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The Effect of Knowledge Construction Web-Based Learning Environments on Undergraduates' Learning Outcomes

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Abstract: The purposes of this research were to examine the learning outcomes and problem solving transfers of undergrad students who learnt with web-baed learning environment for knowledge construction (WLKC). The participants in this study comprised 41 undergraduate student teachers in computer education program. The research design of this study was pre-experimental research. Both quantitative and qualitative data were collected and analyzed. Means and standard deviations were employed to analyze the learning outcomes derived from the transfer and retention test. Moreover, protocal analysis from the interview was employed to analyze the student teachers' problem-solving transfer. The result revealed that 76% of them showed improvement of learning outcome following constructivist way, whereas 24 % of them showed the outcome of rote learning. In qualitative part, the result indicated that the problem-solving transfer was achieved by the constructivist student teacher through retrieving mental model with previous situations to solve new and different problem contexts and then the transfers occurred between similar contextual problems.

Keywords: Problem solving transfers, Web-based learning, Constructivist learning

1. Introduction

Presently, web-based learning is of great interest in education, for it enables learners to obtain access to multi-sources of information and knowledge. It also provides chances for learners to cooperate among themselves and share knowledge and experiences with experts and others via on-line systems (Isara, 2014, Laurillard, 1993; Chen, 2002; Alomyan, 2004). It is also a great potential for education because of the opportunities it offers individuals to control their own learning (e.g., Chen, 2002; Alomyan, 2004). However, although web-based learning media characteristics facilitate flexible learning, past research still revealed learners as consumers of knowledge or in other words, they use traditional didactic learning. Meanwhile, Thai education has established the optimal goal for sustainability through development of quality human resources, at medium and high levels, who are capable to strengthen communities through education, training, practices and incubation so as to lead to sustainable construction of knowledge. This will be the major foundation for appropriate manpower in the learning society in which people know how to think, innovate, create, catch up with others, and become the nation's intellectual resource (Office of Higher Education, 2013). The said concept correlates closely with the teaching and learning under the Constructivism theory, which believes that knowledge is not always true and is subject to change. Teaching design therefore should emphasize the knowledge construction process in learners and teaching them to contemplate and know how to think instead of memorizing. More importantly, Constructivism emphasizes situating cognitive experiences where

learning is more meaningful than the materialism way of teaching in which knowledge transfers are the principle. The latter believes that truth appears only in textbooks, and this concept can lead to decontextualization of learning and non-meaningful learning that is not constructed through experiences. Such learning approach does not contribute to higher education's expected learners' traits, i.e., learners should be prepared to construct their learning method and knowledge by themselves at all time (Chaijaroen, Sumalee; Somabutr, Anucha; and Kanjug, Isara, 2007). The researchers had synthesized and designed the web-based learning environments based on Constructivism, the principle of which requires learners to eagerly construct new and meaningful knowledge via former knowledge or experiences. Students learning with this approach are able to apply the learned problem-solving method in new situations, i.e., problem-solving transfer. Problem-solving transfer occurs when a person utilizes his or her experiences to deploy problem solving in a new confronted problem (Mayer and Wittrock, 1996). This means learners under Constructivism approach must be able to recall the knowledge they constructed and apply it in various situations. Hence, learners depend on a variety of cognitive process when they learn. Knowledge construction of learners according to Constructivism necessitates assessment in order to know how much the learner learned. Measurement can be done through the retention test to measure what was learned (a transfer test). Another important measurement is to assess how learners learned (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). In this research, we were interested in studying what kind of characteristics learners learning with knowledge construction web-based learning are able to demonstrate by looking at their learning outcomes and ability in knowledge and problem-solving transfers in other contexts. The findings will be used in designing lessons and also in exhibiting the efficiency of the teaching innovation developed.

2. Research Objectives

To investigate the effect of web-baed learning environment for knowledge construction (WLKC) in this study, a couple objectives have been proposed as followings:

2.1 To examine learning outcome of university learners learning with WLKC

2.2 To examine problem solving transfers of university learners learning with WLKC

3. Research Method

3.1 Research design and participants

The participants in this study comprised 41 second year undergraduate student teachers in the computer education program of the Faculty of Education, Khon Kaen University, during the second semester of the academic year 2011. To examine their learning outcome and problem solving transfer, the pre-experimental research design of one shot case study was used to conduct this study. That means, the student teachers were examined their learning outcome and problem solving transfer after interacting with the WLKC only.

3.2 The web-based learning environment for knowledge construction (WLKC)

Figure 1. Problem situations

Figure 2. Knowledge bank

Figure 3. Related cases

Figure 4. Cooperation for problem solving

Figure 5. Knowledge construction tools

Figure 6. Scaffolding station

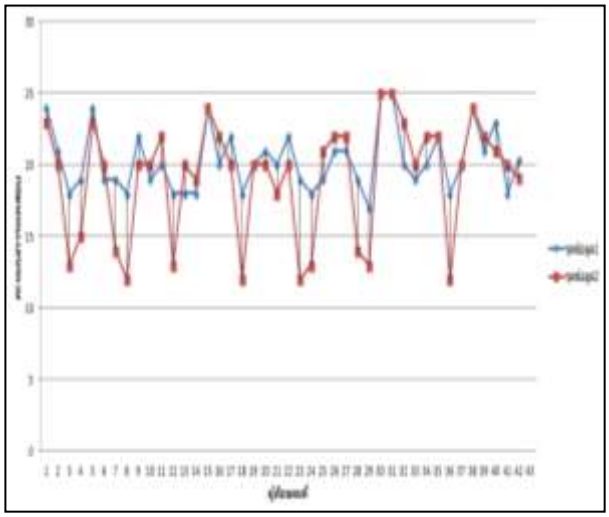
3.3 Data analysis

The problem-solving transfer of undergrad student teachers after interacting with the web-based environment for knowledge construction (WLKC) were analyzed using protocol analysis, including a series of steps; explanation, interpretation, and conclusion, from the clinical interview and their responses of problem solution. An interpretation framework of Mayer and Wittrock (1996) was used in this protocol analysis. In additions, the learning outcomes of them were quantitatively analyzed using basic statistics parameters including means ($\bar{x}$) and standard deviations (S.D.) from the retention and transfer tests.

4. Research Results

4.1 The learning outcome of the learners

For the undergrad student teachers' learning outcomes, after interacting with theWLKC, the mean of retention test was 20.31, with all learners passing the criteria, whereas the mean of the transfer test was 19.09. When comparing the results of the two tests, we found that 31 participants (76 %) were able to make high scores for both tests. According to Mayer and Wittrock (1996), such learning outcome is referred to as the constructivist learning. It was also found that 10 participants (24%) scored higher in



the retention test and lower in the transfer test. Based on Mayer and Wittrock (1996), the outcome is called rote learning. The results can be illustrated in the following figure:

Figure 7. Showing comparison of the retention test and the transfer test scores

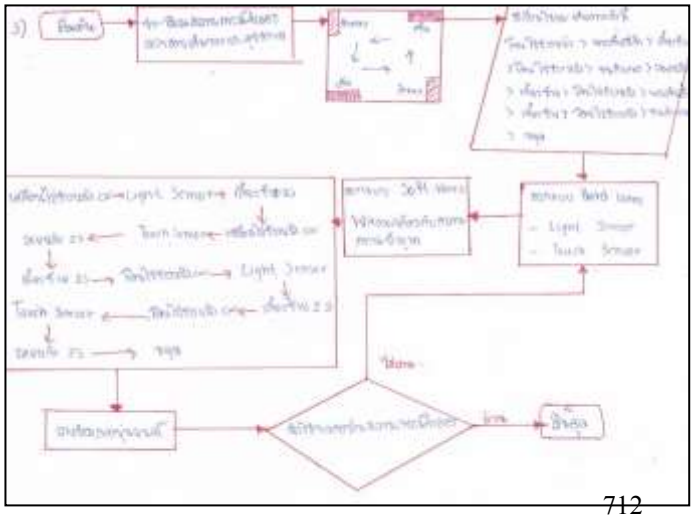
From the graph, we see that 10 learners had different scores in the retention test and the transfer test, which was low. Most learners scored similarly at high levels.

4.2 The problem-solving transfer of learners

For the undergrad student teachers' problem - solving transfer, after interacting with the WLKC, we conducted a clinical interview with the participants to study their transfers of problem solving after learning, and then analyzed the data by means of discourse protocol analysis. It was found that participants transferred their problem solving within a 2-step cognitive process. During the first step, the participants constructed a substitute for problem solution. When they faced a problem, they began to build a model to explain the process, steps, connection between causes and effects from the solution, i.e., the mental model was applied. In the second step, when the participants faced a problem in a new context, the former cognitive structure was triggered and the former mental model for problem solving was utilized in the new context. In the course of this process, similarity between the two contexts was observed, and pairing was done between the targets, situations, methods or steps of the mental model in the former problem solution and the present one. Next, the differences between the targets and situations of the two problems were compared, as discussed in the example below:

Step 1: When the participants faced a problem in program writing to control a robot, they constructed a substitute for problem solution as follows: **(**1**)** Analyzing the operation situation of the robot according to the given conditions and context. After the analysis, the operating model of the robot was set for the robot to work according to the mission. **(**2**)** Designing the robot hardware that correlated to the situation to be solved. **(**3**)** Installing the software in the robot by designing the software to work as required. (4) Testing the robot in a simulated situation and adjusting or modifying if the robot failed to solve the situation. This could be written in a diagram to show the problem solution in Figure 8.

Step 2: The participants compared and contrasted between the target and situation of the new problem and the mental model in the former problem. This was done by pairing the conditions of the problems and the structures of programs used for ordering the robot. They compared the targets, conditions, and outcomes such as when they wanted the robot to move in the set direction and towards a set location in a field. They had to indicate the obstacles in the field which was similar in terms of opaque boundary lines and walls. In this respect, similar tools and instructions were to be used. One protocol was, “From the simulation, the robot had to be programmed to move to certain places and we must know what obstacles there were such as walls or lines in the field so that suitable tools could be chosen.” Another said, “The problem-solving steps were similar to the former problem. We had to write an instruction for the robot to move accordingly. In the new field, we were able to apply the former route. For example, there was an opaque line and a wall in both problems, from which the robot had to



avoid. Therefore, we could use the tools and the former instructions." From these protocols, we can see that the details of the conditions led to attainment of the outcomes.

Figure 8. Example of problem-solving pattern that learners constructed after facing the problem situation

From Figure 8, the transfer of problem solving emphasized the participants' application of an approach, strategy, or process they have in their cognitive structure in the context of the new problem. This happens when an individual uses his experience in solving the former question to solve the new problem he faces. It can be said that problem-solving transfer is part of the transfer method.

5. Discussion of Research Results

The research results presented above are the findings of better means to upgrade the learning qualities of learners at the tertiary level than the traditional design of web-based learning. This was proved by the outcomes of learning, where 76 percent of learners showed the learning outcomes from knowledge construction. Only 24 percent showed the outcomes from rote learning. The findings could happen from the knowledge construction web-based learning environments with components supporting learners to be able to transfer problem solving efficiently. Learners should be provided with chances to perform in real simulated situations. They should be taught to learn meaningfully and see the relationships between the new item learned and the item existing in their cognitive structure. In other words, the learning should be designed such that learners have to search for answers. This includes learning by discovering, which requires the advanced thinking skill, e.g., analytical thinking, critical thinking, and problem-solving thinking. The findings correlated to the study by Kanjug, Issara, Chaijaroen, Sumalee (2012), and learning based on Constructivism where emphasis is on learners as doers or as constructors of knowledge from confrontation with a problem that causes cognitive contradiction or loss of cognitive balance. Learners in this respect have to adjust themselves to an equilibrium by adjusting their cognitive structure or schema, or, in other words, searching for an answer. This enables learners to learn by constructing knowledge on their own. Our findings also correlated to the research content where the importance was placed on learners having to apply the knowledge and truth in their real lives and solve problems confronted in the present world (Duffy, T.M. & Donald, J.C., 1996; Mayer, R.E., 1996; Jonassen, D., 1999). The findings are in accordance with the evidences from the analysis of interview protocol showing learners' problem solving. Learners took two steps in problem solving transfer. The first involved construction of a substitute for the problem solving approach. When learners faced a problem, they built a model to explain the process, steps, and connections between cause and effects. They used mental model in problem solving. The second step happened when learners faced a problem in a new context. Their cognitive structure was triggered and the former mental model was applied in the context of the new problem. In the course of doing this, learners observed what were similar by pairing the targets, situations, methods or steps similar to the mental model used in solving the previous problem and found the differences in the targets and situations of the new problem.

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References

Chaijaroen, Sumalee; Kanjug, Issara; Wattanachai, Suchat; Samat, Charuni; Suriyasupapong, Tubtim;Pakkothanang, Piyasak . (2008). The Learner's Conceptual Thinking Learning with Learning Innovation Encourage Human Thinking. *Journal of Cognitive Technology.*3(2), 48-55.

DeGroot, A.D. (1965). *Thought and Choice in Chess*. The Hague, the Netherlands: Mouton.

Dreyfus, H. L., & Dreyfus, S. E. (1986). *Mind over machine*. NewYork: The Free Press.

Jiambunsri Chisanu, Chaijaroen Sumalee, Kanjak Issara, Samat Charuni. (2012). Design and Develop of Constructivist Learning Environment on Learning Management System. *Procedia - Social and Behavioral Sciences, Volume 46, 2012, Pages 3426-3430*

Kanjug, Issara. (2008). Theoretical Framework for Learning Environments Model Enhancing Expert Mental Model. *Journal of Cognitive Technology.*3(2), 63-74.

Kanjug, Issara, Chaijaroen, Sumalee. (2012).The Design of Web-based Learning Environments enhancing Mental Model Construction**.** *Procedia - Social and Behavioral Sciences. , Volume 46, 2012, Pages 3134-3140*

Hannafin Michel, Susan Land, Kevin Oliver. (1999). Open Learning Environments: Foundations, Methods, and Models. In Charles M.Reigeluth (Ed), *Instructional Design Theories And Models: A New Paradigm of Instructional Theory. Volume II.* Newjersy: Lawrence Erlbaum Associates.

Issara Kanjug. (2009). *Development of Learning Environments Model Enhancing Expertise Mental Model.* Doctor of Philosophy Thesis in Educational Technology, Graduate School, Khon Kaen University.

Samat, Charuni and Chaijaroen, Sumalee. (2009). Design and Development of Constructivist Web-Based Learning Environment Model to Enhance Creative Thinking for HigherEducation Students. *Rajabhat Maha Sarakham University Journal*. 3(2), 161-172.

Bransford, J. D., Brown, A. L. & Cocking, R .R. (2000). *How people learn: Brain, mind, experience, and school.* Washington, DC: National Academy Press.

Jonassen, D.H. (1994). Towards a constructivist design model, *Educational Technology*, 34(4), 34-37.

Jonassen, D.H., & Henning, P. (1999). Mental models: Knowledge in the head and knowledge in the world. *Educational Technology*, *39* (3), 37-42.

Kozma, R. B. (1991). Learning with media. *Review of Educational Research,61,* 179–211.

Liaw, S.S., & Huang, H.M. (2000). Enhancing interactivity in Web-based instruction: A review of the literature. *Educational Technology*, 40(3).

McCormack, C., & Jones, D. (1998). *Building a web-based education system*. New York: John Wiley.

Mayer,R.E. (1996). Designing Instruction for Constructivist Learning. *Instructional Design Theories And Models: A New Paradigm of Instructional Theory. Volume II.* Newjersy: Lawrence Erlbaum Associates.

Palmieri, P. (1997). *Technology in education. . . Do we need it?* ARIS Bulletin, 8(2), 1–5.

Richey, R.C. and Klein, J. (2007). *Design and developmental research*. New Jersey: Lawrence.

Shu-Sheng Liaw.(2004). Consideration for Developing Constructivist Web-based Learning. *International Journal of Instructional Media, 31(3).*

Shu-Sheng Liaw and Hsiu-Mei Huang .(2006). *Developing a Collaborative e-Learning System Based on Users' Perceptions.* Computer Supported Cooperative Work in Design III. 10th International Conference, CSCWD 2006; Nanjing, China, May 3-5,Revised Selected Papers.

Vygotsky, L.S. (1978). Mind in Society. Cambrige MA: Harvard University Press.

Wattanachai, Suchat; Samat, Charuni; Chaijaroen, Sumalee; Kanjug, Issara; Kong-im Kittayanee and Insorn, Pornsawan. (2005). *Design and Development of Learning Innovation Enhancing the Learners' Thinking.* Faculty of Education, Khon Kaen University.

Winn, W. and Synder, D. (1996). Cognitive Perspectives in Psychology. *Handbook of Research for Educational Communication and Technology*. In D.H.Jonassend (ed.) New York: Simon & Schuster.