Lesson Study and Open Approach: Creative Thinking of Students in Mathematical Problem Solving

Khamla Khammeuangkhoun[a]*
Litsay Xaysongkham[b]
Somxay Thepsombath[c]

[a]* Pakse Teacher Training- College, Lao PDR.,
 E-mail: khamlakhammeuangkhoun@gmail.com
[b]Pakse Teacher Training- College, Lao PDR., E-mail: litsayxsk@gmail.com
[c] Pakse Teacher Training- College, Lao PDR., E-mail: somxayth@gmail.com

Abstract

The aim of this research is to explore creativity thinking ability of students in the classroom in solving mathematical problems using Lesson Study and Open Approach of Inprasitha (2011). This study is a qualitative research emphasizing a protocol analysis and analytic description. The target group is the students in the first grade of Demonstration Primary School in Pakse Teacher Training College, Lao People's Democratic Republic in the second semester of the academic year 2020-2021 with two groups of students, 4 students in each group. The tools used to collect the data include sets of lesson plans, video recording, sound recording, pictures by using the framework of Guilford (1967).

The findings found that: In the context of using Lesson Study and Open Approach in teaching and learning process emphasizing the students to learn by themselves and to learn cooperatively with friends in the classroom, it has been found that the students have ability to express their thinking in many types and students' creativity thinking can be found as follow:

1. Originality: is the unique thinking of an individual student that is different from other friends' occurred while solving mathematic problems independently in a group. 2. Fluency: is the thinking that each student brings into the group to discuss and give reasons to the problem together independently. 3. Flexibility: is the thinking that students can adjust or modify after they discuss, examine and get feedback from classmates and from the teacher. 4. Elaboration: is the thinking that students see as the importance when they present or summarize their work with their teacher because it is the top concept of the lesson in each class. This concept can improve or enrich the thinking of some students that is not completed enough. It is as a tool for students to apply in the next lesson.

Keywords: Creative thinking, Problem Solving, Lesson Study and Open approach

Introduction

The framework of teaching and learning for 21st century (P21) has set learning skills into three skills including: life and working skills, learning and innovation skills, and communication, information and technology (ICT) literacy. In addition, students have to be able to read, write and calculate under the standard assessment and evaluation, curriculum, teacher development and learning environment for higher education. The higher education is also responsible for building and developing learning skills to be used in the whole life for all that include critical thinking and problem solving skills, creativity and innovation skills, cross-cultural and understanding skills, collaboration, teamwork and leadership skills, communication, information and media literacy, computing and ICT literacy, and career and learning skills (Partnership for 21st Century Skills, 2011).

It can be concluded that creativity skill is very important to improve the learners in the new era as Isaksen, Dorval and Treffinger (2011) mentioned that the creativity skill is the nature of all human beings, it does not only occur with talent people. People's creativity skill may differ from each other or may exist in different levels. The results from learning or practicing to understand the use of creativity skill will be a primary thing to motivate people to be interested in and they can develop themselves to gain creativity skill. Creativity skill has high flexibility and deep relationship with the content of a matter (Silver, 1997). In the current situation, creativity skill in mathematics is most important and essential for each learner (Mann, 2005). Moreover, Gagne (1985) pointed out that creativity skill is one of problem-solving abilities. It is a combination of ideas and different sources of knowledge that can be said creativity skill is the problem-solving ability in a high level. In addition, Guilford (1973) stated that the connection between creativity skill and problem-solving skill is a direct connection which the creativity skill is a final outcome of the problem-solving process.

Therefore, teaching and learning emphasized on problem-solving process is to promote learners to develop their creativity skill by themselves. Polya (1957) defined that problem-solving means to find methods or ways to overcome the difficult obstacle and to reach the goal which those methods and ways are not easily occurred or spend only a short period. As a result, the ability in solving problems is the skill and process of learning that needs the learners to practice to make it happened in the classroom and can also be used in the real life situation (Jonassen, 1997). In addition, Krulik & Rudnick (1993) and National Council of Teachers of Mathematics (2000) inserted that problem solving is a participation in the process of solving the problem that people use their experiences, knowledge, skills and previous knowledge to find the solution of a new problem that they are not familiar with.

From the previous until now mathematics teaching and learning in Laos, most teachers do not emphasize on the process or problem solving process for students, they use teacher center method to transfer knowledge to students and this results in most students are lack problem solving and thinking skills and the teaching and learning in general does not achieve the goal (Khammeuangkhoun, 2017). In addition, mathematics' teaching and learning in schools mainly consists of three characteristics namely: 1) The situation of mathematics presented in the classroom: the contents of mathematics in the textbook mainly do not relate to or reflect the situation happened in the real life. 2)The contents of mathematics mostly emphasize on calculation to find out the final answer rather than emphasize on the process or important ideas of learner such as: exploration, evaluation, synthesize, analyze, define and etc. 3) The learners are limited representation and problem- solving process (Kouba & Frankin, 1993). As a result, mathematical learning and teaching in the school, teachers mostly depended on teaching materials from textbooks. They tended to follow contents and activities in the textbooks such as teacher giving examples then they let student to practice and give homework to students at the end of class time. It could be said that teaching mathematics is like talking about mathematics and implied teaching expected only high scores in the examination. In almost classes, teachers applied the same methods and did not realize mathematical thinking process. Therefore, students were lack of creative thinking (Inprasitha, 2010).

Lesson study is an innovation to develop teachers' work in Japan as working collaboratively in order to improve the quality of teaching and learning continuously and gradually. It is a collaborative work of teachers that they share their teaching experiences and knowledge together to plan a lesson that is most appropriate for their students (Yoshida, 2005). Lesson study has been applied in several counties around the world. It was first brought to Thailand and Laos in 2002 with the purpose to give a new professional development to the teachers that includes 3 steps namely 1) Collaboratively design a research lesson (Plan), 2) Collaboratively observe the research lesson (Do) and 3) Collaboratively discuss and reflect on the research lesson (See) by integrating with the Open Approach as a teaching methodology in the second step of Lesson Study.

Open Approach means to teach students to open their minds. It is as a gateway for students to be able to think in solving the problem. It is to develop the thinking skills and meaningful activities for students, and to promote the thinking in mathematical problem solving creatively and independently (Nohda, 2000). In addition, Inprasitha (2011) said the Open Approach is a teaching approach that emphasize on students thinking through problem solving by learners' themselves that consists of 4 steps: 1) Posing the open-ended problem. 2) Students' self-learning. 3) Whole class discussion and comparison. 4) Summarization through connecting students' mathematical ideas emerged in the classroom.

Teaching and learning using Lesson Study and Open Approach is a teaching approach that widely accepted especially to develop students' thinking. In Laos, the Ministry of Education and Sports has a strong support for this concept to develop the quality of teaching and learning. Particularly, the Demonstration School in Pakse Teacher Training College, Laos PDR has introduced this approach since 2017. Therefore, the researchers want to explore the creativity thinking of students in the mathematics classroom using the concept of Lesson Study and Open Approach to guide the development of teacher teaching.

Objective

To explore the creative thinking of students in mathematical problem solving by using Lesson Study and Open Approach in Demonstration primary school, Pakse Teacher Training College, Lao PDR**.**

Literature Review

Creative thinking of students in mathematical problem solving means the thinking of students that is the product from the problem solving process based on the concept of (Guilford, 1967: 62) includes: 1) Originality: is a unique thinking of an individual that differ from the others'. 2) Fluency: is quantity of thinking that is not repeated. This might be, for example, the ability to speak many languages in a certain time. 3) Flexibility: is thinking that an individual can adjust and sort the importance of a situation more than one thing. 4). Elaboration: is a thorough thinking that can improve the prior thinking to be more completed.

Mathematical problem solving means an action of students to solve the problem in the classroom with the teaching and learning using Open Approach of Inprasitha (2011)

Open Approach means a teaching approach emphasizes on students' thinking through mathematical problem solving based on four steps of conceptual framework as follows:

1. Posing open-ended problems.
2. Students' self-learning.
3. Whole class discussion and comparison.
4. Summarization through connection students' mathematical ideas emerged in the classroom.

Lesson study means teachers' collaboration to make the lesson plan, to create Open-ended problems and to concept expectation that resulted in students' creative thinking in problem solving. There are 3 processes of lesson study according to Inprasitha (2011) as 1) Collaboratively design a

research lesson 2) Collaboratively observe the research lesson and 3) Collaboratively discuss and reflect the research lesson.

Research Methodology

Research Population
The target group in this study was the first year of an elementary school. It is a Demonstration primary school of Pakse Teacher Training College, Lao PDR. It conducted in the second semester, the academic year 2017-2018. This study was purposive sampling. It divided into two groups of students; there are four students in each group. The total number is 8 students. The classroom design is just like the normal class that the target group is not separated from the other students in the class.

Conceptual Framework
This research is a classroom research using qualitative research method emphasizes on protocol analysis and analytic description by concept of Lesson Study and open Approach (second step) Inprasitha (2011).
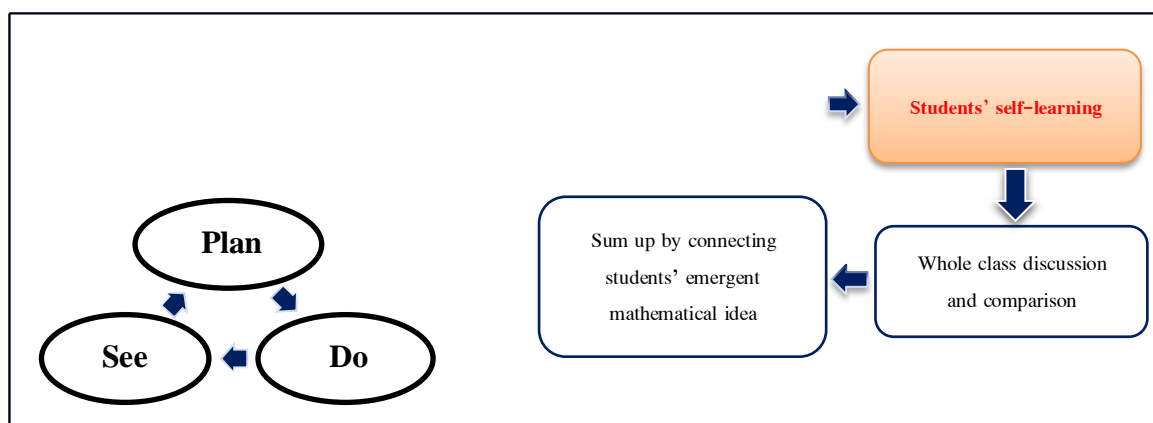
Figure 1: Lesson Study and Open Approach based on the concept of Inprasitha (2011)

Research Tools
1.Lesson plan: the research team collaboratively created 5 lesson plans which each plan made based on the conceptual framework of Lesson Study and Open Approach by Inprasitha (2011).

2.Video recorder: used to record focused groups of students to see their behavior, movement and reaction during the second step of Open Approach. There were two video recorders for two focused groups.

3.Audio recorder: used to record communication sound of students during their group problem solving by using two sound recorders for the two groups.

4.Camera: used to photo students' work, activities, reaction and behavior in problem solving.

5.Students' worksheet

6.Semi-structured observation form: a research assistant used semi-structured observation forms to note thinking and behavior about behavior and students' thinking in the step of they solve the problem.

The data analysis:

The data analysis in this study was qualitative data analysis, protocol analysis, and descriptive analysis. The data obtained from semi-structured observation form, including taking photos, audio and video recording, writing tasks and observation of the two groups. The data were analyzed to find out the behavior of students appeared in each process based on Lesson Study and Open Approach Conceptual Framework of Inprasitha (2011).

1.Collaborative planning the lesson

The research team collaboratively plans the lesson, analyses contents of the lesson and sets the purposes of the lesson. The team also designs open-ended situation related to the real world, meaningful for students and various possible ideas of students in order to make them interested in the lesson, understand the problem and ways to solve it. After that, the research team collaboratively expects students' ideas and creates teaching materials that is most meaningful for the students. This also includes giving the responsibility to support the teaching of the teacher and setting the goal to observe the thinking of students and to record creative thinking of students that occurs from solving the problem.

Figure 2: A picture of planning the lesson of the Lesson Study team

2.Collaborative observing and recording students' ideas

In this step the research team brings the lesson plan to teach and observe the class to record students' ideas in solving the problem.

Step 1: Posing open-ended problem:

Item 25:	Teacher	After we already talked about the old lesson from yesterday, today the teacher has something to show you. Are you really?
Item 26:	Student	Yes, I am ready.
Item 27:	Teacher	Everyone! Look at the board (Teacher puts the picture on the board) Do you know what it is and how will we do it?

Figure 3: A picture of a number board for students to do their study activities.

Item 28:   Student   Table of numbers.
Item 29:   SA2   Write number

Item 30:   SB1   Add number into the empty boxes
Item 31:   SC2   Put the number to complete the table, the winner will get the price
Item 32:   Teacher   Sure, very good all. Next everyone, look at the questions to answer and read them together.


Figure 4: Sample images of questions used in the testing activities.

Item 33	Student	7s are there in the one unit position and 8s are there in the tens unit position (Read the questions)
Item 34	Teacher	Every one understands how to do?
Item 35	Student	Yes
Item 36	Teacher	Each group comes out to pick the work sheet.

From the episode, in item 27 the teacher presents the material to students by putting it on the board that can be seen clearly. Students try to observe the picture then they try to understand the problem and predict what they will do in many ways such as: Item 29: SA2 said "Write number", Item 30 SB1 said "Add numbers into the empty boxes" and Item 31 SC2 said "Put the number to complete the table, the winner will get the price". It can be seen that in this point students try to understand the goal to do the activity with many different ideas that are not repeated. In addition, students also try to understand the questions presented in Item 33.

Step 2: Students' self-learning:

| Item 40: | SB1 | We will put the number for all boxes |
Item 41:	SD1	Zero, one, two, three … nine. Look at this first row. It has number from zero to nine. (using finger to count)
Item 42:	SA1	We do not have to look at the row, just put into the empty box, any row.
Not Item 43:	SC1	Put this one first better because it has a number in the middle
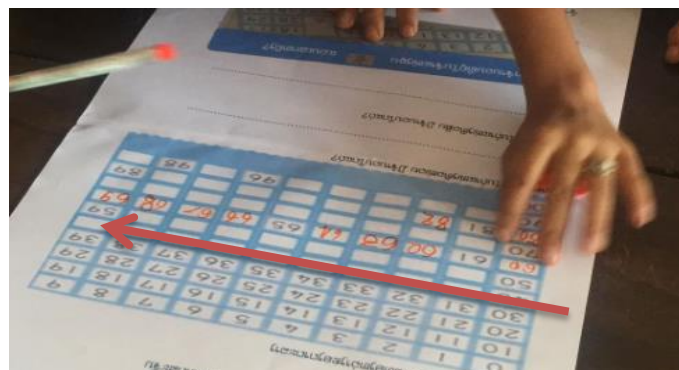
Figure 5: Guidelines for adding numbers

The episode from item 40 to item 43: it shows students solving problem by themselves. In each group, students work cooperatively to help each other that each student shows idea to help in solving the problem. For example, Item 4, SD1 said "Zero, one, two, three … nine. Look at this first row. It has number from zero to nine. (using finger to count)". This indicates an idea from observing an increasing of the number in a row. Moreover, in Item 42, SA1 said "We do not have to look the row, just put into the empty box, any row". From this activity sheet, it shows that this group of students has a basic idea as adding the number from the left to the right.

Related protocol

Item 50:	SC2	Look at this we can add this way. From up here down to the bottom.
Item 51:	SD2	It can be, too. Which one will be faster?
Item 52:	SC2	See, add like this faster. The front numbers are increasing, it is the same number.
Item 53:	SA2	Yes. So we write the front number first it is faster
Item 54:	SD2	Alright then we write the back numbers because they are the same.
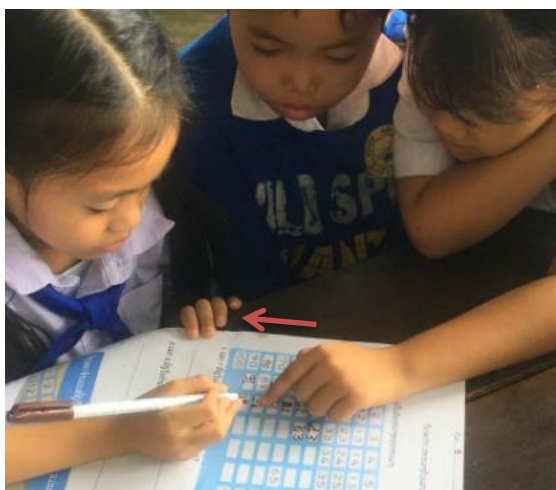
Figure 6: The students began to carry out number addition
activities according to the teaching and learning model.

The episode from item 50, SC2 said "Look at this we can add this way. From up here down to the bottom". It means this student has found a new way to solve the problem by noticing the pattern of number, then tells other friends in the group to do. In addition, there is an idea that tells the easy way and can write quickly as the episode from item 52, SC2 said "See, add like this faster. The front numbers are increasing it is the same number.

From the Semi-structured observation of the research team, it is also found the similar data.
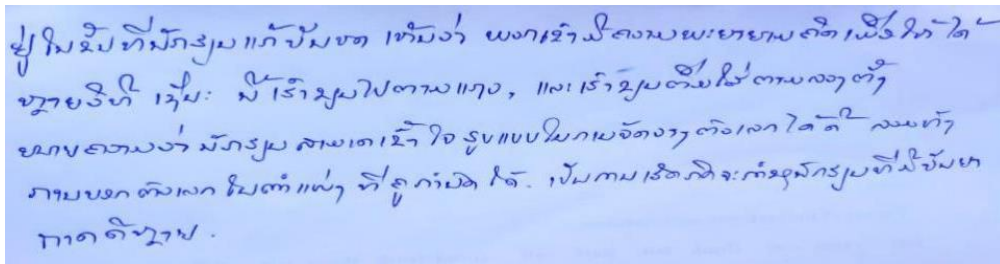
Figure 7: In the students self-learning step, it found that students try to think to solve the problem in many ways such as: students can fill number in the box by a pattern in a row and a column. This means student understand the pattern and number position and they enjoy doing this activity.

Step 3: Whole class discussion and comparison:

Item 62:	Teacher	Now, let's listen to the presentative from group 1 presenting about how they complete the task.
Item 63	SA1	First, we add number into the box from left to right. Then, number 7s in the unit position are 7, 17, 27, 37, 47, 57, 67, 77, 87 and 97
Item 64:	SB1	The number 8s in the 10 units are 80, 81, 82 until 89
Item 65:	SA1	The number in the star box is number 27.

Figure 8: Image of an example of adding a numerical answer.

| Item 66: | Teacher | This is the way to complete the task from group 1. Now I would like each group compares the way to complete the task of group1 to the way of your group, what are the same and what are the differences? |

From the episode, Item 62 to Item 66 are time to present ideas to solve problems in the classroom. It can be seen that students are brave to explain their ideas or the ways to solve the problem of their own group. Each of them in the group also takes responsibility to explain. For example, Item 63, SA1 said "First, we add number into the box from left to right. Then, number 7s in the unit position are 7, 17, 27, 37, 47, 57, 67, 77, 87 and 97" and Item 64, SB1 said "The number 8s in the 10 units are 80, 81, 82 until 89".

Step 4: Summarization through connection students' mathematical ideas emerged in the classroom.

Item 71:	Teacher	Everyone, let's see together how many ways we can add the numbers?
Item 72:	Student	Add in a row (from left to right)
Item 73:	Teacher	What are the other ways? Let's see together.
Item 74:	SA1	Add in a column from top to the bottom.
Item 75:	Teacher	So, we can add the numbers in two ways. Next, let's see the number 7s in the unit. What are there?
Item 76:	Student	There are 7, 17, 27, 37, 47, 57, 67, 77, 87 and 97. It is a column.
Item 77:	Teacher	Next, let's see the number 8s in the 2 units. What are there?
Item 78:	Student	80, 81, 82, 83, 84, 85, 86, 87, 88 and 89. They are in a row.
Item 79:	Teacher	And what number is in the star box?
Item 80:	Student	Number 27

From the episode, in item 71- Item 80 show that students can express their ideas with the teacher to summarize what they have learnt. For example, Item 72 student said "Add in a row (from left to right)". And Item 74 SA1 said "Add in a column from top to the bottom." It can be seen that students see the connection of the numbers in a row and in a column as the teacher only facilitates and motivates them to get their ideas.

3. Reflection.

After finishing the class, the research team collaboratively reflected on the teaching to evaluate whether the teaching achieves its goals or not. Students have all types of creative thinking that arise during all teaching sessions by using Open Approach. The research team had observed what happened during the teaching, what to improve such as: situation problem, instruction, materials and questions in order to stimulate students to acquire the creative thinking and to bring all information to use in the next lesson.

Figure 9: A picture of reflexing after teaching

Table 1 Creative thinking of students in mathematical problem solving

Teaching plan by concept of Lesson Study and Open Approach	Creative thinking (Guilford, 1967)				Note
	Originality	Fluency	Flexibility	Elaboration	
1	✓	✓	✓	-	
2	✓	-	✓	-	
3	✓	✓		✓	
4	✓	✓	✓	-	
5	✓	✓	-	✓	

From Table 1, the thought pattern model Creativity of students in solving mathematical problems to get results 4 privileges for students 1. Originality 2 . Fluency 3 . Flexibility 4.Elaboration In which students will receive all 4 aspects that are added.

Discussion/Conclusion

The study on students' creative thinking in mathematical problem solving in the classroom using the concept of Lesson Study and open Approach of Inprasitha (2011) and teaching 5 lesson plans to find out four types of creative thinking of Guilford (1967). It can be found as follow:

1. Originality: is a unique thinking of an individual that is different from the others'. This type of thinking occurred in any lessons while solving mathematic problems independently in a group. This is because the teacher presented an open-ended problem that related to the real world of students before moving to mathematic world. This step is very important to make students be able to interpret and understand the problem situation clearly before completing the task. In addition, the teacher gave students an opportunity to solve the problem independently, so each student dared to express his/her idea in the group and the ideas from all students in the group were varied. This is in accordance with Inprasitha (2011), he mentioned that an open-ended problem or open-ended question allows various ideas. It challenges students, so they want to know and are interested in the things that they do not know before. The teacher presents this to the students through stories and visual aids.

2. Fluency: is a quantity of thinking that is not repeated. This can be an ability to say something in different ways. This can be found in the second step of open approach because this is the main step that students face the problem and they solve the problem by themselves. This is in accordance with Lithner (2010) asserted that when learners participate in mathematical problem, they will apply their mathematical knowledge to solve the problem and they also adapt their strategies suitably and they can use those strategies and experience to solve the problem numerously and a research of Khammeuangkhoun (2017) found that teaching and learning by using Lesson Study and open Approach, students have abilities to solve a problem using many ways of thinking.

3. Flexibility: is the thinking that students can see the importance of one situation more than one thing. This type of thinking can be found in Open Approach that relates to checking the differences of students' ideas while working together because the checking can help students adjust or modify the way of their thinking and they can accept each other's ideas as Polya (1957) sited in Inprasitha (2011), asserted that in the 4th step of problem solving: "Looking back" is very important that needs to work creatively and thoroughly because it looks back the idea, working process and strategies used from the beginning until the final answer.

4. Elaboration: is a type of thinking that is very neat and can modify students' former thinking to be more completed. This thinking can be seen when students solve a problem together. While solving the problem together, the idea of each student may be in the same point and can be contrasting that lead to reflection of one's own thinking. This reflection can bring about the more completed thought of the student. Moreover, in the conclusion step students can get the new idea or lesson to apply in the next lesson.

Lesson Study and Open Approach are an innovation to develop quality of the new teaching and learning in order to improve students' thinking skill through open-ended problem solving process. The finding from this study is very essential for teachers and students because one lesson plan that can make students able to have all types of creative thinking is very difficult or almost impossible, so the lesson study team and the teacher need to deeply understand the purpose of Lesson Study and Open Approach especially planning the open-ended problem, questions and all visual aids that related to the framework of Open Approach. This is to open students' mind in solving problem on their owns and to develop creative activities for students that enhance various creative thinking in mathematical problem solving independently (Nohda, 2000).

Suggestion

The teacher who uses the concept of Lesson Study and Open Approach in teaching mathematics should set a goal of the lesson plan that emphasizes the development of some types of creative thinking, not all types of creativity thinking in one lesson plan.
There should be a study on teacher's role in teaching and teacher's ability in designing open-ended problems to promote students' creative thinking skill in many types.

Acknowledgment

References

Gagne, R.M. (1985). *Condition of Learning*. (4th ed.). New York: Holt Rine Hart and Winston.
Guilford, J.P.(1967). *The Nature of Human Intelligence.* New York: McGraw-Hill Book Co.
Guilford. J. P. (1973). Traits Creative. "Creative". Penguin Education. 167-188
Inprasitha, M. (2010). One Feature of Adaptive Lesson Study in Thai &: Designing
Learning Unit. In CheongSoo, C., SangGu, L., & YoungHan, C. (Eds.). *Proceedings of the 45th Korean National Meeting of Mathematics Education,* Korea: Dongkook University Gyeongju Korean Society of Mathematics Education. (pp.193-206).
Inprasitha, M. (2011). One Feature of Adaptive Lesson Study in Thail&: Designing a Learning Unit. *Journal of Science & Mathematics Education in Southeast Asia, 34*(1), 47 – 66.
Isaksen, S. G., Dorval, K. B., & Treffinger, D. J. (2011). *"Creative approaches to problem solving".* Sage Publications, Inc.
Jonassen, D. H. (1997). Instructional design models for well-structured & ill structured problem-solving learning outcomes. *Educational Technology Research & Development*, *45*(1), 65–94.
Khammeuangkhoun. K. (2017). *Mathematical problem solving ability of students in classroom using Open Approach in Sathith primary school of Pakse Teacher Training College, Lao PDR.* Master of Education Thesis in Mathematics Education, Graduate School, Khon Kaen University.

Kouba, V.L. & Frankin, K. (1993). *Multiplication and Division: Sense Making and Meaning.* In Jansen, J. (Ed.). Research Idea for The Classroom Early Childhood Mathematics. New York: Macmillan publishing company.

Krulik, S., & Rudnick, J. (1993). *Reasoning & problem solving.* A handbook for elementary.

Lithner, J. (2010). *Mathematical Competencies: a Research Framework*. The seventh mathematics education research seminar, Stockholm . Svensk förening för matematikdidaktisk forskning, SMDF. Umeå University, Sweden.

Mann, E. (2005). *Mathematical creativity and school mathematics: Indicators of mathematical creativity in middle school students*. Retrieved September 15, 2022, from http://www.gifted.uconn.edu/siegle/Dissertations/Eric%20Mann.pdf.

National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics.* Reston: NCTM.

Nohda, N. (2000). Teaching by Open-Approach Method in Japanese Mathematics Classroom. *Proceedings of the Conference of the International Group for the Psychology of Mathematics Education (PME),* July 23-27, 2000. Hiroshima, Japan.

Partnership for 21st Century Skills. (2011). *Frame work for 21st Century Learning.* Retrieved September 15, 2022, from www.p21.org/storage/documents/1.__p21_framework_2-pager.pdf

Polya, G. (1957). *How to Solve It. A New Aspect of Mathematical Method*. (2nd Ed.). Princeton University Press, Princeton.

Silver, E. A. (1997). Fostering creativity though instruction rich mathematical problem solving and problem posing. *International Reviews on Mathematical Education*, *29*(3), 75–80.

Yoshida, M. (2005). *An Overview of Lesson Study. In P. Wang-Iverson & M. Yoshida (Eds.). Building Our Understanding of Lesson Study*. Philadelphia: Research for Better School.