A Development Model of Teaching for Mathematical Problem Solving of Prathomsuksa 6 Students*

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Abstract

The objectives of this study were to: 1) develop and evaluate the quality of a teaching model for mathematical problem solving of Prathomsuksa 6 students and 2) study the findings of employment of a teaching model for mathematical problem solving of Prathomsuksa 6. The research method employed Research and Development (R&D). The research procedure comprised 2 steps: step1, the development of a teaching model for mathematical problem solving of Prathomsuksa 6 students. Step 2, the implementation and the findings of a teaching model for mathematical problem solving of Prathomsuksa 6 students. The subjects were 193 Prathomsuksa 6 students using cluster sampling. The research instrument was a learning model using 2×2 factorial research design. If there was a different statistically significance, it would use a Scheffe Analysis.

The results of research were as follows:

1) The development model of teaching for mathematical problem solving of Prathomsuksa 6 students comprised 5 components: conceptual model, objectives, learning outcome expectation, learning and teaching procedures and evaluation. Learning and teaching procedures comprised 5 steps: 1) Understand the problem, 2) Analyze problem solving and synthesis, 3) Take action, 4) Review problem solving process and 5) Apply of life wide learning.

2) The findings of employment of a teaching model for mathematical problem solving of Prathomsuksa 6 students. Students were taught with 2 models: a teaching model for mathematical problem solving and a normal teaching model. Students with different learning abilities had different mathematical problem solving abilities and different scores of the mathematical post-test. The findings found that there was a significant difference between these two groups at the .05 level. The students were taught with the teaching model for mathematical problem solving in gifted classes. The students who were taught with the teaching model for mathematical problem solving in normal classes, their mathematical problem solving abilities and learning achievement of the post-test mean scores were significantly higher than the pre-test mean scores at the significance level of .05.

Keywords: teaching for mathematical problem solving, a teaching model development for mathematical problem solving

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Introduction

Mathematics is the important role to human thinking development. As a result of relating subjects to thinking and the use of human intelligence, it develops human creativity, systematical thinking, thinking the pattern and work planning and helps human enable to analyze problems and situations carefully, expect, plan, make a decision, solve problems and apply them in the daily life correctly and properly. (Ministry of Education, 2008, p. 56; Siriporn Thinking, 1962, p. 151). On the other hand, many students lack knowledge and understanding of mathematical skill and process. They cannot take mathematical knowledge to solve their problems in the daily life. In order to solve those problems, mathematical teaching is importantly focused on critical thinking, analysis thinking, creative thinking and making a decision using successful, intelligent theory and problem-based learning theory to apply for mathematical problem solving a model of students. The situational problem which is related to the daily life and the way of student's life to be the center of learning activity.

The Research Objectives:

1) To develop and evaluate the quality of a teaching model for mathematical problem solving of Prathomsuksa 6 students.

2) To study the result of employment of a teaching model for mathematical problem solving of Prathomsuksa 6 students.

Related Theory:

The researcher synthesized concept through Sternberg's theory, Problem-based learning – PBL and Successful Intelligence theories. The brief content was the learning activity which promoted students develop the ability of analytical thinking, creative thinking and practical thinking (Sternberg, 2007, p.4). In order to cultivate students enable to manage thinking properly, manage the data and relate to other data, plan problem solving with mathematical problem-solving process clearly, and to view planning before problem-solving. Students who are builders of wide knowledge through thinking process and meaningful problem solving to students by using learning context. (Tan, 2007, p. 30-31, Wassana Kimthoeng, 2010, p. 13; Supaporm Jaisuk, 2012, p. 26,37) to encourage and be initial of knowledge seeking. Furthermore, to build analytical thinking and problem-solving skills as well as getting wide knowledge from brainstorming technique and gather problem-solving strategies creatively

and decision making for choosing the best way including investigation and evaluation of problem-solving properly. The possibility and components of creative problem solving became an experience and skills and were able to take these skills and knowledge related to practical thinking ability and other situational problem solving. Research framework is shown in Figure 1

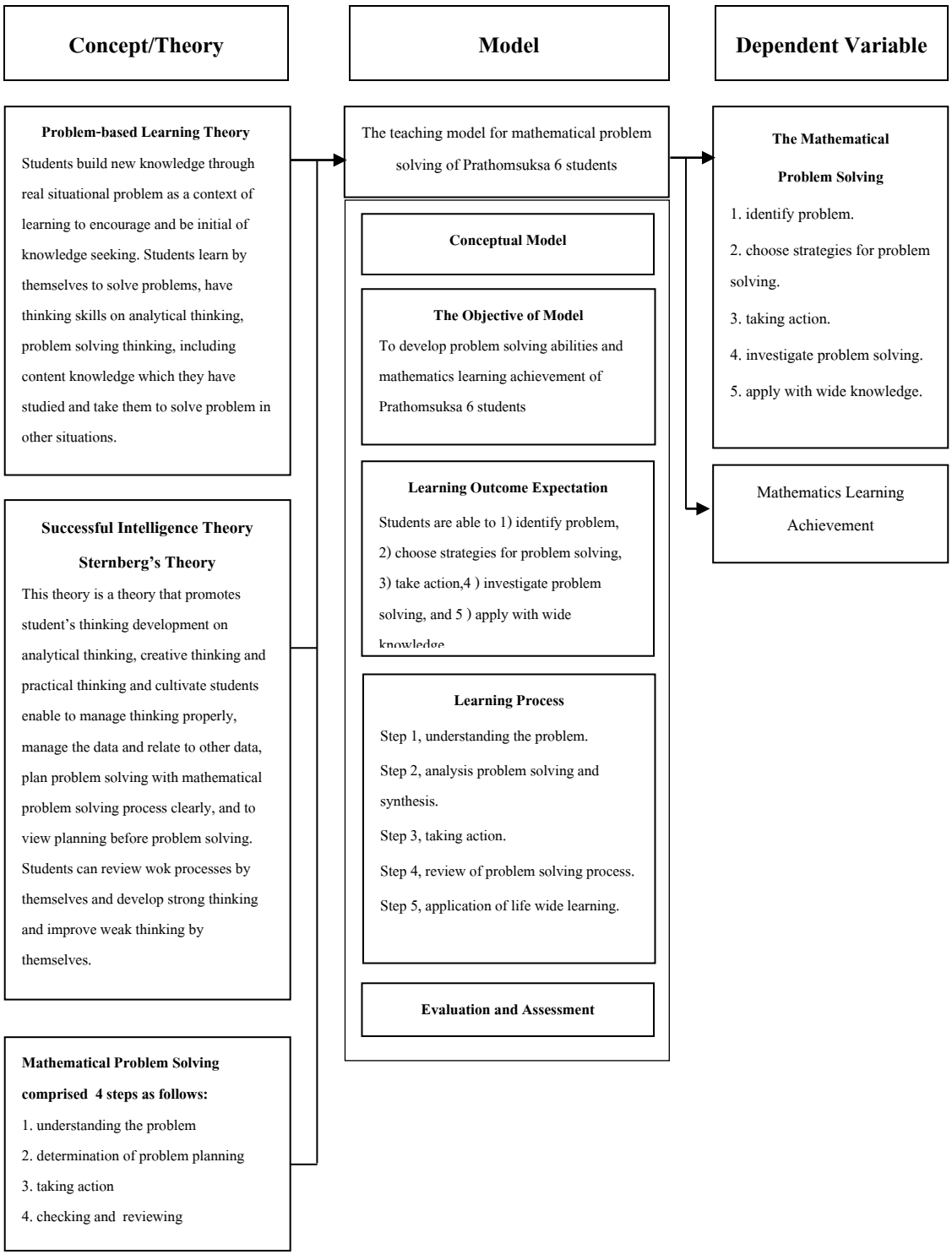

Figure 1: Research Framework

The Research Hypothesis:

1. Students who were taught with a mathematical problem solving the model and a normal model at the different learning abilities. They had different mathematical problem-solving abilities after learning.

2. Students who were taught with a mathematical problem solving the model and a normal model at the different learning abilities. They had different mathematical learning achievement after learning.

3. Students who were taught with a mathematical problem-solving model in gifted classes and students who were taught with a mathematical problem-solving model in normal classes. Their different mathematical problem-solving abilities after learning were higher than before learning.

4. Students who were taught with a mathematical problem-solving model in gifted classes and students who were taught with a mathematical problem-solving model normal classes. Their mathematical learning achievement after learning was higher than before learning.

The Research Questions:

1. What is the component of a teaching model for mathematical problem solving of Prathomsuksa 6 students?

2. What is the content of each component?

3. What is the qualitative level of each component?

4. How does a teaching model for mathematical problem solving of Prathomsuksa 6 students develop student's ability for mathematical problem solving?

The Research Methodology:

The research method employed Research and Development (R&D). The research instrument was the learning model using 2×2 factorial research design. If there was a different statistically significant, it would use a Scheffe Analysis.

The Research Methods as follows:

Population and Samples:

The population was 337 students of Anubanwatnongkhunchat (Uthitpitthayakarn) under Uthai Thani Primary Educational Service Area Office 2, the academic year 2015 comprised 7 classes: 3

gifted classes (class 1-3) and 4 normal classes (class 4-7). Samples were 193 students of Anubanwatnongkhunchat (Uthitpitthayakarn) under Uthai Thani Primary Educational Service Area Office 2, the academic year 2015, comprised 4 classes. Cluster sampling was employed in this research using class drawing lots. It was divided into 1) gifted classes consisted of 50 students of Pratomsuksa 6/2 and 51 students of Pratomsuksa 6/3 and 2) normal classes consisted of 46 students of Pratomsuksa 6/6 and 46 students of Pratomsuksa 6/7.

The Research Variables:

Independent variables were:

1) Teaching model was divided into:

1.1) mathematical problem solving teaching.

1.2) normal teaching.

2) The student's learning ability was divided into:

2.1) gifted classes.

2.2) normal classes.

Dependent variables were:

1) mathematical problem solving ability.

2) mathematical learning achievement.

The research instrument:

1. A mathematical problem solving test was a subjective test comprised 3 mathematical problem solving questions. The score criteria were Rubric scoring and Analytic scoring.

2. An achievement test was an objective test comprised 30 items of 4 multiple choice questions.

The Data Collection:

There were 2 steps in this research as follows:

Step 1: the development of learning model for mathematical problem solving of Prathomsuksa 6 students.

1. Synthesis of knowledge, studying principle concept and theory from related documents and theories.

2. Teaching model development and taking knowledge of item 1 to draft a teaching model

and take the result of the synthesis of knowledge to define teaching model components.

3. The teaching model development used a connoisseurship model. The investigation of this research was to investigate the suitableness And the possibility of a mathematical problem-solving model using a connoisseurship model.

4. The assessment of research tools, the researcher presented the mathematical problem-solving teaching model using a connoisseurship model and the assessment of research tools of a teaching model to 5 experts.

5. The assessment of documents of mathematical problem-solving documents of mathematical problem-solving teaching model including a handbook for drafting teaching model, a lesson plan, and a problem-solving activity package. The researcher presented the documents of mathematical problem-solving teaching model and the evaluation form to 5 experts.

6. Taking the mathematical problem solving teaching a model of Prathomsuksa 6 students and the documents for teaching model that they had been improved following experts' advice to try-out with Prathomsuksa 6 students who were not a sample group. To investigate the possibility of the model for taking mistakes to improve the model.

Step 2: the implementation and the findings of the teaching model for mathematical problem solving of Prathomsuksa 6 students were as follows:

1. Develop and find the quality of research tools for studying the findings of employment of a mathematical problem-solving teaching model. The findings were as follows:

1.1 The problem-solving ability evaluation form, the results of the research tool assessment showed that (p) was 0.60 -0.70, (r) of questions was 0.30 – 0.35, and the reliability of the test were 0.8850.

1.2 The achievement test, the results of the research tool assessment showed that (p) was 0.35- 0.60, (r) was 0.27- 0.58, the reliability of the test was 0.8274.

2. Trying out and studying of the teaching model, the researcher examined the mathematical Problem-solving ability of students and used a learning achievement test, a learning unit, and application of article. Before and after employment of the teaching model with the problem-solving ability evaluation forms for mathematical problem-solving ability and the learning achievement test. Checking and recording scores both of the problem-solving ability evaluation form for mathematical

problem-solving ability and the mathematical learning achievement test. Observing and recording problem-solving behavior of each student. Taking scores of mathematical problem-solving ability and the mathematical learning achievement of students in gifted classes and normal classes to analyze with SPSS program (Statistical Package for the Social Science for Windows). The score comparisons of mathematical problem-solving ability and mathematical learning achievement of students in gifted classes and normal classes after learning used One Way ANOVA and the score comparisons of mathematical problem-solving ability and mathematical learning achievement of students in a control group before and after learning using t - test dependent. The findings were shown in Table1-4 as follows:

Table 1: The examination of the different ability on mathematical problem solving after learning of students who were taught with students who were taught with a mathematical problem solving model and a normal model with different learning abilities.

Sources of Variability	SS	df	MS	F	Sig.
Between the groups	962.156	3	320.719	56.004*	<.05
Within the groups	1082.341	189	5.727		
Total	2044.497	192			

* They was significantly different at the level of .05

As shown in Figure 1. It can be seen from the data in Table 1 that students who were taught with a mathematical problem solving the model and a normal model with different learning abilities. They had different mathematical problem-solving abilities after learning. They were significantly different at the level of .05, which related to hypothesis item 1.

Table 2: The examination of mathematical learning achievement after learning of students who were taught with a mathematical problem solving model and students who were taught with a normal model with different learning abilities.

Sources of Variability	SS	df	MS	F	Sig.
Between the groups	892.250	3	297.417	57.493*	<.05
Within the groups	977.708	189	5.173		
Total	1869.959	192			

* They was significantly different at the level of .05

As shown in Figure 2. It can be seen from the data in Table 2 that students who were taught with a mathematical problem solving the model and a normal model with different learning abilities in 4 classes. The findings found that at least 2 classes that their mathematical problem-solving abilities were significantly different at the level of .05, which related to hypothesis item 2.

Table 3: Comparisons of mathematical problem solving abilities of students who were taught with a mathematical problem solving model of Prathom 6 students before and after learning.

experimental group	N	The ability to solve mathematical problems				t	sig
		Before testing		After testing			
		$\overline{X}$	S.D.	$\overline{X}$	S.D.		
Group a_1 b_1	50	10.32	1.504	23.82	1.976	72.692*	<.05
Group a_1 b_2	46	6.74	1.598	21.28	2.896	44.269*	<.05

* They was significantly different at the level of .05

As shown in Figure 3. It can be seen from the data in Table 3 that mathematical problem solving abilities of students who were taught with a mathematical problem solving a model of Prathom 6 in gifted classes (a_1 b_1). The average mean scores before and after learning were 10.32 and 23.82, and t-test found that mathematical problem-solving abilities of students were significantly higher than the pretest mean scores at the significance level of .05. Mathematical problem-solving abilities of students who were taught with a mathematical problem-solving model in normal classes (a_1 b_2). The average mean scores before and after learning were 6.74 and 21.28 and t-test found that mathematical problem-solving abilities of students were significantly higher than the pretest mean scores at the significance level of .05, which related to hypothesis item 3.

Table 4: Comparisons of mathematical learning achievement before and after learning of students who were taught with a mathematical problem solving model of Prathom before and after learning.

experimental group	N	The ability to solve mathematical problems				t	sig
		Before testing		After testing			
		$\overline{X}$	S.D.	$\overline{X}$	S.D.		
Group a_1 b_1	50	11.66	2.037	25.34	1.814	67.417*	<.05
Group a_1 b_2	46	9.59	2.017	22.54	2.810	39.220*	<.05

* They was significantly different at the level of .05

As shown in Figure 4. It can be seen from the data in Table 4 that a mathematical learning achievement of students who were taught with a mathematical problem-solving model in gifted classes (a_1b_1). The average mean scores before and after learning were 11.66 and 25.34, and t-test found that a mathematical learning achievement of students after learning was significantly higher than the pretest mean scores at the significance level of .05. The average mean scores of a mathematical learning achievement of students who were taught with a mathematical problem-solving model in normal classes (a_1b_2) were 9.59 and 22.54, and t-test found that mathematical problem-solving abilities of students were significantly higher than the pretest mean scores at the significance level of .05, which related to hypothesis item 4.

The Research Conclusion:

1. The findings of a teaching model for mathematical problem solving of Prathomsuksa 6 students.

The development of a teaching model for mathematical problem solving of Prathomsuksa 6 students. The researcher used the results of documents analysis and related theory based on Sternberg's Problem-based Learning and Successful Intelligent theories. Moreover, the development model of teaching for mathematical problem solving of Prathomsuksa 6 students and related theories to draft a teaching model and take the result of the synthesis of knowledge to define teaching model components. Furthermore, the teaching model development used a connoisseurship model for investigating the

suitableness and the possibility of a mathematical problem solving the model. The components of a teaching model for mathematical problem solving comprised conceptual model, objectives, learning outcome expectation, learning and teaching procedures and evaluation. After a teaching model for mathematical problem solving had been developed and used a connoisseurship model. The researcher presented the draft of a teaching model for mathematical problem solving of Prathomsuksa 6 students, a handbook, and a proper teaching model to experts. The evaluation found that a teaching model for mathematical problem solving was at the highest level ($\overline{X}$ = 4.80).

2. The findings of a teaching model for mathematical problem solving of Prathomsuksa 6 students

2.1 Students who were taught with a mathematical problem solving the model and a normal model with different learning abilities. They had different mathematical problem-solving abilities after learning. They were significantly different at the level of .05, which related to hypothesis item 1.

2.2 Students who were taught with a mathematical problem solving the model and a normal model with different learning abilities. They Had different mathematical learning achievement after learning. They were significantly different at the level of .05, which related to hypothesis item 2.

2.3 Students who were taught with a mathematical problem-solving model in gifted classes and students who were taught with a mathematical problem-solving model in normal classes. Their different mathematical problem-solving abilities after learning were higher than before learning. They were significantly different at the level of .05, which related to hypothesis item 3.

2.4 Students who were taught with a mathematical problem-solving model in gifted classes and students who were taught with a mathematical problem-solving model in normal classes. Their mathematical learning achievement after learning was higher than before learning. They were significantly different at the level of .05, which related to hypothesis item 4.

The Research Discussion:

1. The findings of a teaching model development for mathematical problem solving of Prathomsuksa 6 students. The findings found that there was a proper teaching model development for mathematical problem solving and the components of a model as follows:

The conceptual model was analyzed through Sternberg's theories, Problem-based learning –

PBL and Successful Intelligence theories. It was an activity that promoted students' ability development for problem-solving through mathematical problem solving.

The objectives and learning outcome expectation were to develop students' problem solving and mathematical problem and to enable students to define problems, choose the process of problems solving, investigate problems and apply knowledge to wide problems.

The processes of learning and teaching based on a teaching model for mathematical problem solving of Prathomsuksa 6 students comprised of 5 steps:1) Understanding the problem, 2) Analysis problem solving and synthesis, 3) Taking action, 4) Review of problem-solving process and 5) Application life wide learning.

The evaluation and assessment of model, the researcher assessed the mathematical problem-solving abilities and the learning achievement of Prathomsuksa 6 students through ability evaluation forms of mathematical problem solving and a mathematics achievement test.

2. The findings of employment of a teaching model development for mathematical problem solving of Prathomsuksa 6 students.

2.1 The findings of students' abilities for mathematical problem solving. Students who were taught with a mathematical problem solving the model and a normal model with different learning abilities. They had different mathematical problem-solving abilities after learning. They were significantly different at the level of .05,which related to hypothesis item 1. Students who had different mathematical problem solving were as follows: 1) Students who were taught with a mathematical problem-solving model in gifted classes and students who were taught with a mathematical problem-solving model in normal classes, 2) Students who were taught with a mathematical problem solving model in gifted classes different from students who were taught with a mathematical problem solving model in normal classes, 3) Students who were taught with a normal model in gifted classes and students who were taught with a normal model in normal classes.

Students who had no difference in mathematical problem solving were students who taught with a mathematical problem-solving model in normal classes and students who were taught with a normal model in gifted classes.

Since teaching following a mathematical problem-solving model made students use thinking process from a thinking process and a learning process to use in a mathematical problem-solving process.

2.2 The findings of mathematics learning achievement of students. Students who were taught with a mathematical problem solving the model and a normal model with different learning abilities. They had different mathematical learning achievement after learning. They were significantly different at the level of .05, which related to hypothesis item 2. As the result of teaching with a mathematical problem-solving model helped students develop critical thinking, creative thinking, and practical thinking (Sternberg, 2007). Learning based on learning processes of a mathematical problem-solving model that there were activities for thinking process development available for students in each step. It helped students apply thinking process from learning the process to solve mathematical problem solving. It could be seen that students unable to solve situational problems and find answers from doing achievement tests. It can be shown that teaching with a mathematical problem solving the model, which was developed by the researcher, it developed students' thinking abilities on analytical thinking, creative thinking, and practical thinking. (Sternberg, 2007) based on Sternberg's theory, Successful Intelligence including self-efficacy (Pataraporn Saengchai, 2008, pp.37-40) Saengchai,There were self-systematical management, analytical thinking through situational problems and used them to encourage thinking, which related to Problem-based Learning.

From after learning found that students who were in the gifted class had the mathematical problem-solving abilities higher than students who were in normal classes. Due to, students who were in gifted classes passed the process of selecting students from those who were good at in mathematics. Students analyzed only some processes, but they could explain processes and concept in problem-solving clearly and correctly.

2.3 The findings of the student's ability for mathematical problem solving. Students who were taught with a mathematical problem-solving model in gifted classes and students who were taught with a mathematical problem-solving model in normal classes. Their different mathematical problem-solving abilities after learning were higher than before learning. They were significantly different at the level of .05, which related to hypothesis item 3. Since a learning process based on mathematical problem solving in each step helped students develop thinking through problem-solving.

2.4 The findings of student's mathematics learning achievement. Students who were taught with a mathematical problem-solving model in gifted classes and students who were taught with a mathematical problem-solving model in normal classes. Their mathematical learning achievement after learning was higher than before learning. They were significantly different at the level of .05, which related to hypothesis item 4. For the purpose, that teaching with a mathematical problem-solving model helped students develop thinking process with problem-solving through analytical thinking, creative thinking, and practical thinking apart from memorization. (Sternberg, 2007) Moreover, students used thinking process to solve situational problems with content in a learning unit and application of article. The researcher used them for problem-solving ability development. They were relevant to the content of the curriculum.

The Research Recommendation:

1. Using a teaching model for mathematical problem solving of Prathomsuksa 6 students, conceptual model, objectives, learning outcome expectation, learning and teaching procedures and evaluation should be studied clearly for successful mathematical problem-solving learning of students.

2. A teaching model for mathematical problem solving of Prathomsuksa 6 students was not focused on Content Free. Therefore, mathematical problem-solving promotion for students, the teachers should apply improved learning model for mathematical problem solving of students to every level.

The Research Recommendation for Further Studies:

1. The study of mathematical problem-solving promotion for students in any levels should be employed Sternberg's theory, Problem-based Learning, and Successful Intelligent theories.

2. The study of teacher development in any levels should be developed for mathematical problem solving based on the Basic Education Core Curriculum B.E. 2551 (A.D. 2008)

3. The study of the relationship between the mathematical problem-solving ability and the mathematical learning achievement of students should be done.

4. The study of the relationship between the intelligence and the mathematical problem-solving ability should be done.

References

The Ministry of Education, Office of the Basic Education Communission (2008). *Basic Education Core Curriculum B.E.2515 (A.D,2008)*. Learning Area of Mathematics.Bankok: The Agricultural Co-operative Federation of Thailand.

Pattaraporn Saengchai. (2008). *An analysis of interaction effects between problem-solving teaching method based on the triarchic theory and problem-solving styles on creative problem-solving ability and mathematics learning achievement of ninth grade students*. Degree of Master of Education Program in Educational Research. Chulalongkorn University, Bangkok.

Sternberg, R. J., & Grigorenko, E. L. (2007). *Teaching for successful intelligence* (2nd ed.). Thousand Oaks, CA: Corwin Press.

Supaporn Jaisook. (2012). *The development of an instructional model by integrating problem based learning and collaborative learning approaches to enhance mathematical problem solving, communication, and connection abilities of sixth grade students*. Doctoral Thesis of Doctor of Education (Curriculum and Instruction). Chulalongkorn University, Bangkok.

Tan, O. S. and Hung, D. (2007). Problem-Based Learning in E-Learning Breakthroughs. Singapore: Thomson Learning.

Wassana Kimterng. (2010). The effect of *problem based learning instruction activities on problem solving skill, mathematical connection skills and inquiry learning of mathayomsuksa III students*. Master of Education Degree in Secondary Education. Srinakharinwirot. Srinakharinwirot University, Bangkok.

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