The Effects of Interactive Learning Environment Model to Enhance the Creative Problem Solving Thinking for Computer Education Students

Pornsawan Vongtathum[a*], Sumalee Chaijaroen[b]
[a]*Faculty of Education, Khon Kaen University, Thailand*
[b]*Faculty of Education, Khon Kaen University, Thailand*
*benzkkn@hotmail.com

Abstract: This research aimed to study the effect of the interactive learning environment model to enhance creative problem-solving thinking for computer education students. The Developmental Research Method Type II (Richey and Klein, 2007) was applied in the third phase which involved the procedures for model use, the factors leading to success of the model, and model outcomes. The findings are as follows: 1) For model use, the appropriate number of group members is 3, the time frame for learners to solve the problem base is 2 hours, and the model is based on 4 steps of the innovative approach of Sumalee Chaijaroen (2008). 2) The factor leading to success is the experience and qualifications of those involved in the model design and development. 3) The model outcomes can be illustrated by the impact of the model on learners' learning, i.e., the learners' creative problem solving thinking skill was at a high level ($\overline{X}$ = 15.17, S.D. = 5.19), the learning achievement was at a very high level ($\overline{X}$ = 12.65, S.D. = 3.29), and the attitude of leaners towards learning with the environment model and the web-based instruction was at the highest level ($\overline{X}$ = 13.86, S.D. = 2.00 and $\overline{X}$ = 14.65, S.D. = 4.09).

Keywords: Interactive learning environment, Creative problem solving thinking, Constructivist

1. Introduction

The present world society has continuously changed in many aspects as a result of industrial revolution, technology, and the surrounding. This makes the world situations different from the past century. We are entering the world of the 21st Century which progresses speedily owing to the use of information technology that connects information from all regions of the world together, with a lot of impact on our living. Development of learners in the 21st Century is therefore different from the past centuries due to tremendous changes, especially the system of education that now needs to be reformed. The new contexts of the world have to be taken into account to be in line with the arrival of new situations (Panit, 2012). The world of education has also changed dramatically during the recent past. Education accepted as construction of knowledge, competency, and development of a person's potentiality is where the learners are centered. This means all learners are given a chance to perceive and increase their knowledge and experience, and at the same time their potentiality is as much as possible sharpened with no limits, covering the intellects, ability to perceive and more. Learners are expected to learn without constraints in time and place. The other important point is provision of opportunities for learners to think for problem solving, analyze and synthesize knowledge at all levels (Jitmitraparp, 2012). Therefore, thinking skills should be enhanced for learners of the 21st Century who will be confronted with multiple complex problem bases and the leaping technological growth. Finally, the target of education at present requires learners to be able to creatively solve problems surrounding themselves with efficient use of technology.

The learning environment was the design based on constructivist theoretical. It is the basis for learning to solve problems especially the problem is a complex structure (Ill-Structure). By focusing on

learning from the complex problem. Problems or objectives to learn it's from the attendees themselves and learning is active and focus on the Authentic Situation. (Eargarnna, 2011)

The thinking that covers the necessary process and skills for the 21st Century is the creative problem-solving thinking. The thinking processes that enable the design and development of various new concepts consist of 'Convergent Thinking', which relies on former knowledge and experiences and 'Divergent Thinking', which refers to creative thinking including fluent thinking, initiative thinking, flexible thinking, and elaborate thinking, all of which mutually and appropriately supporting one another before being creatively modified for problem solving (Techakup, 2014). It can be seen that the process of complex problem solving requires advanced thinking, i.e., both convergent thinking and divergent thinking should be applied harmoniously in order to lead to success. Before learners can solve any problem, they would use convergent thinking to construct various concepts. This thinking spreads out aspects; it is free thinking beyond any rules and without logics or principles but would lead to the best answer. They can use divergent thinking, which means analyzing based on logics and principles in order to acquire the best answer. The study by Guilford concludes that there are two major thinking behaviors. One is convergent thinking which is one-way thinking and is a narrow problem solving process. There are few alternatives that lead to the best way to solve the problem which is selected from the environment surrounding that problem. It is referred to as critical thinking which requires a wide range of reasoning. The other major thinking behavior is divergent thinking, which is the brain process enabling thinking in various aspects and various directions in order to find unlimited numbers of answers, leading to new and uncommon idea from the set stimulant. Thinking can be in various directions and relies on imagination, intuition, intention, and is referred to as creative thinking. Thus, for problem solving in the 21st Century, creative thinking and critical thinking are very important. The two thinking processes must harmoniously interrelate, and problem solving will be successful or not depends on the use of these two skills, not only one of the two (Treffinger, 2003).

From the above reasons, the researcher designed and developed the interactive learning environment to enhance creative problem-solving thinking for computer education students. The results of the study on the efficiency of the learning environment model developed in Phase 2 indicated that the learning environment model is efficient. Hence, the researchers used the learning environment model in the study of the creative problem solving thinking of the learners.

2. Research Objectives

1. To study the procedures for model use
2. To study the conditions promoting the success of the model
3. To study the model success from the outcomes of:

3.1 the creative problem-solving thinking process of learners learning with the interactive learning environment model

3.2 the learning outcomes of the learners learning with the interactive learning environment model

3.3 the opinions of learners the learning with the interactive learning environment model

3. Research Delineation

This study was conducted based on the Developmental Research Type II (Richey and Klein, 2007), which focused on the process of design and development of the model. The research was divided into 3 phases: Phase 1 - model development, Phase 2 - model validation, and Phase 3 – model use. The design and development of the interactive learning environment model was in Phase 3, model use, with an aim to study effective utilization of the model. This phase involved the procedures for model use, conditions that promote successful model use, and explanations of successes or failures of model use. The interactive learning environment model which underwent quality assessment in Phase 1 and Phase 2 was used with the target groups to measure the effectiveness in Phase 3. The details of this Phase are as follows:

3.1 Target Groups

The target groups under Phase 3 comprised:

1. Experts

The experts inspecting the quality of the learning environment model consisted of 3 validity experts, 3 instructional design experts who inspected the quality of the model according to the Constructivist, 3 experts inspecting the web-based media quality, and 2 evaluation and assessment expert who evaluated the qualities of research tools.

2. Students

Twenty first year undergraduate computer education students, Faculty of Education, Khon Kaen University who registered for the 2nd group of the course 237111 Computer for Education during the first semester of academic year 2014.

3.2 Research Design

The survey research design was used in the study of model use and conditions promoting model use. The pre-experimental design was used to study the success of model use with one shot case study.

3.3 Research Tools

1. Experimental tool was the learning environment model passing the effectiveness criteria in Phase 1 of the research and testing of validity in Phase 2.

2. Data collecting tools consisted of:

2.1 The interactive learning environment model evaluation forms for experts inspecting qualities in terms of content, web-based media, learning environment model, and evaluation.

2.2 The test of creative problem solving thinking which was developed according to the framework of Donald J. Treffinger (2000). The test comprised 3 main components: 1) understanding the problem, 2) forming concept, and 3) planning.

2.3 The achievement test was a subjective test with scoring guideline for each test item by setting rubric for holistic scoring.

2.4 A survey form for learners' attitudes towards the interactive learning environment model. This consisted of open-ended questions including 3 aspects, namely, the content, the web-based learning, and the design that enhanced creative problem-solving thinking. Space was given for respondents to add reasons, additional opinions and other suggestions.   5) The model use record form for making remarks on the use of the model. The form was adapted from the use of innovation approach by Sumalee Chaijaroen (2008), i.e., introduction to the lesson, grouping of learners, learning with innovation, and cooperating in conclusion making.

4. Data Collection

1. The experts in instructional design checked the qualities and internal validity of the various components of the interactive learning environment model and adjusted it according to their suggestions.

2. The interactive learning environment model was used in instruction, following these procedures:

2.1 Explaining the students on the methods of learning with the interactive learning environment model.

2.2 Introducing to the lesson by linking the students' schema with the content to learn, i.e., Algorithm Design

2.3 Dividing the students into 7 groups of 3

2.4 The students learning with the interactive learning environment model on Algorithm Design – by having them study the problem base and find a means to obtain the answer from the different components of the model such as the resource center, the related- case center, the coaching center, and using different tools at the mind tool center in order to find the answer. While they were learning, learners cooperated to find the answer and discussed together to draw conclusion. The researcher coached and encouraged learners to think for the solution and assisted those who needed help. The instruction using the model was performed 3 hours each for a total of 4 times.

2.5 The researcher and the students made a conclusion of the lesson at the end of each period.

3. After learning with the model, the students did the achievement test, the test of creative problem-solving thinking and the survey of attitudes after learning.

4. The characteristics of individuals involved in the design and development of the model were studied: the designer, the developer, the students, and the teacher. Those involved in the design and development completed the survey form for the designer, the developer, the students, and the teacher, respectively.

5. Data Analyses

Data analyses were performed both quantitatively and qualitatively:

      1. The recorded data of model use was based on analytical description and interpretation.

      2. The attitudes of learners on the interactive model collected from the open-ended survey questions were concluded and interpreted.

      3. Learners' creative problem-solving thinking from the test was analyzed using descriptive statistics including percentages, means, and standard deviations.

      4. Learners' learning achievements from the achievement test were also analyzed using descriptive statistics including percentages, means, and standard deviations.

      5. The characteristics of individuals involved in the design and development of the model were studied: the designer, the developer, the students, and the teacher, were analyzed through conclusion and interpretation from the characteristics survey.

6. Results of Research Implementation

The results of the study are as follows:

6.1 The model use procedure:
(1) The scope of data – it was found from model use in Phase 1 that the number appropriate for small groups was 3 students per group and the suitable time for problem solving was roughly 2 hours. Nevertheless, at the beginning, learners spent a long time, but it took them less time when they obtained experience in doing it. (2) The resource – it was found that web-based media could assist in the design of the learning environment model such that accessibility to necessary resources was available. This broadened learners' perspectives and support cooperative working online. Web-based media enables development of learning environments to be interesting, motivating learning, and more importantly, it enables interaction with learners. (3) The information infrastructures – the computer used in data collection could accommodate multimedia work effectively, and the internet network allowed learners to learn and interact with the environment model at all time. (4) The product characteristics – the product was obtained from the model developed by the researcher or the interactive web-based learning environment model on the topic of Algorithm Design designed from the components of the learning environment including the problem base, information resources, related case, mental tool center, brainstorming center, thinking skill training, coaching, scaffolding. (5) The use of model based on the innovation use approach of Sumalee Chaijaroen (2008) with 4 steps, namely: (1) Introduction to lesson in order to link former knowledge with new knowledge by stimulating learners to become curious to learn and to find an answer. (2) Grouping learners appropriately into small groups of 3 to learn with the interactive environment learning model – this number is effective for interactive web-based learning and discussion. (3) For the interactive learning environment model, the teacher had to explain the learning objectives and procedures in details since the learners had not learned with the interactive learning environment before. The mission to be completed was composed of many steps, each of which had its own internal solution-finding procedures which were relatively complicated. The teacher needed to start with explanation of the use of different components of the model and demonstration of the use. The learners could then start to learn by studying the situation at the problem base center by reading or looking at motion pictures in order to analyze the assigned mission. The learners entered the center to study and analyze problem-related information by discussing together and finding the answer from different components in the learning environment model such as the information resource center, the related case center, the mental tool center, the brainstorming center, the thinking skill training, the related people center, the coaching and scaffolding centers. Throughout the learning the teacher was providing advices and instruction for problem solving via the expert center. (4) Cooperating to make conclusion of the

knowledge took place after the learners had made conclusion together in their group. Each group presented the concept from their conclusion and exchanged perspectives and viewpoints with other groups. If there was any discrepant understanding, the teacher would give more explanation, resulting in the learners understanding the topic under study better. The teacher needed to cover all relevant items as this would enable the learners to build up comprehensive thinking.

6.2 The factors promoting the success of the model
Depends on many parts. Firstly, the people who design and develop the learning environment model must be well qualified and experienced in instructional design and development, able to link principles and theories to concrete designing. This includes from the start the synthesis of the components, setting the major characteristics of the components, designing of storyboard, and the design of front pages for developers to accurately utilize them. Those involved in the design and development of the model must have knowledge in instructional design with experience in designing and developing innovations computer multimedia, computer graphic, and web-based instruction design. The learners must be able to communicate and use information technology at a good level, e.g., using internet and communicating on web board, e-mail, and facebook. Finally, the teacher must have expertise in the content to teach, be attentive and able to give instruction and advice to learners besides always encouraging learners to learn; hence the teacher also requires information technology skill for the instruction.

6.3 Success of the model
The study on the outcomes of the use of the model shows that:

1. The learners acquired creative problem-solving thinking according to the framework of Treffinger (2003). Their skill in this respect was found at an average ($\overline{X}$) of 15.17, the standard deviation (S.D.) was 5.19, indicating their creative problem-solving thinking at a high level.

2. From the achievement test on Algorithm Design, the learning outcomes of 55 percent of the 20 students learning with the interactive learning environment had shown the scores passing the criterion and higher than 80 percent. Their average score ($\overline{X}$) was 12.65 and the standard deviation (S.D.) was 3.29, which indicated a high level of achievement.

3. The attitudes of the 20 learners towards the learning environment model were surveyed using the survey form on 3 aspects: the learning content, the web-based media, and the learning environment. The results were analyzed based on the basic statistics including the means ($\overline{X}$) and the standard deviations (S.D.). It was found that the students agreed with the content and the learning environment at the highest levels ($\overline{X}$ = 13.86, S.D. = 2.00 and $\overline{X}$ = 14.65, S.D. = 4.09, respectively).

7. Conclusion and Discussion

The design and development of the interactive learning environment to enhance creative problem-solving thinking utilized the Developmental Research Type II (Richey and Klein, 2007). The research was divided into 3 phases: Phase 1 on model development, Phase 2 on model validation, and Phase 3 on model use. This article presents Phase 3 implementation and results of model use. The appropriate number of learners per group was 3 students, the length of time per one period of problem solving was 2 hours plus one more hour for conclusion drawing and knowledge sharing as a whole class. The problem-solving time was rather long because of the concreteness of the content and because the learners had no basis in algorithm thinking before. They needed time for research and study additional information during the problem-solving period. The factors promoting the success of the model depended on the people involved in the design and development of the model. The designer must possess the right qualities and experiences in instructional design and concrete linking of principles and theories to design through synthesizing components, stipulating the important characteristics of the components, designing the storyboard, and designing various front pages for developers to be able to construct the model precisely and completely. The learners must be able to use information technology and communicate well. They must be able to use the internet and network communications such as webboard, e-mail, facebook). The teacher must perform a role to encourage learners to learn continuously and search knowledge all the time, besides having expertise in content

and the use of information technology for instruction. The success of the model, as found from the results of the model use related to learners' creative problem-solving thinking skill based on Donald J. Treffinger, Scott G. Isaksen, and K. Brian Dorval (2005) consisted of 3 major element: 1) understanding of the problem, 2) concept forming, and 3) planning. These were found to be at a high level ($\overline{X}$ = 15.17, S.D. = 5.19) as a result of the learning environment model having the problem base that promoted creative problem-solving in 3 steps according to Donald J. Treffinger, Scott G. Isaksen, and K. Brian Dorval (2005). Moreover, the learning environment was designed with the center for training creative problem-solving thinking skill that allowed the learners to practice using the skill. The training might enable the learners to solve the problem with high effectiveness, and show a very high level of learning achievement ($\overline{X}$ = 12.65, S.D. = 3.29). This resulted from the design for self-learning through group arrangement, with the teacher acting as a coach facilitating and giving instruction when needed. The learners thus had freedom in learning without pressure. In addition, there were components in the learning environment model that supported and assisted when the learners found obstacles such as scaffolding, resource, related case, and stakeholders. The latter was very important in showing the learners to perceive the perspectives of related individuals holistically and covering the problem in all aspects.

8. Recommendations for Further Research

1. A study should be conducted on the design of each component to see how it supports the learners' creative problem-solving thinking process, for example, problem base and design of scaffolding, in order to apply in designing learning innovations that enhance learners' creative problem-solving thinking.

2. A study should be conducted on learners' creative problem-solving thinking process before learning with the interactive learning environment model in order to analyze each learner's potentiality and the results of model use.

3. A comparative study can be performed on the creative problem-solving thinking process between the control group and the experiment group in order to distinguish clearly between the two groups.

Acknowledgements

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