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A Study on Information Technology Integrated Guided Discovery Instruction towards Students' Learning Achievement and Learning Retention

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In the information explosion era with constant changes of information, educators have promoted various effective learning strategies for students adapting to the complex modern society. The impact and influence of traditional teaching method have information technology integrated modern instruction and science concept learning play an important role. Teaching methods promoted in guided discovery instruction are to cultivate learners' abilities of discovery, exploration, problem-solving and independent thinking, and creation and invention through discovery or creative learning. Students could actively and positively participate in learning and integrate and construct knowledge by themselves. In other words, all knowledge is individually operated and explained, rather than passively acquired. By applying quasi-experimental research with experimental design, 98 students in two classes in Fuzhou No.1 Middle School and Affiliated High School of Fujian Normal University are preceded the 16-week (3hr per week) experimental teaching research. The research results reveal that 1. Guided discovery instruction would affect learning achievement, 2.guided discovery instruction would influence learning retention, and 3.learning achievement presents significantly positive effects on learning retention. Based on the research results, conclusions and suggestions are proposed at the end of this study, expecting to provide reference and improvement for teachers' teaching method.

Keywords: information technology, guided discovery instruction, learning achievement, learning retention, teaching method

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INTRODUCTION

The knowledge explosion and the changeable science and technology in past years have resulted in the expansion of curriculum contents and the increase of categories in schools. The development of information offers people with convenient life as well as results in impact and influence on traditional teaching method. Information technology integrated modern instruction and science concept learning therefore plays a primary role.

Under the lecture in traditional instruction, knowledge is mostly acquired from a teacher's direct lecture, and a teacher seldom interacts with students. Under such a method, learners are used to passive thinking and simply memorize the learned knowledge so that they could not flexibly apply the learned knowledge to solve problems in daily life. The teaching idea in discovery instruction is to have students independently explore answers in the learning context. Nonetheless, discovery instruction is restricted to "time" and "wrong" problems. In this case, a teacher should be able to guide students, through problems, to make correct thinking and control the entire teaching context in order to reduce mistakes.

In the discovery process, a teacher should offer guidance to reduce teaching time and enhance learning results, apply technology and information abilities, and stimulate the active exploration and research spirit as the curriculum objective at current stage of education. Information technology integrated instruction therefore presents primary status on contemporary education and learning. Information technology integrated instruction delicately compiles curriculum materials and learning theories into the software and present the teaching content through visual and audio information, with information technology as a medium, so that students could acquire more and changeable sensory stimulations and enhance the learning interests. A teacher designs definite teaching objectives, provides information with several media, and uses non-linear teaching sequence for students interactively transferring the teaching contents at any time and achieving the teaching objectives with individual learning. The major value is to satisfy the needs of several educational ideas, such as adapting to students with different abilities, satisfying individual needs, adjusting learning speed, offering diverse feedback and learning environments, monitoring and evaluating student performance at any time, complying with students' individual needs, and adapting to individual differences. Accordingly, it is an instrument to help teachers' instruction and students' learning and a method to improve instruction.

State of the literature

- The development of information offers people with convenient life as well as results in impact and influence on traditional teaching method. Information technology integrated modern instruction and science concept learning therefore plays a primary role.
- The major value is to satisfy the needs of several educational ideas, such as adapting to students with different abilities, satisfying individual needs, adjusting learning speed,

Contribution of this paper to the literature

- For students with high learning achievement, a teacher should propose more challenging problems and encourage students to evaluate different problem-solving methods in order to explain the thinking.
- A teacher could guide students to understand problems with enquiry and propose questions in the learning process for students reviewing the thinking process, explaining the answers, interpreting the problem-solving strategies, and comparing the relationship between previous problems and current problems.
- A teacher should encourage students to propose questions, praise students for the correct answers, and accept students' mistakes and failure by timely offer correction and feedback, as both correct and wrong answers are the reinforcement in the discovery learning process.

LITERATURE REVIEW

Guided Discovery Instruction

Guided discovery instruction refers to re-arranging or transforming existing facts

to generate new insight (De Smet et al., 2012), or a specially set learning activity allowing students, in proper learning environments, applying the mental power to discover new concepts or principles. Hernandez et al. (2011) emphasized that guided discovery instruction could help learners learn various problem-solving strategies, transfer cognitive data to be more useful, and know how to commence learning. In regard to the property and process of guided discovery instruction, Ooi et al. (2011) indicated that it was possible and more important to assist an individual in independent discovery, in spite of discovery processes not being completely realized. Guided discovery instruction focused on guiding learners' self-discovery and assessment. In the process, Peng et al. (2011) regarded the major obstacle as psychologically assuming that one could not discover. Two unfavorable habitual attitudes were pointed out to affect discovery learning; one was being lazy to think and regarding the impossibility of discovery, and second was regarding discovery as giving only a passing glance at things. Such two learning attitudes largely hindered the effect of guided discovery instruction. Hong et al. (2011) argued that a person, seeking for rules and the relevance in the learning environment, had to capture the expectation to dig certain things or have others remind of such expectation so as to find out various digging methods (Teo, 2011). Ozkan & Kanat (2011) pointed out six elements for learning with guided

discovery instruction, including using one's own head, making knowledge one's own, competence as self-rewarding, problem solving through hypothesizing, the self-loop problem, and the power of contrast. Chen (2011) promoted guided discovery instruction and advocated to arrange various "structural" situations for student discovery in actual instructional contexts and have students discover the final form of materials, i.e. knowledge, through operation, discussion, contrast, comparison, search, discovering contradiction, and applying intuitive thinking. The learning process would cohere, combine, and organize new and old information, i.e. combining independent and scattered knowledge and information to construct a relevant "cognition body" (Zhan et al., 2011).

Information Technology Integrated Instruction

Chen et al. (2011) described information technology integrated instruction as integrating information technology into curricula, materials, and instruction so that science and technology became a necessary instrument for teachers' instruction and students' learning, i.e. the use of science and technology being a part of daily life and extended to regard information technology as an approach or a program to seek for answers at any time and ay places. Deutsch et al. (2012) pointed out information technology integrated instruction as computer multimedia or Internet technology which presented digital, video, and audio stimuli and was easily accessed, rapidly processed, and convenient for communication. In other words, it could match the teaching contents and strategies, apply computer multimedia, regard information technology as the teaching instrument, and show more flexibility than traditional lecture to provide several two-way communications for students' learning. Moreover, Huang et al. (2012) stated that information technology integrated instruction could present materials and problems, provide students with opportunities to think, answer, or inquire, and immediately feedback after accepting students' responses. In this case, it was a two-way communication teaching method. When students encountered difficulties, they might not show any responses because of teacher's authority or students' laugh, even though there was an opportunity for two-way communication. Under information technology integrated instruction, the interaction between both parties would be enhanced. Pynoo et al. (2011) considered information technology integrated instruction as to promote students' learning outcome in the field and enhance the information abilities through the integration of information technology

and learning field. Accordingly, information technology integrated instruction covered teachers' teaching activities, students' learning activities, teaching preparation, and classroom management (Pynoo et al., 2012; Reid-Griffin & Slaten, 2016).

Learning Achievement

Referring to Lee et al. (2011), learning achievement is learners' physical and mental interaction with environments. There are lots of factors in learning achievement. People with low achievement are predicted the achievement according to personal intelligence or aptitude performance; when the actual achievement appears large differences from the predicted achievement based on intelligence or aptitude, the significantly low academic achievement is called low achievement (Arenas-Gaitán et al., 2011). In this study, learning achievement aims at learning performance in general learning processes, rather than academic performance caused by certain factors. Ramnarain (2015) stated that students with high learning achievement normally present more active learning attitudes and motivation with higher abilities of creation, reasoning, and critical thinking to think and solve problems as well as better academic achievement. Terzis & Economides (2011) pointed out the difference of learning achievement among students; however, learning ability was closely related to academic achievement. Generally speaking, students with high learning achievement would have positive and active learning attitudes and better learning retention. Cheng et al. (2011) mentioned that students with high learning achievement outperformed those with low learning achievement on common sense, language performance, spatial concept, and knowledge absorption. Eickelmann (2011) indicated that ones with high learning achievement showed higher learning speed than those with low learning achievement, and students with high learning achievement presented learning characteristics of 1.finding out problems without too much time, 2.being able to maintain learning speed and sense of achievement, 3.being able to support peers with zone of proximal development (ZPD), and 4.definitely understanding the property and content of the learned knowledge in the learning process to further dominate knowledge for solving problems. As a result, they could better self-estimate the learning accuracy and discovery mistakes and rapidly notice problems and the property, think of problems from various aspects (Sánchez et al., 2011), and present better comprehension and computing abilities.

Learning retention

Bourgonjon et al. (2011) regarded learning retention as to retain memories after learning. Cognitive psychologists divided information processing into three stages of sensory memory, short-term memory, and long-term memory. Choonenboom (2012) explained that the temporary memory (a fraction of a second) induced by an individual receiving external stimuli through seeing, hearing, smelling, and tasting was the sensory memory; and, after sensory register, paying attention to such stimuli for about 20 seconds was the short-term memory (Erdo mu&Esen, 2011). Chua & Mageswary (2015) said that regarding modern research on memory, psychologists not only focused on the memory after learning (i.e. learning retention) but also emphasized how to memorize in the learning process. According to the mental process in information processing, Choi & Baek (2011) divided human memories into sensory memory, short-term memory, and long-term memory.

(1) Sensory memory: External information was received through senses (including vision, hearing, smelling, and tasting) and temporarily retained in the storage of sensory memory. When such information, which temporarily retained in sensory memory (a fraction of a second), was not noticed by an individual, the

memory would fast disappear (Wiseman & Anderson, 2012).

(2) Short-term memory: Short-term memory referred to information being noticed and coded after sensory register and then kept for 20sec.

I. Long-term memory: Information going through sensory memory and short-term memory and being permanently retained and unforgettable was called long-term memory; therefore, long-term memory was also called "permanent memory" (Terzis et al., 2012).

Research hypothesis

Lee et al. (2012) discovered that learning retention required the detailed and definite instruction of a teacher. Besides, students with low learning achievement could not clearly understand the learned knowledge, i.e. not realizing the implied meaning and principle; in this case, they could not effectively utilize self-monitoring and self-regulation, nor did they know how to discover mistakes in the problem-solving process (Shin et al., 2011). Moreover, they revealed less prior knowledge than students with high learning achievement did. Hadjithoma-Garstka (2011) indicated that students' learning retention, which was not simply related to heredity, but also teaching conditions and approaches, needed to be cultivated. Guided discovery instruction allowed students mastering the rules of memory and correctly memorizing. With teachers and parents' conscious and purposive cultivation, students' learning retention could be enhanced. For this reason, the following hypotheses are proposed in this study.

H1: Guided discovery instruction would affect learning achievement.

H2: Guided discovery instruction would influence learning retention.

Chou et al. (2012) explained that a teacher should consider students' needs, stimulate their learning motivation, concern about their learning achievement, activate the teaching contents, and avoid dull teaching strategies when planning teaching activities so as to effectively enhance students' learning retention. Terzis & Economides (2011) stated that each student presented distinct learning achievement, and learning ability was closely related to academic achievement. Generally speaking, students with high learning achievement showed positive learning attitudes and better learning retention. Šumak et al. (2011) described the common difficulty in education as students not having learning motivation and achievement which resulted in pressure on parents and teachers to eventually give up. Vanderlinde et al. (2012) proposed students' learning interests and learning achievement as the primary task to promote guided discovery instruction; once a student enhanced the learning achievement, the learning retention would be promoted. The following hypotheses are therefore proposed in this tudy.

H3: Learning achievement reveals significantly positive effects on sensory memory in learning retention.

H4: Learning achievement appears remarkably positive effects on short-term memory in learning retention.

H5: Learning achievement presents notably positive effects on long-term memory in learning retention.

RESEARCH METHOD

Measurement of research variable

Learning achievement

Referring to Lee et al. (2011), learning achievement is divided into (1)high learning achievement and (2)low learning achievement.

Learning retention

Referring to Choi & Baek (2011), the dimensions contain (1)sensory memory, (2)short-term memory, and (3)long-term memory.

Research subject and sampling data

An experimental design is applied to the quasi-experimental research in this study, in which 98 students in two classes in Fuzhou No.1 Middle School and Affiliated High School of Fujian Normal University are selected as the experimental research subject. An experiment class (49 students) is taught with information technology integrated guided discovery instruction, and another control class (49 students) remains traditional instruction. The experimental teaching research is preceded three hours per week for 16 weeks (total 48 hours). The collected data are analyzed with SPSS, and Regression Analysis and Analysis of Variance are utilized for testing the hypotheses.

Analysis method

Analysis of Variance is applied to discuss the difference of information technology integrated guided discovery instruction in learning achievement and learning retention, and Regression Analysis is further used for understanding the relationship between learning achievement and learning retention.

ANALYSIS RESULT

Effects of information technology integrated guided discovery instruction on learning achievement and learning retention

1. Analysis of Variance of information technology integrated guided discovery instruction on learning achievement
2. High learning achievement and low learning achievement are analyzed and explained by applying Analysis of Variance to discuss the difference of information technology integrated guided discovery instruction in learning achievement. From Table 1, information technology integrated guided discovery instruction reveals significant effects on learning achievement that H1 is supported. Analysis of Variance of information technology integrated guided discovery instruction on learning retention

Sensory memory, short-term memory, and long-term memory in learning retention are analyzed and explained by discussing the difference of information technology integrated guided discovery instruction in learning retention with Analysis of Variance. From Table 2, information technology integrated guided discovery instruction presents remarkable effects on learning retention that H2 is partially supported.

Table 1. Analysis of Variance of information technology integrated guided discovery instruction on learning achievement

Variable	F	P	Scheffe post hoc
High learning achievement	7.623	0.043*	Guided>general
Low learning achievement	9.156	0.003*	Guided>general

** stands for p<0.05*

Table 2. Analysis of Variance of guided discovery instruction on learning retention

Variable	F	P	Scheffe post hoc
Sensory memory	11.426	0.000*	Guided>general
Short-term memory	10.537	0.283	
Long-term memory	16.255	0.000*	Guided>general

** stands for p<0.05*

Table 3: Analysis of learning achievement and learning retention

Dependent variable→	**Learning retention**					
Independent variable↓	Sensory memory		Short-term memory		Long-term memory	
Learning achievement	Beta	t	Beta	t	Beta	t
High learning achievement	0.183	2.075**	0.196	2.166**	0.211	2.406**
Low learning achievement	0.132	1.738*	0.143	1.681*	0.078	0.931
F	11.862		15.237		16.698	
Significance	**0.000*** **		**0.000*** **		**0.000*** **	
R2	0.127		0.136		0.172	
Adjusted R2	0.010		0.012		0.015	

*Note: * stands for p<0.05, ** for p<0.01.*
Data source: Self-organized in this stud

Correlation Analysis of learning achievement and learning retention

1. Correlation Analysis of learning achievement and sensory memory

The analysis shows notably positive effects of high learning achievement (t=2.075**) and low learning achievement (t=1.738*) on sensory memory, Table 3, that H3 is supported.

2. Correlation Analysis of learning achievement and short-term memory

The analysis reveals remarkably positive effects of high learning achievement (t=2.166**) and low learning achievement (t=1.681*) on short-term memory, Table 3, that H4 is supported.

3. Correlation Analysis of learning achievement and long-term memory

The analysis presents the notably positive effect of high learning achievement (t=2.406**) on long-term memory, Table 3, that H5 is partially supported.

CONCLUSION

This research result shows that students with information technology integrated guided discovery instruction outperform those with traditional instruction on learning achievement. Regarding learning retention, information technology integrated guided discovery instruction does not appear difference on short-term memory, but students with information technology integrated guided discovery instruction present better sensory memory and long-term memory. Apparently, information technology integrated guided discovery instruction indeed reveals the functions of multiple video and audio stimuli, accessibility, fast processing, and convenient communication on instruction. Besides, it benefits students' discovery in various contexts, allowing students discovering the final form of materials, i.e. knowledge, through operation, discussion, contrast, comparison, search, finding out contradiction, and application of intuitive thinking. The learning process is to cohere, combine, and organize new and old information to enhance students' learning achievement and learning retention.

SUGGESTION

Aiming at above research results, the following suggestions are proposed in this study.

1. In the process of practicing guided discovery instruction, a teacher should induce the motivation of students with low learning achievement before they propose questions, reinforce students to understand problems, provide definite and direct prompts, and divide complex problems into small portions to ask students. For students with high learning achievement, a teacher should propose more challenging problems and encourage students to evaluate different problem-solving methods in order to explain the thinking.
2. Before solving problems, a teacher should ask students whether they have solved similar or relevant problems. After solving problems, the teacher could help students recall the problem-solving process, cultivate the generalization ability, and observe the common characteristics from several questions. A teacher could guide students to understand problems with enquiry and propose questions in the learning process for students reviewing the thinking process, explaining the answers, interpreting the problem-solving strategies, and comparing the relationship between previous problems and current problems.
3. The harmonious climate which is good for discussion and thinking as well as mutual respect should be created. A teacher should encourage students to propose questions, praise students for the correct answers, and accept students' mistakes and failure by timely offer correction and feedback, as both correct and wrong answers are the reinforcement in the discovery learning process. Moreover, a teacher should encourage students to propose various possible problem-solving strategies, help students compare such strategies, and propose different problems or ones with similar essence but different expression according to students' level.

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