A Development of Scientific Method by Using Problem-Based Learning Cooperated with Mind Mapping for Matthayomsueksa 4 Students

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Abstract
The purpose of this research was to study the students' ability of using scientific method by using the problem-based learning cooperate with mind mapping method .The samples were 33 Matthayomsueksa 4 students of academic year 2015 from Kalasinpittayasan School, Kalasin province, Thailand. The sample was selected by purposive sampling. The research tools were 10 lesson plans and scientific method testes (subjective of essay test) which measured in five parts including asking a question, formulating a hypothesis, collecting data, analysis data, and making a conclusion. The data was analyzed by using mean, percentage, and standard deviation. The t-test for dependent was employed for testing hypothesis. The research findings found that the students' ability in all parts of using scientific method tend to improving gradually.

Keywords: problem-based learning, mind mapping, scientific method

Introduction

Science makes human life more convenient and simpler. We are woken up by alarm clocks. We drive or ride vehicle to work. These things all are made from science knowledge combined with creative thinking. Science knowledge not only brings us good life but also help us developing countries. Especially, prepare people to be good conductor and good consumer base on science societies (Department of Curriculum and Instruction Development, 2001). It can be clearly seen that education is important to develop human. So, studying activities have to emphasize scientific method (Paitoon Suksri-ngam, 2002).

Thailand is now facing a crisis in education. Many Thai students are not taught to think or learn by using their own knowledge and abilities with full potential. Especially in the science subject, they cannot investigate base on the reasoning. In daily life, they cannot apply their experiences to solve the problem that they face themselves. Moreover, from the Programe for International Student Assessment: PISA 2012, which assesses the students' abilities and skills to apply their knowledge and experience outside the class indicate that the score of Thai students in scientific literacy was 444 from the average 501. It was literacy which consists of 3 parts including reading literacy, mathematical literacy and scientific literacy. The results show that Thailand education system is still not efficiency -Thailand ranking 50 from 63 countries. Thai students do not familiar with the examination. They should be practiced by expository writing, reasoning and using evidence (The institute for the Promotion of Teaching Science and Technology and Ministry of Education, 2014). Ministry of Information and Communication Technology (Thailand) indicated that the one important cause is learning activity which cannot improve student's higher order thinking skills. Moreover, learning activities do not encourage the students to investigate by using scientific method which is a good way to test hypothesis and answer the problem. These problems can be found all size of schools in Thailand.

Scientific inquiry refers to the various ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. In the learning activity by using Problem-based Learning (PBL), it can stimulate the students' curiosity. This method uses the problem situations which associate the student's life to lead the student interested in their lesson. It should be a rather complex in order to lead the students use various way to solve the problem (Montree Wongsaphan, 2013). This method help the learners improve thinking skill and reasoning skill. The learning activity steps consist of 1) problem identification, 2) understanding the problem, 3) data collection, 4) synthesize data, 5) conclusions and evaluations, and 6) present and assessment which compared with scientific method (Office of the Education council, 2008) The learners have more opportunity to investigate from resources that they are interested while the teacher acts as their coach (Tisana Khammani, 2009).

Mind Mapping is the graphical way to represent ideas and concepts by using lines, words, spots and geometric form. It is used drawing information in diagrams, instead of writing in sentences (Tisana Khammani, 2009). It is a visual thinking tool that helps structuring information, helping student to better analyze, comprehend, synthesize, recall and make new ideas. It is also able to raise the students' connection abilities. The students used it to be an important material during learning activities.

Thus the learning activities by using mind mapping will be benefit for student for understanding the problem situations, making a hypothesis, analysis data and making a conclusion. It is easy to show how each concept is connected and related (Suvit & Orathai Moonkhum, 2001).

As aforementioned, that the student's scientific method skill can be developed by using problem-based learning cooperated with mind mapping. The purpose of this research was to develop the students' ability of using scientific method - asking a question, formulating a hypothesis, collecting data, analysis data, and making a conclusion – to pass the criterion 75 percent by using the problem-based learning cooperate with mind mapping method.

Methods

In this study, the independent variable was teaching by using problem-based learning cooperated with mind mapping. The dependent variable was the students' scientific method. The 10 lesson plans were implemented for 5 week with 2 cycles of action research. Each cycle consisted of Plan, Act, Observe, and Reflect phases.

The first cycle starts with "planning phase". The researcher studied the problem of sample from reading the document and making conversation with students and teachers. Then the researcher made research instruments and designed learning activities which were suitable for solving the problem of students' studying. Secondly "acting phase", the students were taught by PBL activities - problem identification, understanding the problem, data collection, synthesize data, conclusions and evaluations, and presentation and assessment. They were required to create a group of four. Each groups got a problem situation, laboratory's direction and experiment materials. Every group had to read a situation then created a problem and formulate a hypothesis from previous knowledge or their prediction. After that, each group planned to study in order to answer the question. During the students were studying, the teacher acted as a facilitator who always observed behavior and gave suggestion. Thirdly, "observing phase", the researcher observed and made note during students' learning time. The teacher checked students' work and access the students individually in order to adjust and improve learning activities for the second cycle. Finally "reflection phase", when the students have studied 5 lesson plans already, the researcher discussed the result and problem with the students in class to develop learning activities in the second cycle.

The second cycle, the researcher had improved and adjusted the lesson plans. The mind mapping was added to use in learning activities. While the students were studying, the mind mapping was used to help students' brainstorming by following the phases of action research in the first cycle.

Participants

The sample was 33 Matthayomsueksa 4 students of academic year 2015 from Kalasinpittayasan School, Kalasin province, Thailand. The sample was selected by purposive sampling.

Instruments

This research was divided in to two cycles. In the first cycle, the instruments were 1) 5 PBL lesson plans, 2) scientific method test **(**subjective of essay test**)** which measured five parts. In the second cycle, the instruments were 1) 5 PBL cooperated with Mind mapping lesson plans, which were improved from the lesson plans in the first cycle 2) scientific method test **(**subjective of essay test**)**.

Results

The t-test statistical method (One Sample t-test) was used to analyze the score of scientific method by comparison with criterion 75 percent. In the first cycle the results are presented in the table 1.

Table 1: the result of each part of the scientific method in the first cycle

parts	full score	criterion 75 percent	score		*t*	p
			$\bar{x}$	percent		
total	30	22.5	18.06	60.20	5.56*	.00
asking question	6	4.5	4.06	67.68	1.88*	.07
formulating a hypothesis	6	4.5	4.24	70.71	1.29*	.03
collecting data	6	4.5	3.46	57.58	3.66*	.00
analysis data	6	4.5	3.12	52.02	4.68*	.00
conclusion	6	4.5	3.18	53.03	6.25*	.00

* $p<.05$

From the table 1, in the first cycle, the total mean score of scientific method was 18.06 or 60.20 percent of full score. The mean score of asking question, formulating a hypothesis, collecting data, analysis data, and conclusion were 4.06, 4.24, 3.46, 3.12 and 3.18 respectively. They were lower than the criterion with statistical significantly ($p<.05$).

In addition, the researcher found that most students made a mistake on asking question. For the example, they cannot define the independent variable which effected to the dependent variable in asking question, their questions did not relate the matter or problem situation. Most students were able to create the good hypothesis but some student made mistake on the matter or problem situation. For instance, some hypothesis did not relate with the question, some hypothesis related with question but also it was not the main purpose of the studying. Moreover, it can be found during learning activities, the students did not familiar with learning activities. Especially at the initial of the first cycle, as a result they take time too long on forming group, doing activity, discussion in a group, and presentation.

In the second cycle, the researcher had added the mind mapping to the student's lesson plans in order to help the student linked each step of learning easier. Furthermore, it could be used to consider and sort the importance of content by the students. The result of each scientific method part shows in the table 2.

Table 2: the result of each part of the scientific method in the second cycle

parts	full score	criterion 75 percent	score		*t*	p
			$\bar{x}$	percent		
total	30	22.5	24.09	80.30	3.51*	.00
asking question	6	4.5	5.39	89.90	6.52*	.00
formulating a hypothesis	6	4.5	4.94	82.32	2.61*	.01
collecting data	6	4.5	3.91	65.15	2.97*	.01
analysis data	6	4.5	4.91	81.82	2.48*	.02
conclusion	6	4.5	4.94	82.32	2.81*	.01

* $p<.05$

From the table 2, it showed that the students' mean score in every part were higher than the first cycle. The total mean score of asking question part, formulating a hypothesis part, analysis data part, and conclusion part were higher than the criterion. The score were 24.09, 5.39, 4.94, 4.91 and 4.94 respectively. Only the mean score of collecting data was lower than the criterion with score 3.91. There were significant differences in all part ($p < .05$).

Discussion and conclusion

In the first cycle, the total mean score was lower than the criterion. The highest mean score was asking question. The second, third, fourth, and fifth were the formulating a hypothesis, conclusion, collecting data, and analysis data respectively. This probably, in the PBL, the students must start studying from the problem situation. After that, they have to investigate in order to find the cause and answer the problem. The process aforementioned helps the students to study systematically (Office of the Education council, 2007). Correspond with studying by using scientific method which study base on deductive and inductive method. Therefore, the basic requirement is competence in logical reasoning and analysis. When the students need to study or solve problem, they have to identify the problem. Then, they have to formulate the hypothesis before collecting data in order to test the hypothesis (Pimpan Dachakupt, 2001). In this study, the PBL supported the students to investigate by using scientific method. They had a chance to learn together within their groups. They exchanged and discussed the data that each student found. It helped students to see several information. During the learning activities, they always had interaction with their friends and a researcher. Although the PBL was an effective way to motivate students to study but in this cycle the students still were not familiar with PBL. It was rather different with traditional learning – the teachers teach front the class and the students write on the notebook. Moreover, the students had not enough background knowledge about the scientific method especially reasoning. They cannot answer the problem correctly. This probably, the students were not able to connect the main topic to detail. The students could not see a relationship between ideas and information. As a result, they spent long time in each step of PBL for exploring the situation and related information to achieve the goal of each step. For instance, they searched the information of the concept in order to define problem and formulate hypothesis of situations. In addition, they took long time to collect data for testing hypothesis.

Consequently, the students had no enough time to practice the scientific method. As a result, the score of scientific method was lower than the criterion.

In the second cycle, the researcher added the mind mapping to the learning activities. The results indicated that the mind mapping was successful to support the PBL to develop the student's scientific method. The total mean score was higher than the criterion with statistical significantly. The score of asking question part, formulating hypothesis part, analysis data part, and conclusion part were also higher than the criterion with statistical significantly ($p < .05$). Only the score of collecting data part was lower than the criterion. As the meaning of collecting data which refer to put the design for collecting information into the operation, the students have to design the process for collecting data by direct observation, experiment, searching or others (Suwat Niyomka, 1988 cite from Maccraken et al, 1976). In addition, the good collecting data process has to set a variable including independent, dependent, and control variable in order to decrease an error from the process. The one of method to enhance the ability of collecting data was always practicing. In this study, the students did not practice experiment sufficiency because the researcher allowed the learners designed their own method to collect dada during PBL activities which most of all student preferred collecting data with the relevant documents. Consequently, they did not design the experiment methods and set the dependent, independent, and control variables. Therefore, the students who selected other methods except do the experiment to be their learning process in PBL activity had a chance to practice the collecting data less than others. As a result, when they did a test, they cannot give the corrected answer. Therefore, they got a low score in the part of collecting data.

As a result, the mind mapping helped the students organizing learning activities. They were able to study with PBL approach more systematically than the first cycle. This includes gathering thoughts, coming up with new ideas, learning planning, and synthesizing knowledge. The students did not take too long time on each step so they had time enough to practice their scientific method with full potential. As process aforementioned, the learners had chances to practice observation and asking question, data collection, synthesis data, and conclusion by using scientific method. It was investigation systematically (Sujin Visawateeranon, 2005). Other that, mind mapping was able to help student to relate each topic. It enhanced students to associate ideas, think creatively, and make connections that might not otherwise make (Tony Buzan, 2010). It can be seen that mean scores of each part have been improved in the second cycle. The problem-based learning can be defined best as the learning that results from the process of working toward the understanding or resolution of a problem (Barrows and Tamblyn, 1980). As students learn to think through the designs and developments of their own inquiry, they also develop a sense of self-responsibility. According to Ornpreeya Promwong (2014) who studied about The Development of Science Learning Achievements and the Ability in Using Scientific Method through the Use of Problem-Based Learning Approach of Matthayomsuksa 3 Students, the result was found that mean post-test of scientific method score of students, who were taught by PBL, was higher than pre-test. Correspond with Jiraporn Tupsai's study (2004) who studied about The Students' Achievement and Retention in Physics on Linear Motion using Concept Mapping , the finding was found that teaching by using concept map supported the students had ability to link and organize the importance of the content learning. The students understood the lesson properly.

In conclusion, the results of the study indicated that scientific method can be developed by using problem-based learning cooperated with mind mapping. Although some part was lower than the criterion, but the total mean score of scientific method was higher than the criterion with statistical significantly (.05). Therefore, the PBL cooperated with mind mapping process was successful in increasing the students' scientific method.

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