

Full Length Research Paper

Development of learning management model based on constructivist theory and reasoning strategies for enhancing the critical thinking of secondary students

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The objectives of this research were to study issues around the management of science learning, problems that are encountered, and to develop a learning management model to address those problems. The development of that model and the findings of its study were based on Constructivist Theory and literature on reasoning strategies for enhancing critical thinking among secondary school students. In the demonstration project of the developed model, two classes of grade 9 students were selected. One class of 33 students and another of 30 students became the experimental and control groups, for instruction based on the learning management model (experimental), and the traditional approach (control). This research used a Research and Development methodology (R&D), which included three phases for implementation. The research findings found that the teachers who implemented the learning management model assessed its usefulness at a “moderate” level. In addition, they agreed about the need for such a model for enhancing critical thinking at “the highest” level. Evaluation of one of the models found it to be appropriate at “the highest” level and the effectiveness of the model conducted from post-tests of critical thinking ability scores was 76.30/77.47. The effectiveness score conducted from the perspective of academic achievement was 76.30/76.67. The students who participated in the experimental group obtained a higher score on the post-test on critical thinking ability at .05 level of significance. In addition, the experimental-group students obtained a higher level of post-test scores in both critical thinking and academic achievement than the control group at .05 level of significance.

Key words: Learning management model, constructivist theory, reasoning strategies, critical thinking.

INTRODUCTION

Critical thinking is an important feature of the educational development of children that should be developed

continuously at every school level. In addition, it is widely seen as a necessary and important thinking process for

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every student at every age level. It is a cognitive skill that enables people to consider evidence or data that could be applied in various situations. Its importance has been supported by various sets of national criteria for evaluating the educational management of curricula. This can be seen in the separate criteria of the National Education Commission standards of analytical thinking, synthetic thinking, critical thinking, creative thinking, pondering, and vision (Office of National Education Commission, 2000: 1). Ennis (1985: 45-48) has explained critical thinking as a process that requires one to use one's knowledge as well as skill in making decisions in action. It is described as a kind of pondering with reason aimed to help one decide what should be believed or acted upon. It is a cognitive process that entails negotiation with reasons by using the evidence for ascertaining one's opinion in order to reach conclusions (Marzano, 1988: 121-125) as well as changes in one's viewpoint on the basis of evidence. Chantarachit (2013: 21) classifies it as a kind of logical thinking. Watson and Glaser' Critical Thinking Theory (1964: 2) stated that critical thinking consists of one's attitude, knowledge, and skill in different issues. They described five aspects of critical thinking ability: ability to conclude, awareness of basic assumptions, deduction, interpretation, and evaluation of premises premise or negotiation.

A review of the literature provided this researcher with perspectives and guidelines for presenting an approach for implementing a learning management model for enhancing critical thinking skills. The theoretical basis for this work includes Constructivist Theory, a process in which students construct knowledge by associating their experience or what they had seen in a new environment or via information technology, with their prior knowledge in order to construct their own understanding. This resulting understanding is called a cognitive structure (Piaget, 1985, cited in Parke and Gauvain 2009: 274-275), which can also be seen in Vygotsky's intellectual approach (1978, cited in Cohen et al. 2010: 63). These theoretical approaches have transformed teaching into a method for developing one's thinking via peer collaboration by sharing social interactions in social groups.

Considering the recent instructional situation in Thailand, the Thai educational system has consistently devalued critical thinking ability; most instructional processes in classrooms still emphasized knowledge to be fed by teachers and maintaining an uncritical deference to authority. The students learn by memorizing rather than thinking or reasoning (Sinlarat, 1992: 23). This criticism is congruent with evaluations by the Office of National Education Standard and Quality Assessment (Public Organization), which found that the students were very weak in analytical thinking, synthetic thinking, creative thinking, pondering, and vision, evaluated at the lowest "to be improved" standard. In conclusion, the students had very little ability in analysis, synthesis, critical thinking, or any other measurable form of creative thinking (Bureau of Academic Affairs and Educational

Standard, Ministry of Education, 2010:1). Lastly, the author chose to focus this project on science and science teachers to encourage the application of instructional strategies for fostering the student's critical thinking abilities. Since most Thai students at the secondary level indeed have quite low levels of critical thinking, and because these cognitive abilities are so essential in science, the learning strategy in this project was an opportunity to develop effective teaching in science.

According to the above reasons and its clear significance, the researcher developed the proposed model, named the Learning Management Model Based on Constructivist Theory. It employs reasoning strategies for enhancing the students' critical thinking by integrating it into the learning management process of the science curriculum, and was developed through a Research and Development process.

Research objectives

The following goals were established as the framework for this study:

1. To study the situation and problems in science learning management for enhancing secondary school students' critical thinking;
2. To develop a learning management model based on constructivist theory and reasoning strategies for enhancing students' critical thinking;
3. To study the findings of use in a learning management model based on constructivist theory and reasoning strategies for enhancing students' critical thinking in the following issues;
 - a. The efficiency of in learning management model based on constructivist theory, and reasoning strategies for enhancing the students' critical thinking.
 - b. The comparison of students' critical thinking between pre-test and post-test by a learning management model for enhancing students' critical thinking.
 - c. The comparison of students' critical thinking between the experimental group who were taught via a learning management model based on constructivist theory and reasoning strategies, and the control group who were taught via a general method.

To study the impacts of the implementation of this Learning Management Model looking specifically at the following issues:

1. The effectiveness of the proposed Learning Management Model.
2. Comparison of pre-test and post-test scores of sampled students taking critical thinking tests after instruction in the proposed learning model.
3. Comparison of results between the experimental group and the control group in the acquisition of critical thinking

skills.

RESEARCH METHODOLOGY

This project consisted of three phases:

Phase 1 consisted of a survey of the literature, a study of the current situation, an analysis of the existing problems, and creating a statement of the need for an instructional model that will enhance the critical thinking abilities of secondary schools.

A population consisting of 70 secondary school science teachers and their students were selected to participate. In all, 3,010 students in grade 9 took part, during the second semester of the 2013 academic year. All of the schools were under the jurisdiction of the Office of Secondary Educational Service Area 24.

The samples were 35 Secondary School science teachers, selected by Simple Random Sampling, and the 105 grade 9 students of these teachers. The study took place during the second semester of 2013 academic year.

The research instruments were a questionnaire sent to the teachers and students, and semi-structured interviews with participating teachers and students.

Phase 2 is further divided into four steps,

1. The tentative curriculum was designed using the conceptual framework derived from the analysis of the situation, problems, and expressed needs of teachers. It was a theoretical synthesis of Constructivist Theory and the reasoning strategies model of Joyce, Weil and Calhoun (2004:85-101).
2. The tentative model was examined by seven experts taking part in a focus group discussion, from which the implemented instructional model was refined.
3. The final draft of the instructional model was further examined for its quality and propriety.
4. The instructional model was then tried out in a pilot study with 44 students in grade 9, during the second semester of 2013 academic year. Instruction took place over twelve weeks for two hours/week, totaling 24 hours of instruction.

Phase 3 looked at the findings from the usage of the instructional model. A comparison of student performance between the pre-test and post-test for their critical thinking skills was measured. Furthermore, scores for control and experimental groups were compared.

The total population of the sample was 255 grade 9 students. Of this total population, two classrooms were selected as the sample to take part in the instructional model during the first semester of the 2014 academic year. They were assigned into an experimental group of one classroom consisting of 33 students who received the instruction from the developed model, and a control group of one classroom consisting of 30 students who received customary instruction. They were selected by Cluster Random Sampling and the study followed Randomized Control Group Design (Taweerat, 1997: 40). The research instruments consisted of the model syllabus, a test of critical thinking skills, and a learning achievement test.

Data analysis

The researcher analyzed data by calculating the mean, percentage, and standard deviation. The effectiveness E1/E2 test was applied, and a comparison was calculated between pre-test and post-test by using t-tests for dependent samples (Srisaad, 2010:137), and Hotelling's T2 test for independent samples (Boonreungrat, 1997: 153).

RESEARCH FINDINGS

During Phase 1, it was found that the teachers provided information about the need for critical thinking education, and offered suggestions for the design of a Learning Management Model. They rated the current skill level at a "Moderate" level, and the need for this Learning Management Model at "the Highest" level.

Phase 2 produced an instructional model which consisted of the following components: 1) the basic rationale, approach, and theory; 2) the instructional objectives and learner outcomes of the model; 3) the steps of implementing instruction according to the developed model. This last component had five aspects: motivation, creation of understanding in various incidents or situations, associating the basic experience with previous understanding, considering and accepting the consensus through reference and negotiation, and the evaluation and assessment of performance practice, 4) the social system, 5) the principle of response, and 6) the support system.

Phase 3: findings from the implementation of the instructional model were as follows:

The Effectiveness of the model can be seen in Figure 1. According to Figure 1, it was found that the effectiveness of the learning management model was calculated by the Process Effectiveness formula, resulting in a score of 206 with an average of 157.15, and a percentage of 76.30%. The post-test critical thinking test score was 60 with an average of 46.48, resulted in an effectiveness score of 76.30/77.47. Furthermore, the effectiveness of the model, as calculated by the learning achievement test, was 76.30/76.67.

The comparison of critical thinking scores between pre-test and post-test

As can be seen in Table 1 and Figure 2, the students taught by the instructional model had average scores on the test in critical thinking (maximum score was 60) of 27.26, and the average post-test score was 46.48. This difference was at the .05 level of significant.

Comparison of the experimental group and the control group

According to Table 2 and Figure 3, the experimental group had a higher mean score on the post-test than the control group at .05 level of significance.

DISCUSSIONS OF RESEARCH FINDINGS

Since science is a critical a subject that requires experimentation and practice, it is also a subject most in need of adding the methodologies of critical thinking.

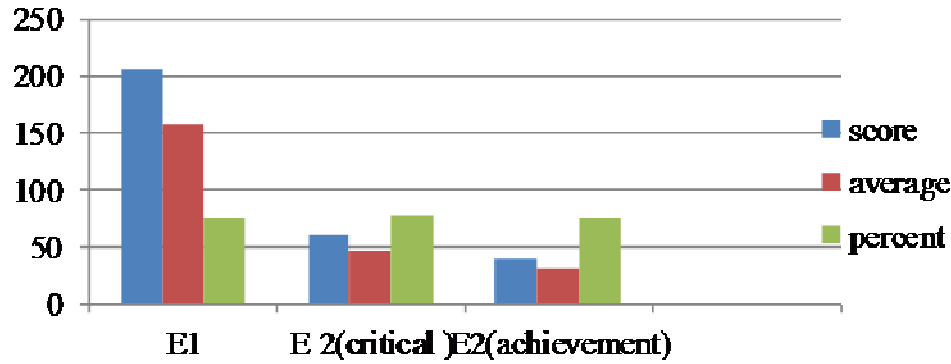


Figure 1. The Effectiveness of the instructional model as calculated by a comparison of pre-test and post-test scores and the achievement test.

Table 1. Means and standard deviations in pre-tests and post- tests.

Test score	Score	\bar{X}	S.D.	t	p
Pre-test	60	27.26	4.66	29.536*	.000
Post-test	60	46.48	4.48		

*at the .05 level of significance.

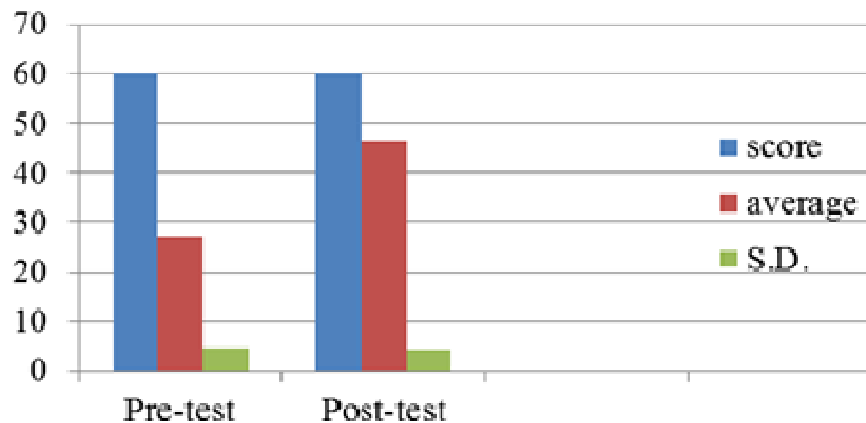


Figure 2. Comparative findings of pre-test and post-test scores in critical thinking.

Table 2. Means and standard deviations between the experimental group and control group

Post-test score	n	Score	\bar{X}	S.D.	t	p
Experimental group.	33	60	46.48	4.84	9.418*	.000
Control group.	30	60	34.43	5.32		

* at the .05 level of significance

Despite this, a seriously large number of teachers still teach using a teacher-centered method based on lectures and requiring their students to memorize rather than to learn the material through problem solving or

empowering them to seek out knowledge by themselves. The findings in Phase 1 found that the sampled science teachers identified this problem at the “Highest” level (\bar{x} = 4.58, S.D = 0.16) They also expressed that most of the

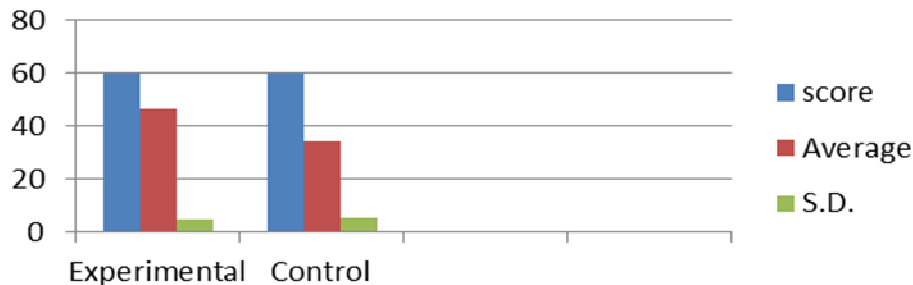


Figure 3. Comparative findings between the experimental group and the control group.

teachers didn't have sufficient knowledge to provide different ways to teach their subjects. As a result, they wanted the training for enhancing critical thinking among their students through the science curriculum so that their students could practice and apply these skills and use their reason from former experience in problem solving.

Interviews with science teachers and their students found that in science classes, most learning occurs in structured learning activities, experimentation, group presentations, and individual presentations based on guidelines of the Institute for the Promotion of Teaching Science and Technology (IPST, 2003:41). In this approach, all learning is controlled by teachers through lecturing. The students answered questions on worksheets or knowledge sheets and they are not expected to use any other kinds of knowledge. The teachers concluded from these guidelines that knowledge can only be learned by students taking notes. The teaching could only focus on content because it had to be used for competitive testing as well as national testing. The students reported that sometimes experimentation activities couldn't be concluded on time. As a result, they often didn't pay attention to participate in these activities. In measurement and evaluation activities, the students didn't like to do work by themselves, and instead copied from their friends. Their reasons were that they were never taught how to think through the activity and thus could not do it. Most of teachers said that it was necessary to train students in the critical thinking process since it would help their students to think on their own by considering or pondering different situations through their prior experience, comparing good and weak points before making decisions, and selecting from reliable supportive reasons, and using their former experiences to be able to use the applied knowledge in their daily life

Phase 2 was investigated, based on the work of Joyce et al. (2004: 85-101) including: 1) basic theoretical approach, 2) objective, 3) steps for learning management, 4) social system, 5) principle of response, and 6) support system. In addition, the researcher had added five of learning management as follows:

a) Motivation, providing activities to stimulate the students' interest to be curious based on problem situations in the

lesson, to analyze the major material and factors in the situation by discussion and asking.

b) Comprehension: creating steps to help comprehension in the given incident and by association from basic experiences, providing a situation to be faced by students in order to develop their understanding and explanation for the factors as well as conditions by analysis associating it with prior knowledge and experience. Then, using conjecture, try to answer the problem, specify their understanding with reasons and which aspects of prior knowledge was reliable.

c) Hypothesis: outline the steps for examining the possible alternatives and searching for the answers by presenting the alternatives believed to be reliable and correct, and analyze these alternatives in searching of correct answers.

d) Pondering: by consensus through inference and negotiation, present and explain the issues of supportive and negotiated issues, and make decisions to either accept or reject a hypothesis.

e) Evaluation: judge the value or evaluate the practice performance, ascertain and support the conclusion and apply it in other situations.

In Phase 2, the focus group evaluation of the model found that there were 10 items of the assessment in their evaluation by using statistics value, the mean (4.61), and the Standard Deviation (S.D.) = 0.11. Every issue was appropriated in "the Highest" level.

Phase 3 found that the overall effectiveness of the Learning Management Model (E1/ E2) was 76.30/77.47. In addition, the effectiveness as calculated from the Learning Achievement Test was 76.30/76.67, meaning that the Process Effectiveness (E1) obtained from percentage of average value of the Learning Behavioral Evaluation, activity participation, and quiz after finishing the study in all three units, was 76.30. The Output Effectiveness (E2) obtained by percentage of the average scores from the critical thinking ability test after instruction was 77.47. Moreover, the Output Effectiveness (E2) obtained by percentage of average scores from the Learning Achievement Test after studying was 76.67. These results were supported by Jeremiah (2013: 171-A), who found that the most successful critical thinking

was to pay continuous attention to the teachers, and the most successful teaching was performed by assigning challenging work tasks, and providing advice in the form of guidelines for problem solving. Furthermore, these results were also supported by Steffen (2012:194-A), who found that critical thinking in the classroom needs to be persuasive and challenging for students' learning. The creation of a conducive environment would develop one's critical thinking as well as thinking ability. It is thus necessary for the school to add more content and teaching processes in critical thinking skills in the curriculum and lesson plans.

Students who were taught by the critical thinking model received post-test scores in the test of critical thinking ability that were significantly higher than the pre-test scores at a .05 level of significance. The pre-test mean score was 27.26, while the post-test mean score was 46.48 points. The instruction that these students experienced focused on five steps of critical thinking as informed by the above theoretical framework. This apparently had an effect on the development of the critical thinking skills of the participating students. These five steps included interpreting a situation, explanation and reference, considering and pondering the reliability of information, conjecture and analysis of negotiation, and evaluating alternatives of decision making and opinion. Key in the model's instruction was to promote the ability to consider, to judge, and to conclude based on available information. This teaching approach was supported by Thurman (2009:118-A), who integrated critical thinking into an English language learning curriculum. According to multiple research findings, the teaching strategy for critical thinking could affect one's learning in other areas. It was able to help to develop the students' thinking, and enhance the teaching process as well as giving the students more self-confidence in their own thoughts which would bring one's learning to a higher level.

The comparison of test results between the experimental group and the control group found that the experimental group obtained higher scores in the test of critical thinking ability than the control group at a level of significance of .05. The average score of the experimental group was 46.48 and the control group was 34.43. Furthermore, the experimental group's post-test learning achievement was higher than the control group's at a .05 level of significance. The experimental group's average score was 30.67, while the control group's average score was 27.50. These results were supported by Burn (2010: 183-A), who conducted similar research at the primary level

Nevertheless, positive results of this research bring up some serious questions about the methodology. In this research, providing groups of students in the experimental class and subject contents used for this research may lead to inappropriate practices. For example, a group of students that was randomly assigned might already prefer learning with problem-solving and critical thinking.

The subject matter used in this model already uses a learning process that is intended to encourage the students to thinking critically. Thus, the subject matter itself can affect the results.

Conclusion

This study outlined an approach to teaching critical thinking. The objectives of this research were to enhance the critical thinking skills of secondary school students and to develop a learning management model that focuses on science content at the secondary school level. The findings of this study indicate that the learning management model that was constructed by the researcher was able to develop critical thinking abilities in the participating students. The success of this model was explained by its use of five steps for learning management that were synthesized from a variety of theoretical approaches and related literature in educational management. The teachers who participated were able to adapt the model to science content in other levels by focusing on the questions stimulating the students to think. Learning management emphasized participatory discussion and sharing of opinions, group working skills, choosing roles as leader or follower, critiquing, expression with logical opinion, listening to others' opinion and having the courage to express one's own opinion. Finally, we hope this research can point the way to future research in other subject content areas.

Conflict of Interests

The authors have not declared any conflict of interests.

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