operating the memory and preceding the processes of selection, organization, and integration. The multimedia information technology integrated learning theory suggests that receiving information from multiple channels could help learning. However, the multi-form information presentation could enhance learning burden.

Multi-sensory instruction

Human's sense organs of eyes, ears, nose, mouth, and skin could be used for inducing the senses of sight, hearing, smell, taste, and touch. Anthony (2012) pointed out Maria Tecla Artemisia Montessori as the first educator proposing sense-training learning. Montessori emphasized that the early education of children should focus on sense training, as each child "explored and knew" the world with the sense organs and acquired various abilities and skills through feeling, walking, and touching. Such training allowed children's sense organs being keen and cultivated their abilities of concentration, willpower, observation, and judgment.

Krista (2012) indicated multi-sensory instruction as the combination of teachers' lecturing, students' reading, and other activities and materials allowing students listening, doing, watching, and feeling in the learning process. The stimulation of such senses would reinforce each other that a lot of students could better understand and remember the learning content when various senses were applied. Castaneda (2011) also mentioned that multi-sensory instruction could help students mobilize and coordinate seeing, hearing, speaking, and writing for more effective learning. Multi-sensory instruction is a learning model operated by integrating with several senses. Hansen (2010) considered that it was not a unique learning model designed for specific students, but a better diverse learning model. When such sensory learning activities could be preceded simultaneously, students could see and operate at the same time or in shorter time to make the learning more efficient. For some students, receiving external information through several senses would be more effective than learning through one or two channels. In short, multi-sensory instruction referred to teachers proceeding instruction through various methods, sometimes teachers' interpretation and students' active reading, while the other time, the utilization of some actual experiences or other materials. Allowing students receiving information through eyes, ears, mouth, or hands could have students more efficiently comprehend and memorize the learned knowledge by

such senses reinforcing each other to further comprehensively develop the potential (Skamp et al., 2013). Accordingly, the multi-sensory instruction in this study allows students receiving the content of teaching materials through visual observation, ear listening, or kinesthetic touching to further enhance the learning outcomes and motivation.

Learning motivation

Kukkonen et al. (2013) defined motivation as extrinsic behaviors and intrinsic learning motivation of an individual. Cindy & Douglas (2010) regarded motivation as the essential condition for long-term, effective, and meaningful learning. Learning motivation was a kind of motivation. Oyzon& Olmos (2010) pointed out learning motivation as an intrinsic process to induce students' learning activities, maintain the learning activities, and have the learning activities move towards the objectives set by teachers so as to achieve instructional objectives and proceed effective instruction. Porter et al. (2012) considered that learning motivation could guide individual learning objectives as well as induce the sustainable learning behaviors, reinforce the cognition process, and strengthen and improve the learning outcomes (Marijana,2015). Şahbaz (2012) regarded learning motivation as the intention or desire of students participating and devoting to learning, which was performed on students' selection for specific learning activities and the strength to continuously devote to such activities. Consequently, learning motivation is defined in this study as being able to guide students to sustainable learning and make efforts to the learning objectives set by teachers, in the learning activity process. Referring to Baş's (2012) Expectancy Value Model, motivation contains work value, expectancy for success, and ability beliefs in this study. 1. Work value refers to students' evaluation of the learning. 2. Ability beliefs refer to students perceiving the ability in the learning. 3. Expectancy for success refers to students' expectation about the future learning performance.

Learning outcomes

Learning was the process when individual behaviors appeared permanent changes after certain practice or experiences (Bybee, 2011). Learning referred to learners internalizing and absorbing knowledge; in other words, learning could not be directly measured, but the learning effect could be evaluated (Palmer, 2010). The so-called learning outcome was the evaluation of learners and the achievement of expected effect after completing certain learning activities (Jordan, 2011), i.e. learners' changes in knowledge, skills, behaviors, and attitudes after the end of instruction (Nilssom&Jakobsson, 2011).

Students' learning performance was a major indicator to measure learning outcomes as well as a major evaluation of teaching quality (Corredor et al., 2014). In this case, outcomes aimed to test the achievement of learning or instructional objectives and could be the reference for timely revision or feedback to improve the next lesson. Silburn (2012) considered learning outcomes as the cognitive abilities of knowledge, skills, and reasoning practiced and learned after a period of time to change behaviors or behavioral models, apply and solve problems, promote working abilities, and improve the life. Nonetheless, learning outcomes would be affected by learners' personal factors, teaching quality, learning styles, curriculum design, and learning environments (Nilssom&Jakobsson, 2011). Referring to Kuo (2011), learning outcomes are measured by the dimensions of curriculum instruction (including curriculum design, teachers, and teaching methods), learning environment, and learning performance (containing professional knowledge, skills, and learning effect).

METHODOLOGY

Research hypothesis

Wang et al. (2011) mentioned that students being lack of motivation or presenting insufficient motivation would not show favorable outcomes, despite of the adequate cognitive abilities to learn (Yilmaz et al., 2010). Learning motivation would have students make preparation for learning and enhance the attention to and absorption of new knowledge; students with strong learning motivation revealed better preparation for learning than those with weak motivation. Accordingly, Kuo (2011) considered that the maximal learning efficiency could be acquired by understanding students' learning motivation and explained the relationship between motivation and outcomes by proposing the model of motivation affecting outcomes. According to the research result on students, Şahbaz (2012) proposed that the higher learning motivation revealed positive correlations with higher learning outcomes, i.e. the positive correlation between learning motivation and learning outcomes. The following hypothesis therefore is established in this study.

H1: Learning motivation reveals significant correlations with learning outcome.

Cindy & Douglas (2010) indicated that students with worse cognitive comprehension would be enhanced the opportunities in success after receiving multimedia information technology integrated sensory instruction. Krista (2012) discovered that multimedia information technology integrated friendly multi-sensory instruction could enhance students' learning motivation and allow students promoting the learning outcomes by memorizing and comprehending under relaxing and pleasant environments. Kukkonen et al. (2013) discovered that the use of multimedia information technology integrated instruction could stimulate students' senses and supply the insufficiency of word explanations to reinforce learners' comprehension and outcomes. Castaneda (2011) indicated that the introduction of multimedia information technology integrated learning and the operation of specific objects could help pupils comprehend the meanings of questions. Baş (2012) also suggested that multi-sense information could enhance the correctness to solve problems. Porter et al. (2012) discovered that multimedia information technology integrated multi-sensory instruction allowed students finding out learning interests, arousing learning motivation, and enhancing learning outcomes from solving real problems. Anthony (2012) revealed that multimedia learning methods could enhance students' learning interests. As a result, the following hypotheses are established in this study.

H2: Multimedia information technology integrated multi-sensory instruction shows notable correlations with learning motivation.

H3: Multimedia information technology integrated multi-sensory instruction presents remarkable correlations with learning outcome.

Research subject and research design

To effectively achieve the research purpose and test the research hypotheses, the design of experiments is applied to the quasi-experimental research. 92 students in two classes in Fuzhou No.1 High School in Fujian are studied; one experimental class (46 students) is proceeded multimedia integrated multi-sensory instruction, while the other control class (46 students) remains traditional lecturing instruction. The

designed teaching program of multi-sensory instruction in math is preceded in both classes for 4 months.

Analysis

Regression Analysis is applied to understand the relationship among multi-sensory instruction, learning outcome, and learning motivation

EMPIRICAL DATA AND ANALYSIS

Operational definition of variables and the measurement

Multi-sensory instruction

Multi-sensory instruction is divided into three dimensions of visual observation, ear listening, and kinesthetic touching. The scale is referred to Anthony (2012), and the questions are scored with Likert 7-point scale, where 1 stands for "extremely disagree" and 7 represents "extremely agree". The overall reliability coefficients show 0.83 on visual observation, 0.88 on ear listening, and 0.81 on kinesthetic touching.

Learning outcome

Learning outcome contains three dimensions of curriculum instruction, learning performance, and learning environment. Referring to Baş (2012), the scale is scored with Likert 7-point scale, where 1 stands for "extremely disagree" and 7 represents "extremely agree". The overall reliability coefficients appear 0.85 on curriculum instruction, 0.84 on learning performance, and 0.80 on learning environment.

Learning motivation

Being classified into work value, ability beliefs, and expectancy for success, the scale of learning motivation is referred to Kuo (2011), and the questions are scored with Likert 7-point scale, where 1 stands for "extremely disagree" and 7 represents "extremely agree". The overall reliability coefficients reveal 0.87 on work value, 0.82 on ability beliefs, and 0.90 on expectancy for success

RESULTS AND DISCUSSION

Regression Analysis of learning motivation and learning outcome

Regression Analysis is utilized for testing the hypothesis and the theoretical structure. The first regression tests the effect of learning motivation on curriculum instruction where work value, ability beliefs, and expectancy for success in learning motivation present positive effects on curriculum instruction ($\beta=2.342$, p$=0.000$; $\beta=1.833$, p$=0.022$; $\beta=2.137$, p$=0.000$). The second regression tests the effect of learning motivation on learning environment where work value, ability beliefs, and expectancy for success in learning motivation appear positive effects on learning environment ($\beta=1.735$, p$=0.035$; $\beta=1.619$, p$=0.041$; $\beta=2.246$, p$=0.000$). The third regression tests the effect of learning motivation on learning performance where work value, ability beliefs, and expectancy for success in learning performance reveal positive effects on learning motivation ($\beta=2.163$, p$=0.000$; $\beta=$

2.031, p = 0.004; β = 2.489, p = 0.000), Table 1. Hypothesis 1 that learning motivation presents significant correlations with learning outcome is supported.

Table 1. Regression Analysis of learning motivation and learning outcome

Dependent variable ⟶ Independent variable ↓	Learning outcome					
	Curriculum instruction		**Learning environment**		**Learning performance**	
	β	P	β	P	β	P
Work value	2.342**	0.000	1.735*	0.035	2.163**	0.000
Ability beliefs	1.833*	0.022	1.619*	0.041	2.031**	0.004
Expectancy for success	2.137**	0.000	2.246**	0.000	2.489**	0.000
F	8.722		12.433		17.381	
R^2	0.183		0.214		0.238	
Adjusted R^2	0.166		0.193		0.217	

*p < 0.05 **p < 0.01
 Data source: Self-organized in this study

Regression Analysis of multi-sensory instruction and learning motivation

Applying Regression Analysis to test the hypothesis and the theoretical structure, the first regression tests the effect of multi-sensory instruction on work value where visual observation and ear listening show positive effects on work value (β = 2.165, p = 0.000; β = 1.891, p = 0.017). The second regression tests the effect of multi-sensory instruction on ability beliefs where visual observation and kinesthetic touching reveal positive effects on ability beliefs (β=1.926, p=0.013; β=2.133, p=0.000). The third regression tests the effect of multi-sensory instruction on expectancy for success where visual observation, ear listening, and kinesthetic touching appear positive effects on work value (β=2.291, p=0.000; β=2.377, p=0.000; β = 2.516, p = 0.000), Table 2. As a consequence, Hypothesis 2 that multi-sensory instruction reveals remarkable correlations with learning motivation is partially supported.

Table 2: Regression Analysis of multi-sensory instruction and learning motivation

Dependent variable ⟶ Independent variable ↓	Learning motivation					
	Work value		Ability beliefs		Expectancy for success	
	β	P	β	P	β	P
Visual observation	2.165**	0.000	1.926*	0.013	2.291**	0.000
Ear listening	1. 891*	0.017	1.238	0.059	2.377**	0.000
Kinesthetic touching	1.163	0.067	2.133**	0.000	2.516**	0.000
F	10.739		14.306		19.451	
R^2	0.206		0.229		0.257	
Adjusted R^2	0.183		0.202		0.238	

*p < 0.05 **p < 0.01
Data source: Self-organized in this study

Regression Analysis of multi-sensory instruction and learning outcome

Regression Analysis is used for testing the hypothesis and the theoretical structure. The first regression tests the effect of multi-sensory instruction on curriculum instruction where visual observation, ear listening, and kinesthetic

touching present positive effects on curriculum instruction (β＝1.691, p＝0.031; β ＝1.783, p＝0.023; β＝1.946, p＝0.016). The second regression tests the effect of multi-sensory instruction on learning environment where visual observation, ear listening, and kinesthetic touching show positive effects with learning environment (β＝2.273, p＝0.000; β＝1.688, p＝0.033; β＝2.047, p＝0.005). The third regression tests the effect of multi-sensory instruction on learning performance where visual observation, ear listening, and kinesthetic touching appear positive effects on learning performance (β＝2.188, p＝0.000; β＝2.096, p＝0.000; β＝2.371, p＝ 0.000), Table 3. Hypothesis 3 that multi-sensory instruction reveals notable correlations with learning outcome is therefore supported.

Table 3. Regression Analysis of multi-sensory instruction and learning outcome

Dependent variable → Independent variable ↓	Learning outcome					
	Curriculum instruction		Learning environment		Learning performance	
	β	P	β	P	β	P
Visual observation	1.691*	0.031	2.273**	0.000	2.188**	0.000
Ear listening	1.783*	0.023	1.688*	0.033	2.096**	0.000
Kinesthetic touching	1.946*	0.016	2.047**	0.005	2.371**	0.000
F	13.182		15.416		21.456	
R^2	0.237		0.261		0.296	
Adjusted R^2	0.212		0.238		0.277	

*$p < 0.05$ **$p < 0.01$*
Data source: Self-organized in this study

CONCLUSIONS

The research results show the significant correlations between multimedia information technology integrated multi-sensory instruction and learning motivation, between learning motivation and learning outcome, and between multimedia information technology integrated multi-sensory instruction and learning outcome. The findings reveal that students with multimedia integrated multi-sensory instruction are given more opportunities for manual operation, which is internalized after the learning, that the learning content appears longer period of retention for long-term memory. The test performance is therefore largely enhanced to present positive effects on learning and assist in learning outcomes. Multimedia information technology integrated multi-sensory instruction could promote learning motivation, while it does not show obvious effects on Work Value and Ability Beliefs, revealing that the practice of multimedia information technology integrated multi-sensory instruction could not immediately change students' idea of what is important being dull. Such value and beliefs are often ingrained and hardly changed. Students with kinesthetic learning styles prefer operate specific and tangible objects manually that they could learn the content rapidly. Students with visual learning styles present better comprehension through the written words on projected presentation or blackboard. Multimedia information technology integrated multi-sensory instruction stresses on real experiences or instruction with other media so that students could receive information through various senses of sight, hearing, speaking, or operation. They therefore might fit the learning styles of students with kinesthetic and visual learning styles. The learning achievement and learning motivation would be apparently promoted. Concluding the research results and findings, practical suggestions are further proposed in this study.

1.   Multimedia information technology integrated multi-sensory instruction emphasizes on inducing students' senses with various teaching activities in order to enhance the learning effect. For this reason, teachers need to increase teaching activities of students' DIY and team discussions when proceeding multimedia information technology integrated multi-sensory instruction so that students have more experiences in seeing, hearing, and doing in the learning process as well as easily apply and reinforce different senses to adapt to the multimedia information technology integrated multi-sensory instruction to enhance the learning comprehension and promote the learning outcomes.

2.   It is rather difficult to change ordinary habits and opinions about objects. Generally speaking, strong motivation and needs are required for changing habits. Once a behavior is cultivated, it will take more time to make changes. It is the same to change students' learning motivation. Teachers have to continuously encourage students' behaviors for a long time so that students generate learning interests and establish confidence in learning. In this case, students might change the existing concepts in the deep beliefs to enhance the learning motivation.

It is suggested that teachers have to understand each student's dominant senses on multimedia information technology and the learning style tendency before practicing multimedia information technology integrated multimedia multi-sensory instruction, present distinct methods correspondent to multimedia information technology integrated multi-sensory instruction during the instruction, utilize students' dominant senses for learning, and construct multimedia learning environments to eliminate defects in traditional instruction and enhance the learning effect.

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