Effects of the Creative Problem Solving (CPS) Learning Model on Matter and Properties of Matter for Seventh Grade Students

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Abstract

The purpose of this study was to study the effects of the Creative Problem Solving (CPS) Learning Model on the students' learning achievement, scientific creativity skill, and scientific attitudes. The CPS learning model was developed based on the creative problem solving approach and five essential features of inquiry. The key strategy of the CPS learning model is depending on real life problem situations to provide students with opportunities to practice creative and logical thinking through five learning steps: engaging, problem exploring, solutions creating, plan executing, and concepts examining. The design of this study was pretest-posttest control-group design. The findings indicated that 1) the students who learned through the CPS learning model had the overall mean scores in learning achievement, scientific creativity skill and scientific attitudes higher than those who learned with the conventional learning model. 2) Thoroughly, the result showed that the learning achievement test mean scores in "recall and reproduction" level were not significantly different. Also, the mean scores of scientific attitudes in aspects of "scientific knowledge" and "functions of science" of the students who learned through CPS learning model and the students who learned with the conventional learning model were not significantly different. The research findings revealed that the CPS learning model was effective and could be used in the science classroom.

Key Words: Creative Problem Solving Approach, Five essential features of inquiry, The CPS Learning Model

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Introduction

Over a past decade of the education reform in Thailand, the result is still unsatisfied. The Office for National Education Standards and Quality Assessment (Public Organization) indicated that Thai education has limitations and problems about instructional strategies. The major problems consist of (1) insufficient basic concept in science, (2) lack of thinking skills especially creative thinking skill and problem solving skill (Katesing, 2005, Klainin, 2006, NIETS, 2008, IPST,2009). As aforementioned, many science educators mentioned that there are the problems of teaching and learning process (Hitt, & Townsend, 2004, Jeon, Huffman & Noh, 2005, Klainin, 2006). Therefore, the teaching and learning process must more concerning in deepen understanding in science concepts as well as enhancing students' higher order thinking skills.

Many factors could contribute to students' thinking, and learning achievement. Schwab (1996) argued that the deepened understandings in knowledge of learners will occur when it is students' own idea. National Reseach Counsil (2000) indicated that students' deepen conception understanding in science could promote by emphasizing questions, evidence, and explanations within a learning context. Several studies (Hammett, 2005, Dobbs, 2008) reported that students' deeper understanding of science concepts was promoted by using five essential features of inquiry where consisting of (1) learners are engaged by scientifically oriented questions, (2) learners give priority to evidence, (3) learners formulate explanations from evidence to address scientifically oriented questions, (4) learners evaluate their explanations in light of alternative explanations, and (5) learners communicate and justify their proposed explanations, in learning science (National Research Council, 2000).

Structure of scientific creativity has been defined by Hu & Adey (2002) as remarked that scientific creativity is concerned with creative science experiments, creative scientific problem finding and solving, and creative science activity. The creative problem solving approach is one of several attempts to support creative and problem solving thinking work together. Creative and critical thinking are two complementary, mutually important ways of creative problem solving process (Treffinger & Isaksen, 2005). Therefore, the creative problem solving approach should be adopted as an instructional strategy to assist students in their thinking development, especially creative and problem solving thinking. Many researches showed that creative problem solving approach is the suitable approach for adaptation into science instructional strategies to enhance thinking skills especially problem solving skill and creative thinking skill (Wood, 2006, Cheng, Liu & Chang, 2007).

With aforementioned, the researcher attempts to improve the science teaching and learning for enhancing the students' learning achievement and thinking skills. In this study, new science learning model using creative problem solving approach and the five essential features of the classroom inquiry was developed for raising students' scientific creativity, and learning achievement. This model is called, for convenience, the Creative Problem Solving Learning Model (CPS learning model). It consists of 5 steps: engaging, problem exploring, solutions creating, plan executing, and concepts examining. This learning model emphasizes not only practicing the problem solving skills underlining the creative problem solving approach but also giving precedence the students to construct scientific knowledge by themselves following five 4 essential features of inquiry. The learning activities of CPS learning

model focus on solving the problems in real life. Students also have opportunities to think and share their ideas with other in order to improve their creative thinking skills. The model is designed to support the national science standards of Thailand that appropriate for seventh grade students. The contents of this study are focused on matter and properties of matter. The CPS learning model emphasized on students practicing to think, and apply knowledge and skills into their real life outside the classroom. In other words, this invention concerning practices students creative thinking skills and problem solving skill emphasizing scientific creativity skill as well as develop deep understand in scientific conception and reinforce scientific attitudes in harmony.

Research Purpose

The purpose of this research was to study effects of the CPS learning model on students' learning achievement, scientific creativity skill and scientific attitudes.

Methodology

Research Design

The design of this study was pretest-posttest control-group design. In this design, the experimental group has learned with the CPS learning model while they studied in the classroom and the control group did not receive the treatment while they studied in the classroom.

Participants

The participants consisted of two classrooms of seventh grade students who studying in the second semester of the 2010 academic year. One classroom was the control group (48 students) and another one was the experimental group (46 students).

Variables

1. Independent Variable was the science learning models which categorized into 2 models: the CPS learning model and the conventional learning model which is a usual learning model used in the classroom.

2. Dependent Variables consisted of learning achievement, scientific creativity skill, and scientific attitudes.

Research Instruments

1. There fifteen lesson plans based on the CPS learning model were developed by the researcher. The content of the study was matter and properties of matter which consisted of three units: Matter, Solution, and Acid-Base. The structure of creative problem solving approach and five essential features of inquiry that were incorporated in the CPS learning model is shown in figure 1. These figure point out in to every step of CPS learning model emphasizes students thinking creatively and logically through the problem solving process. In addition, the CPS learning model encourages students to do the activity that matches the five essential features of inquiry. The activities based CPS learning model is focusing on real life problem situations to provide students with opportunities to practice creative and logical thinking through five learning steps: engaging, problem exploring, solutions creating, plan executing, and concepts examining like in Figure 2.

2. Achievement Test was developed by the researcher. The learning achievement test was classified to four levels following the Depth of Knowledge (DOK) (Webb, 1999) which consisted of level 1: recall and reproduction, level 2: skills and concepts, level 3: strategic thinking, and level 4: extended thinking. This instrument consisted of

two sections: twenty five multiple-choice questions, each of which has four alternatives and one correct answer and five opened questions. The difficulty (p) and item discrimination (r) of items were between 0.20-0.80 and the internal consistency reliability of multiple choices and open-ended question was 0.79 and 0.94, respectively.

3. Scientific Creativity Test was adapted from A Scientific Creativity Structure Model: SCSM (Hu & Adey, 2002). This test consists of the four items in written open-ended format which allow the students express their own ideas in writing the answer. This test focuses on the students' traits that consist of 1) fluency, 2) flexibility, and 3) originality. The reliability coefficient of this test was 0.56.

4. Scientific Attitudes Inventory (SAI: II). The SAI II has 40 five-response Likert-type scale attitude statements to assess the students' scientific attitude (Moore & Foy, 1997). This inventory assesses the scientific attitudes with six statements which consist of S1: Scientific knowledge, S2: Almighty of science and scientists, S3: Scientific methodology, S4: Functions of science, S5: Science liberal education, S6: Science interests and science careers. This inventory administered to the students was present in Thai version by Punyain(2008). The reliability coefficient for SAI II for Thai was 0.81.

Data Collection and Analysis

The fifteen lesson plans based the CPS learning model were implemented with the seventh grade students in the experimental group for twenty seven periods (50 minutes per period) while the control group was taught by the conventional learning model. In the data collection, students in both groups took a pretest and posttest of learning achievement test, scientific creativity test, and scientific attitudes inventory.

In the analysis, the mean, and standard deviation were statistic used to analyze data. Moreover, the Analysis of Covariance (ANCOVA) was selected to analyze the difference between the experimental group and control group because of the pretest scores of both groups were non-equivalent.

Results

The ANCOVA results of the students' mean scores of learning achievement, scientific creativity, and scientific attitudes were showed in Table 1. The results indicated that as the follows:

1. Learning achievement

The overall mean scores of learning achievement between the experimental group and control group were significantly different at the .05 level. Considerably in each level of learning achievement, the results indicated that in the level of "recall and reproduction" the students in the experimental group and control group were not significantly different at the .05 level. However, the level of "skills and concepts", "strategic thinking", and "extended thinking", the result indicated that the students in the experimental group were higher scores than the students in the control group. This finding showed that this model not only affected the students' basic knowledge (recall and reproduction) like a conventional learning model but also supported degree the complexity knowledge (skills and concepts, strategic thinking, and extended thinking). In other words, the CPS learning model can enhance the students' deepen understanding in scientific concepts better than the conventional learning model.

2. Scientific creativity skill

The mean scores in overall and all aspects of scientific creativity between the students in the experimental group and control group showed that they were significantly different at

the .05 level. This indicates that students who had learned through the CPS learning model gained higher posttest scientific creativity scores than the student who had learned with the conventional learning model. In other words, the CPS learning model had a competence to enhance the students' scientific creativity skill.

3. Scientific attitudes

The students' scientific attitudes mean scores in overall between the students in the experimental group and the control group indicated that they were significantly different at the .05 level. Considerably in each statement of scientific attitudes, the results indicates that in the aspects of "scientific knowledge" and "functions of science" of the students in the experimental group and the students in the control group were not significantly different at the .05 level. Whereas, the results of students' scientific attitudes mean scores in aspects of "almighty of science and scientists", "scientific methodology", "science liberal education", and "science interests and science careers" between the students in the experimental group and the students in the control group were significantly different at the .05 level. In other words, the CPS learning model had a competence to enhance the students' scientific attitudes.

Conclusions

The finding confirmed that the CPS learning model was effective and could be used in the science classroom because it can gain students a deepened understanding of scientific concepts as well as creative thinking and also more positive scientific attitudes.

Discussions

1. Learning achievement

Considering learning achievement, the mean scores in overall of learning achievement of the students who had learned with the CPS learning model were significantly higher than the students who had learned with the conventional learning model. The result is similarly to the findings of Myrmel (2003, 25-26) and Wood (2006, 21-32) which stated that creative problem solving approach was the methodology to develop and produce materials for teaching and learning which take problem solving well above the level of algorithmic manipulation and into the realm of creativity. Moreover, it can be feasible useful in the classroom that can promote the students' cognitive learning outcome and also creative thinking and problem solving skill. Moreover, this supports Dobbs (2008) that integrated the inquiry approach with problem-based learning concerning in chemistry. In this study found that this instruction can improve students' achievement in high school chemistry to a greater degree than conventional teaching methods. In addition, using this instructional the students can understand the deep scientific concept and apply the concept to solve problem solving.

As seen from the research results, both the experimental group and control group were not different in their basic intellectual skill, namely, "recall and reproduction" level. On the contrary, both groups of students were significantly different in their higher intellectual skills that were "skill and concepts", "strategic thinking", and "extended thinking". Thus, this result is in consistent with numerous researches in which indicate problems in Thailand's science education that has been unsuccessful in promoting higher order thinking, especially for creative thinking skill and problem solving skill

(Katesing, 2005, Klainin, 2006, NIETS, 2008, IPST, 2009).

Also, this result confirmed the strength of the CPS learning model that is more effective than the conventional learning model in terms of promoting higher order intellectual learning skills and learning achievement.

2. Scientific creativity skill

Considering scientific creativity skill, the mean scores in overall and all aspects of scientific creativity skill of the students who had learned with the CPS learning model were significantly higher than the students who had learned with the conventional learning model. Loehle (1990, 242) proposed that many instructional strategies can definitely promote creativity to the students. Particularly, in science subjects, creativity is important and is necessary to teach. In the same way, activities in science subjects can support students' creativity more than other subjects (Torrance, 1987, Park & Seung, 2008, 45). Regarding the learning activities based the CPS learning model, the researcher created lesson plans by using various types of instructional strategies under the five essential features of inquiry and creative problem solving approach, emphasized group discussion for sharing and generating the novel things. Consequently, the students who had learned with the CPS learning model can improve their students' scientific creativity skill. This result agreed with the previous study indicating that the scientific intervention programme, Cognitive Acceleration through Science Education (CASE), focused on the problem solving approach can promote the overall development of scientific creativity of secondary school students (Chongde, Weiping, Philip & Jiliang 2003, 143-162).

3. Scientific attitudes

Considering scientific attitudes, the mean scores in overall of scientific attitudes of the students who had learned with the CPS learning model were significantly higher than the students who had learned with the conventional learning model. The result supported the article of Adesoji (2008, 21-24) that claimed the students who had learned with the problem solving instructional strategy developed more positive scientific attitudes after treatment. Furthermore, Almaarify (2007) stated that the inquiry approach can be promote the students' scientific attitudes. However, respecting in each statement of scientific attitudes found that the mean scores of scientific knowledge and functions of science of the students who had learned through the CPS learning model were not significantly different with the students who had learned through the conventional learning model. For aspect of scientific knowledge which state to scientific theories are subject to change and aspects of and functions of science which state to science is an idea-generating activity can refer to nature of science. There was a research indicated that one half of high school students hold misconceptions of the nature of science. They also hold the view that scientific theory is reality that was discovered by scientists instead of being invented (Ryan & Aikenhead, 1992). In order to achieve the nature of science, curricula and instructions must explicitly address nature of science. Nevertheless, in this study the learning activities based the CPS learning model still weak to concentrate on the nature of science. The activities were not providing students focusing on view of science information and methods as it is changeable. As a result, the students' inadequate understanding in nature of science cause the mean scores of both statements between the students who

had learned through the CPS learning model and students who had learned with the conventional learning model was not difference.

Consequently, considering the learning outcomes, they confirm that the CPS learning model is suitable model to teach students in science classroom because this learning model provided them with opportunity gained more deepen understanding in scientific concepts as well as enhanced creative thinking and problem solving skills including promoted scientific attitudes. Therefore, the learning activities of the CPS learning model are good activities for the science classroom.

The results of this study revealed that the CPS learning model was effective as a means to develop science learning achievement, scientific creativity skills and scientific attitude of students. Additionally, its findings revealed that the CPS learning model was effective and could be used in the classroom. These outcomes will be used as basic knowledge for educators and science teachers for developing the instructional strategies. Moreover, the CPS learning model will be an alternative pedagogy for science teachers to promote students gain deepened knowledge, develop scientific creativity skill, and foster the scientific attitudes. This will prepare the students get more readiness to confront the social change and get higher quality of life in community.

Recommendations

1. Recommendations for teachers

1) For application of this learning model to be the most successful, the students should have teachers to facilitate them most of the time. The teachers have to set up and check some equipment for laboratory experiment before the class, and also to prepare extra and unexpected instruments just in case students ask for. Moreover, the teachers should have enough time for students even outside class time.

2) Science teacher who adapts the CPS learning model with other contents should use other instructional techniques such as cooperative learning, lecture, question/answer, multi-media, etc modifying with the CPS learning model. Moreover, the teacher should concern with the difficulty of the content including decide the problem situation that go along with the content, closely with the real life, and could be awoken students get more readiness to learn.

2. Recommendations for further studies

1) Further studies should consider the content change from matter and properties of matter to other contents. Also, further studies should change the content from chemistry to be physics, biology, or any other science areas even if other subjects that have nature of subject different from nature of science.

2) When each step of CPS learning model was considered there were still some problems especially about time allocation. There was the limitation of time in which students wanted to spend more time for discussion and reach to the goal of each step. So, further studies should allocate the time for each step more suitably.

3) Further studies should strongly consider to integrate nature of science in developing learning activities based the CPS learning model. As a result of, the students should understand nature of science belong with scientific concepts that gain more positive scientific attitudes.

Acknowledgement

This research was financially supported by Graduate school of Srinakharinwirot University and the Institute for the Promotion of Teaching Science and Technology (IPST).

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