



Benefits of PISA Lessons towards Mathematics Learning Process at Elementary Level

Wichai Panichsuay*, Sumon Waiboonya, Pacharaporn Suphkit and Ratanaporn Loungkeaw

Elementary Education, Faculty of Education, Suan Dusit University

No. 295 Nakhon Ratchasima Road, Dusit, Bangkok 10300, Thailand

*Corresponding author. E-Mail address: wichai329@yahoo.com

Received: 16 October 2019; Revised: 4 December 2019; Accepted: 19 December 2019

Abstract

Thai students' mathematical abilities in every level of education have been found the lowest comparing with other subjects, especially thinking and problem solving skill. Mathematics teachers still lack confidence and adequate ability to adapt mathematical process skills, which are the heart of teaching mathematics, into teaching three contents of mathematics as defined by The National Education Curriculum. According to the Programme for International Student Assessment (PISA), the result from the sample group of 15-year old Thai students was found that their mathematical literacy average score in 2015 was only 415, which is lower than the Organization for Economic Co-operation and Development (OECD) average score that is 490. This result indicates that Thailand's education quality is significantly lower than the standard. One of the methods to improve Thai students' mathematical abilities is to apply PISA Lesson into mathematics learning process since elementary level. The PISA lesson is the mathematical process skills practice which is designed to respond the PISA test. This lesson does not focus only on content, but also on the process and contexts. After the PISA Lesson had instructed, the ability of mathematical process skills of 850 Grade-4 students was significantly higher than of those before they were instructed at the 0.05 significant level.

Keywords: PISA Lesson, Mathematical Process Skill, Mathematics Learning Process

Introduction

Time changes, so does everything e.g. belief, attitude, value, etc. However, there is one thing that time cannot change or devalue, "value of thoughts". It has been always believed that thinkers gain more advantage and tend to be more successful in career. Concerning mathematics as the subject concerning with reasoning, thinking process and problem solving; it has been found that Thai students' mathematics skill in every era and every level of studies is still low, comparing with other subjects related to thinking and problem solving. Most of the mathematics teachers still lack of confident and adequate competence to apply mathematical processes, which is the main factor of teaching mathematics, into teaching three contents as indicated by Basic Education Core Curriculum B.E. 2551. Several experts on teaching have agreed that teaching students to think is very important, yet it is not very easy to do so. This is because thinking process is abstract and complicated so that it is difficult to teach explicitly and effectively. The Primary-6 students' approximate mathematical O-NET test result, academic year 2018, is found 37.50 (National Institute of Educational Testing Service, 2019) similar to the result of academic year 2017 which is 37.12 percentage (National Institute of Educational Testing Service, 2018). This is obvious that the primary-level students' mathematical skill is consistently low, which surely results in the higher-level mathematical skill. According to the Programme for International Student Assessment (PISA) which is the collaboration between The Institute for the Promotion of Teaching Science and Technology (IPST) and Organisation for Economic Co-operation and Development (OECD); the mathematical score of the sample group of Thai 15-year-old students is found only 415 approximately, which is lower than OECD score (490 scores)

(OECD, 2018). It can be implied that the Thai education quality is still far from excellence (The Institute for the Promotion of Teaching Science and Technology (IPST), Ministry of Education, 2018, pp. 1–9).

Considering the nature of teaching mathematics, which is related to thinking process and problem solving, as stated earlier, as well as is generally accepted; the major elements of mathematics in primary level consist of three elements: conceptual thinking, mathematical skill, and problem solving. Among those three elements, problem solving is the most important one. Therefore, the goal of teaching problem solving is teaching its processes. However, the mathematical problem-solving process has been found that almost all problems are routine problems in which students are familiar with from the previous classes. The differences are just the number to be operated to find the resolution. Meanwhile, mathematical process problems are found only a few. Students who are able to solve this kind of problem need a lot of mathematical processes (Panichsuay, 2012). As a result, mathematical processes are the students' weak point which are in need to be improved and intensively trained. Teachers should also apply their teaching methodologies by integrating mathematical processes continuously.

According to those mentioned issues, there comes the question of how to manage mathematical teaching in order to improve students' mathematical process skill to be similar to other countries. Mrs. Sunee Klainin, Special Expert of The Institute for the Promotion of Teaching Science and Technology (IPST) has addressed about learning mathematics in Thai schools that even though there were innovations in teaching mathematics, it is still the subject that focuses on contents which has not yet been integrated social or real-life situations into it (Klainin, 2015, p. 4). The speech agrees with the PISA test which does not focus only on content evaluations, but also processes and contexts. Therefore, if there is any particular test to improve mathematical skills, which is in accordance with PISA test and can be applied into teaching in primary level, it will be one of the encouragements of mathematical skills since primary level. This is also the preparation of Thai students to take the PISA test in the future.

What is mathematical process skill? How important it is?

It is common that mathematics is one of the subjects that works together with Thai subject. Both mathematics and Thai subjects are the important tool to learn other subjects. Students who are good at Thai subject and mathematics will be successful in these two subjects as well as other subjects. However, the meaning of "skill" in the two subjects are naturally different; for example, listening, speaking, reading, and writing skills in Thai subject, while calculating and problem-solving are the skills of mathematics. Students who are good at calculating will be able to solve the addition, subtraction, multiplication, and division easily and accurately. Meanwhile, students who are good at problem-solving will be able to analyze the problems, plan and find the answer of the particular problem easily and accurately. To find the answer in mathematical problem, besides a lot of skills, it is supposed to be planning, action based on the plan, and presentation of the action to explain to other students to understand. So, mathematical process skill is the important element in studying mathematics.

Manual of Mathematics, B.E. 2560 ed., (The Institute for the Promotion of Teaching Science and Technology (IPST), Ministry of Education, 2018), identifies the mathematical process skills that are in need to be improved include problem-solving, reasoning, communication, mathematical meaning communication and presentation, connection mathematical knowledge with other subjects, and creativity.

Singapore's mathematical program structure, as the ASEAN country that won the first world ranking of PISA test, also focuses on problem-solving. It has been identified that problem-solving process is one of the five mathematical teaching strategies apart from skill, concept, attitude, and metacognition. Problem-solving processes



include: 1) reasoning, meaning transfer and connection; 2) application and appropriate format creation; and 3) thinking skill directly gained from the students (OECD, 2016, p. 16).

The origin of PISA lesson

In 2016–2017, Mr. Wichai Panichsuay and the team has been supported by National Research Council of Thailand (NRCT), budget year 2017, to conduct the research study on *Effects of applying PISA Lesson on Mathematical Process Skills of Elementary Student (Phrase II)*. The study was about the application of created PISA lesson, the mathematical process skill practice related to PISA test, into mathematics classes for 6–8 weeks, 2–3 times a week which took 20–30 minutes each time. The sample group were 850 Grade-4 students from Bangkok, Northern, North Eastern, and Southern schools. The result of mathematical process skill practice measurement was found that its reliability was 0.73, p was between 0.28–0.78, and r was between 0.26–0.65 (Panichsuay et al., 2017). The study was found that the posttest score of the sample group after PISA lesson was significantly higher the pre-test score, 0.05. The study was also found that: 1) more than 50 percent of the sample group were the most satisfied with PISA lesson because of its interestedness and enjoyable environment; and they would like to use this lesson in the next academic year; and 2) the teachers of the sample group of students agreed that PISA was interesting and encouraged students to apply knowledge and mathematical skill into real-life situation. Moreover, it should be applied in teaching mathematics in every level of primary education. The sample group of students should also be supported to use PISA lesson in the next academic year.

What are the characteristics of PISA lesson?

The researcher has addressed earlier that PISA lesson was the mathematical process skill practice which was in accordance with PISA test. Before describing about PISA lesson, the research will introduce the concept and some examples of PISA test.

Programme for International Student Assessment (PISA) is the project of international students' assessment to OECD countries and partner countries. The objective of the program is to search for the educational quality key-performance indicator to the member country in order to do the assessment. The sample group consists of about 15-year-old 510,000 students, from 65 countries. The assessment includes three aspects: reading, sciences, and mathematics. For mathematics assessment, PISA emphasizes that mathematical literacy is an important factor to live. The assessment objective is to evaluate the mathematical knowledge and skills. Instead of mathematical contents as taught in schools, PISA focuses on real-life situations in which students must apply their knowledge into various real-life situation. PISA introduces **mathematical knowledge assessment framework** covering three aspects as following.

1. Process: explain what each person does in order to connect the problem context with mathematics, and solve the problem;
2. Content: solve the mathematical problems through the content
3. Contexts: where the problems exist (PISA THAILAND, 2014, pp. 1–2).

Example of PISA test

Dice

There are 2 dices on the right

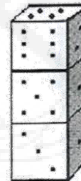
Dice is a cube, marked on its faces with spots from one to six,
Its rule is the addition of the opposite parts is always 7

Question 1: Dice

On the right-hand side, there are 3 dices laid on each other. The first one has 4 spots on the top.

How many spots on the parts of the dices that are parallel with the 5 parts (the bottom parts of the first dice on the top and bottom of the second and the third dices).





First Dice

Second Dice

Third Dice

Answer

Correct answer: 17

Other answers: no points

Test's Characteristics

Content: Space and shape

Field of study: -

Situation: Personal

Potential: Connectivity

Type of test: Closed answer

Country: Correct

Thailand 15.71

Notice:

This test is specially for field test, so there are no data of other countries

Figure 1 PISA Sample Test on Dice

Source: PISA THAILAND, 2014



Bookshelf

To make a bookshelf, the carpenter needs the following elements:

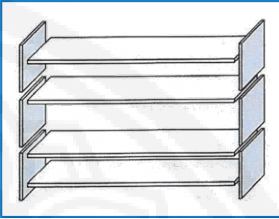
4 plates of long wooden board	6 plates short wooden board	12 small pins
2 big pins	14 screws	

Question 1: Bookshelf

The carpenter has 26 long and 33 short rectangle wooden boards, 200 small pins, 20 big pins, and 510 screws.

How many bookshelves can the carpenter make?

Answer



Answer

Correct answer: 5

Other answers: no points

Test's Characteristics

Content: Quantity

Field of study: Quantity

Situation: Career

Potential: Connectivity

Type of test: Short answer

Countries: Correct

Japan	70.04
Korea	72.25
Hong Kong - China	74.47
Macao - China	66.76
Thai	35.16

Figure 2 PISA Sample Test on Bookshelf

Source: PISA THAILAND, 2014

Sample of PISA lesson

PISA lesson is the mathematical skill practice created to improve primary level students' mathematical process skill, which is similar to PISA Test. The examples in this study are excerpts from PISA lesson for primary level (B.E. 2559).

Sample of PISA lesson

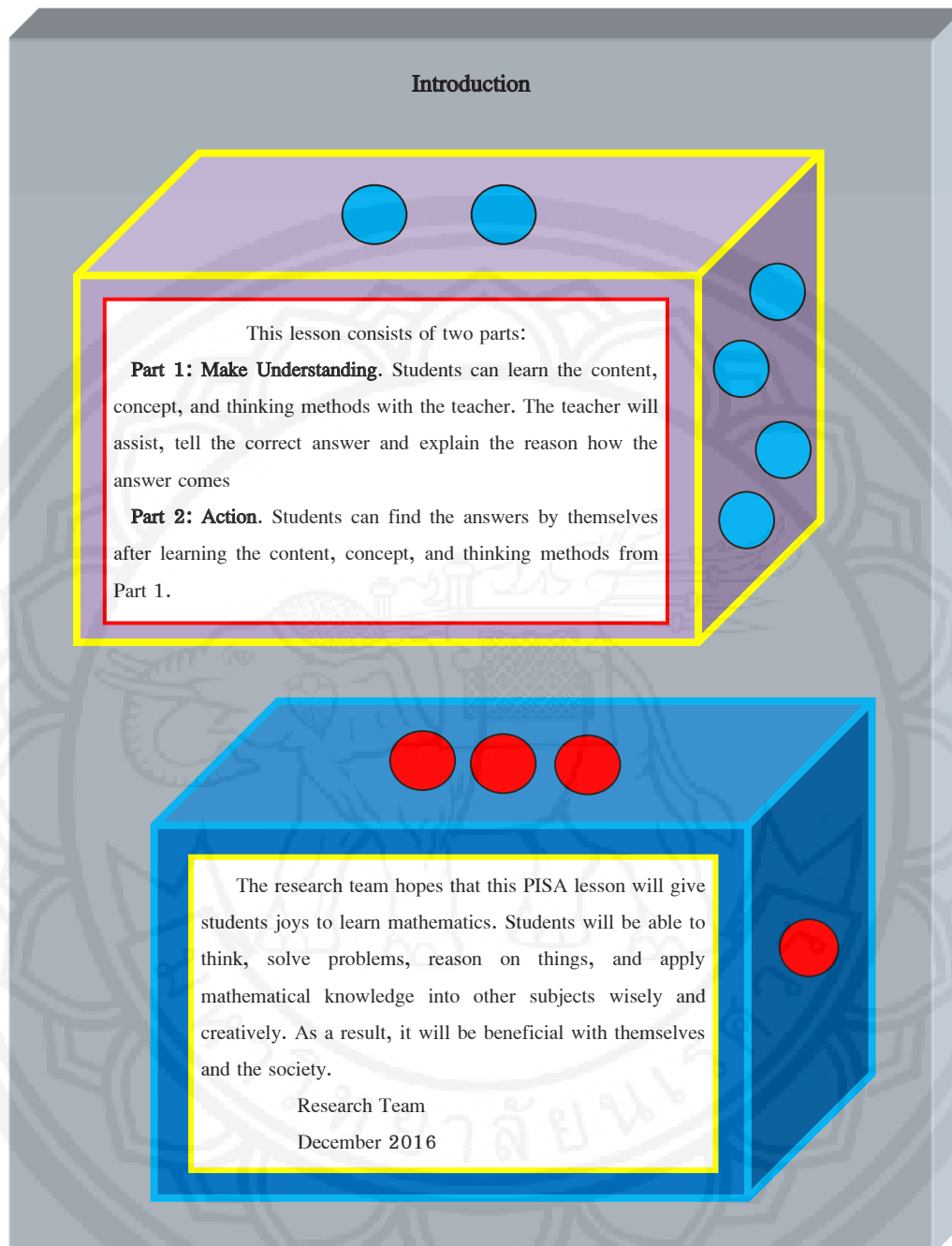


Figure 3 Introduction of PISA Lesson

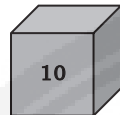
Source: Panichsuay et al., 2016



Young Architect

Part 1: Make Understanding

This is the “block” that students use to build a building. There are 2 types of “block”.

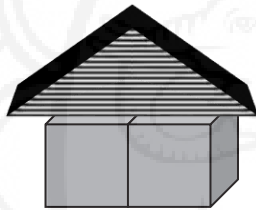


“Classroom” blocks have number 10 on them

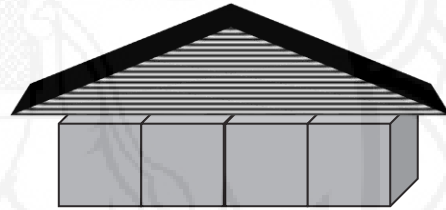


“Roof” blocks consist of 2 different sizes with 2 different numbers on them, for each building

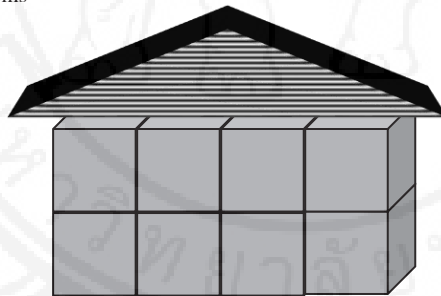
These are the examples of each building:



1 story 2 classrooms



1 story 4 classrooms



2 stories 8 classrooms

Figure 4 Sample of PISA Lesson on Young Architect (1)

Source: Panichsuay et al., 2016



Mark ✓ in the ☐ of the correct answer

1. If we want to build a 1-story-2-classroom-building, what is the sum total?

☐ 20

☐ 40

2. If we want to build a 1-story-4-classroom, what is the sum total?

☐ 80

☐ 100

3. If we want to build a 2-story-4-classroom building, what is the sum total?

☐ 60

☐ 80

4. If we want to build a 2-story-8-classroom building, what is the sum total?

☐ 100

☐ 120

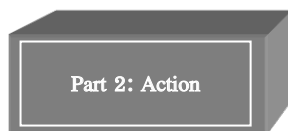
5. If we want to build a 3-story-12-classroom building, what is the sum total?

☐ 140

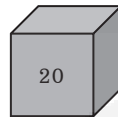
☐ 160

Figure 5 Questions on Young Architect (1)

Source: Panichsuay et al., 2016



There are 2 types of blocks to build a dormitory:



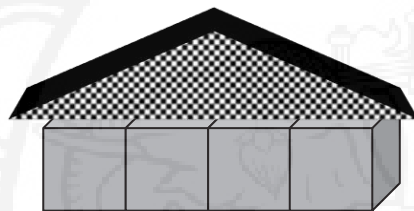
Every “dormitory” block has number 20 on it



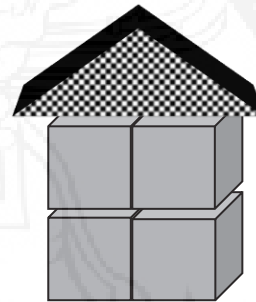
There are 3 types of “dormitory roof” block.

Each type has a different size and number on it so that we can choose which is suitable for a particular dormitory.

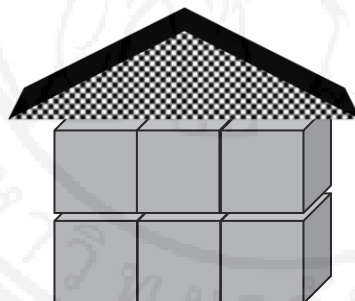
These are the samples of each type of dormitory



1 story 4 rooms



2 stories 4 rooms



2 stories 6 rooms

Figure 6 Sample of PISA Lesson on Young Architect (2)

Source: Panichsuay et al., 2016



Mark ✓ in the ☐ of the correct answer, or write down the correct answer

1. If we would like to build a 3-story-6-room dormitory, what is the sum total?

☐ 170

☐ 195

2. If we would like to build a 3-story-12-room dormitory, what is the sum total?

☐ 315

☐ 340

This following table shows the construction costs of each dormitory

Type of Dormitory	Cost (baht)
1 story 2 rooms	90,000
1 story 3 rooms	135,000
2 stories 8 rooms	260,000

3. If we would like to build a 1-story-4-room dormitory, what is the sum total?

☐ 130,000 baht

☐ 155,000 baht

☐ 180,000 baht

4. If we would like to build a 3-story-9-room dormitory, what is the sum total?

☐ 230,000 baht

☐ 255,000 baht

☐ 280,000 baht

5. Aek would like to use the blocks to build a 2-story-10-room dormitory. Can he do it? Why or why not?

.....
.....
.....
.....

Figure 7 Questions on Young Architect (2)

Source: Panichsuay et al., 2016

What are the good characteristics of mathematical process skill practice?

There are various kinds of skill practice media which differ based on the purposes. Therefore, the mathematical process skill practice is also different. The good characteristics of mathematical process skill practice are described below.

1) Always integrate word or story problems into teaching mathematics. Teaching mathematics should emphasize on problems/situations and should be identified into the mathematical curriculum. Occasional integration of problems/situations is not recommended. Teaching mathematics integrated with situations helps studying mathematics easier. When students understand the problem/situation, training them to create a problem/imitated situation/ same situation as well as create a problem/new situation are also recommended. This will improve students' creativity, understanding, and adaptation to real-life situation.

2) Design various kinds of problems/situations including convergent questions and divergent questions. A convergent question is generally used. It is sometimes a measurement of thinking level or basic understanding. However, it does not mean that convergent questions are not good due to the fact that several situations require only one correct answer. Divergent questions encourage students to think divergently and be confident with complicated situations.



3) Design the performance context for the students to solve the problems by themselves. Teaching problem/ situation needs to focus on students and to design the contexts that students will face and solve the problems. The school context is different from home context; so, parents should take benefits from outside-school contexts e.g. home or department store to improve mathematical skill. Tucker (2014, p. 12) suggested the similar idea in which creating a mathematical learning environment to be close to the real-life situations is important. Encouraging and inspiring students to be active to study, as well as giving students opportunities to interact and consult with each other are the things that should not be ignored. These factors offer students good experiences so that they will realize the value of mathematics. Van de Walle, Karp, Lovin, & Bay-Williams (2014, p. 19) also suggested that introducing students the situation/ context that stimulates students to find the answer is one of the methods of making mathematical class livelier and more beneficial. For example, teaching to find the sum total of 2-digit numbers' multiplication. If the teacher introduces by telling the students that "today, we will use the table template to find the sum total of 2-digit numbers' multiplication"; the students may not be enthusiastic about finding the answer despite using the table template as the teaching media. On the other hand, if the teacher creates a situation of the school annual festival where the primary-4 students take part as the water sellers. The students have 14 boxes of water, but there are only 4 boxes of water with 7 rows, 4 bottle each row. The rest is kept at another place. So, the teacher leads the students to think about how many bottles of water they have. This sample of creating a situation will encourage the students to find the answer and have fun with it.

4) Use easy language to avoid confusing problem/ situation/ context that is created. For the new way teach mathematics, which focuses on students to find the answer from problem/ situation/ context that is created, what is unavoidably related is language. Molina (2012, p. 1) stated in her book *The Problem with Math is English* about the similar issue that there are 2 difficulties in teaching mathematics: the mathematics itself and the language and symbols. Therefore, the teachers should use easy language. This is because when the students do not understand for are confused with the problem/situation/context, the problem of learning mathematics immediately occurs.

5) Design the problem/situation that helps student to apply in real-life situations. Bartlett (2013, pp. 6-8) addressed that mathematics is everywhere around us, so we should learn and use it. For example, the teacher creates a situation of taking 40 students to a study tour by minibus. If a minibus can contain 12 students, how many buses is required? If the students answer 3.33 buses, it shows that they still lack of reasonable real-life situation. This is because, the reasonable number of buses is 4.

Another step to prepare PISA lesson for the educational benefit

Throwing back to the previous study on *Effects of applying PISA Lesson on Mathematical Process Skills of Elementary Student*, in which the research team has applied PISA lesson with primary students in both Bangkok and regional schools, it has been found that despite the students' interests, the mathematical teachers who taught the sample group of students were also interested in it. 24 teachers of the sample group of students have learned the characteristics of PISA lesson along with applying in classes while the research study was conducted. Moreover, the teachers have created 1 PISA lesson and submit to the research team to assess the quality. The result of the PISA lesson quality assessment made by the teachers has been found that 1 story was in the Very Good level, followed by 7 Good-level stories, 15 Fair-level stories, and 1 Improvement-needed story. The result is in the satisfied level which reflects that the teachers intended to apply PISA lesson into mathematical classes. At the brainstorming meeting on "PISA Lesson and the Application for Educational Benefits" held by National Research Council of Thailand (NRCT), in June 2019; it was found that primary-level mathematical teachers from the



central and regional parts had the same idea as the mathematical teachers of the sample group of students, which PISA lesson should be applied in mathematics subjects in every level of study. Those teachers who attended the meeting agreed that PISA lesson's contents cover all the three groups of mathematics in primary level, including number and algebra, measurement and geometry, and statistics and probability. The learning standard and key performance indicators also emphasize the process of real-life application. 15 of 16 teachers who attended the meeting would like to apply PISA lesson into their teaching, in the "high" and "highest" levels.

Conclusion

An application of media/lesson/practice into teaching process provides students knowledge, competency, skill, and experience based on each field of study's purposes. PISA lesson also encourages students with mathematical process skill in which they can apply into real-life situations. However, mathematical teachers in primary level should initially realize that the heart of teaching mathematics in primary level is to teach students the concepts, followed by calculation, and application of mathematical skill to solve the problem in each lesson/unit. After that, the teachers train the students to solve the problems from each situation that they have created. In this step, the teachers can apply PISA lesson into teaching. Another important issue is that teacher should always realize that the better mathematical process skill practice than PISA lesson is the practice made by the teachers to use with their own students. This is because the made lessons are truly in accordance with the students' school/community context. Finally, PISA lesson should be apply all around the country without any command from those who indicate the educational policy, because the most effective action does not come from command, but the love and intention to develop one's work (Chunharas, 2014). So, there should be more studies which primary-level teachers can create their own mathematical process skill practice. The works will then be transferred to the next generations of teachers through routine to classroom research. The educational institutes will be the organization of learning by applying action learning and action research (ALAR), by Zuber-Skerritt (2001), as the conceptual framework.

References

- Bartlett, J. (2013). *Becoming an Outstanding Mathematics Teacher*. New York: Routledge. <https://doi.org/10.4324/9780203797372>
- Chunharas, S. (2014). *Routine to Research (R2R): Dream Come True?* Retrieved from <http://r2rthailand.org/download/25Jul2014%20Grand%20ปาฐกถาพิเศษ%20เรื่อง%20R2R%20ในพื้นที่อยากเห็น.pdf>
- Klainin, S. (2015). *Mathematics Education of Thai School: Development–Effect–Present Recession*. Bangkok: The Institute for the Promotion of Teaching and Technology (IPST). Retrieved from <https://pisathailand.ipst.ac.th/ipst-958/>
- Molina, C. (2012). *The Problem with Math is English*. San Francisco, CA: Jossey-Bass.
- National Institute of Educational Testing Service. (2018). *Annual Report 2017*. Bangkok: National Institute of Educational Testing Service.



National Institute of Educational Testing Service. (2019). *Annual Report 2018*. Bangkok: National Institute of Educational Testing Service.

OECD. (2016). *Ten Questions for Mathematics Teacher... and How PISA can Help Answer Them*. Paris: OECD Publishing. <https://doi.org/10.1787/9789264265387-en>

OECD. (2018). *PISA 2015 Results in Focus*. Retrieved from <https://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf>

Panichsuay, W. (2012). *How to Teach the Child to be Good at Problem Solving* (2nd ed.). Bangkok: Institute of Academic Development.

Panichsuay, W., Waiboonya, S., Suphkit, P., Loungkeaw, R., Choonddee, A., Chanapai, K., & Noimai, C. (2016). *PISA Lesson for Elementary Level*. Bangkok: Graphic Site, Suandusit University.

Panichsuay, W., Waiboonya, S., Suphkit, P., Loungkeaw, R., Choonddee, A., Chanapai, K., & Noimai, C. (2017). *The Effects of Using PISA Lesson Instruction on the Ability of Mathematical Process Skills of Elementary Students (Phase 1)* (Research report). Bangkok: Graphic Site, Suandusit University.

PISA THAILAND. (2014). *Examples of Mathematics Test PISA 2012*. Bangkok: V. J. Printing. Retrieved from <https://pisathailand.ipst.ac.th/isbn-9786163620248/>

The Institute for the Promotion of Teaching Science and Technology (IPST), Ministry of Education. (2018). *Curriculum Handbook Group of Mathematics (Revised edition 2017) Elementary Mathematics*. Retrieved from <http://www.scimath.org/e-books/8378/8378.pdf>

Tucker, T. K. (2014). *Mathematics through Play in the Early Years* (3rd ed.). New Delhi, India: Sage Publications.

Van de Walle, J. A., Karp, K. S., Lovin, L. H., & Bay-Williams, J. M. (2014). *Teaching Student-Centered Mathematics: Developmentally Appropriate Instruction for Grade 3–5 (Volume II)* (2nd ed.). New Jersey: Pearson Education.

Zuber-Skerritt, O. (2001). Action Learning and Action Research: Paradigm, Praxis and Programs. In S. Sankara, B. Dick, & R. Passfield (Eds.), *Effective Change Management through Action Research and Action Learning: Concepts, Perspectives, Processes and Applications* (pp. 1–20). Lismore, Australia: Southern Cross University Press. Retrieved from <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.464.5871&rep=rep1&type=pdf>