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Development of Learning Activities Concrete-Pictorial-Abstract (CPA) That Promotes Mathematical Concepts Concerning Solving Problems in Addition, Subtraction, Multiplication, and Division for Students In 3 Grade Students

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Received: September 18, 2025 Revised: March 25, 2026 Accepted: June 26, 2026

Abstract

The objectives of this research are: 1) To develop learning activities based on the Concrete-Pictorial-Abstract (CPA) concept that promotes mathematical concepts on problem solving, addition, subtraction, multiplication, and division for grade 3 primary school students to be effective according to the 80/80 criteria 2) To compare the mathematical concepts of solving problems of addition, subtraction, multiplication and division of 3 grade students according to the Concrete-Pictorial-Abstract (CPA) concept with the 75 percent criterion and 3) To study the satisfaction of grade 3 primary school students towards learning mathematics on solving problems involving addition, subtraction, multiplication and division. The sample group was 10 third grade students in the first semester of the academic year 2024 at Wat Devarajkunchorn School, selected by purposive simple. The research instruments were 4 learning plans, a 10-item achievement test with a reliability of 0.73, and a satisfaction questionnaire. The statistics used were mean (M), standard deviation (SD), and one sample t-test. The research results found that 1) the mathematics learning activity development plan had an efficiency of 82.26/81.50, which met the specified criteria. 2) The post-study mathematics concept test score was 81.50 percent, which was higher than the specified criteria with statistical significance at the .05 level. 3) Overall satisfaction was at the highest level with an average value (M=4.75, SD=0.48).

Keywords: Development of learning activities; Concrete-Pictorial-Abstract (CPA); Mathematical concepts; Problem solving

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■ Introduction

In Thailand, mathematics plays a very important role in the success of learning in the 21st century because mathematics helps humans to be creative, think logically, systematically, and methodically, analyze problems or situations carefully and thoroughly, and helps to predict, plan, decide, and solve problems correctly and appropriately, and can be applied in real life effectively. In addition, mathematics is a tool for studying science, technology, and other sciences, which are the foundation for developing the quality of the nation's human resources and developing the country's economy to be on par with international standards. Therefore, the study of mathematics must be continuously developed in order to be up-to-date and consistent with the economic, social, and scientific and technological conditions that are rapidly advancing in the era of globalization (Ministry of Education, 2019). Humans are creatures that can continuously develop their thought systems effectively. This is so that humans can survive and continue their species until today. One thing that makes humans intelligent in thinking is logical thinking or numerical thinking. This results in humans having a logical and systematic thought process. They have developed a good and efficient thought system, which allows society, country, and the world to continuously develop due to human thought processes. Solving mathematical problems is therefore considered an important and necessary process that all students should learn and understand, be able to think and solve problems, in order to apply this process to solve problems in daily life (Institute for the Promotion of Teaching Science and Technology, 2019). It is also a basic skill that students can use to solve problems in daily life throughout their lives.

It can be seen that mathematics is important to human life. It helps humans to have the ability to solve problems, reason, communicate and convey meaning, make connections, and be creative. They can cope with problem situations in the context of real life. In addition, the rapid advancement of technology requires the separation of data to be used for decision making in various contexts correctly and appropriately. Problems and situations that occur must be analyzed thoroughly and carefully. Mathematics is therefore useful for life. For this reason, each educational institution will use mathematics as a main component in organizing learning in order to create a foundation of thinking for solving problems in daily life effectively in Thailand (Ministry of Education, 2019).

Mathematical concepts are an important foundation for learning mathematics because success in learning mathematics depends on understanding the correct concepts. If students have the correct concepts, they will be able to learn and solve mathematical problems well, including having the foundation to connect and think about mathematics well (Mhajibakklang, 2011). From the problem of organizing the learning activities in mathematics that have not yet been successful as the school has set its goal from the past academic achievement of the students, the researcher as a teacher in the school has tried to develop the classroom teaching to be suitable for each situation that the teacher has encountered. This is to develop the teaching methods to be suitable for the context of the school where the researcher teaches, especially in the subject of mathematics, which is a subject where students have lower academic achievement than

other subjects.

When considering the content level in the subject, the researcher found that students have the lowest academic achievement in solving problems, addition, subtraction, multiplication, and division, which students still lack understanding in solving problems, addition, subtraction, multiplication, and division, causing students to have low academic achievement in such subjects from the past academic achievement reports from the report of student quality assessment results.

From the national test of basic abilities of students (national test: NT) in mathematics of grade 3 students in the academic years 2019, 2020 and 2021, the national level had scores of 44.94 percent, 40.47 percent and 49.44 percent, respectively, and Wat Devarajkunchorn School had scores of 54.76 percent, 30.61 percent and 51.85 percent, respectively, which were found to be low scores and in the academic year 2020, the scores were lower than the national level National Institute of Educational Testing Service (2022). From the consideration of the learning achievement in mathematics, it was found that it was lower than the criteria set by the school. And when considering the details of the content, it was found that solving mathematical problems on addition, subtraction, multiplication and division had the lowest scores (Wat Devarajkunchorn School, 2022).

The researcher therefore studied the teaching methods that would help develop the learning achievement in mathematics of students to a higher level as a teaching method that promotes mathematical concepts. The approach to promoting mathematical concepts is that students need to gain experience from appropriate learning activities, and teachers must take into account physical and intellectual development, and must create correct concepts with concrete media, giving students the opportunity to touch, learn through thinking, analyzing, and synthesizing (Isaraprida, 2006), which is consistent with Piaget's theory of intellectual development (Angganapattarakajorn, 2011), which states that knowledge structures will continuously develop according to the stages of intellectual development. Students in late primary school correspond to Piaget's thinking stage of children aged 7-11 years, who are in the Concrete Operation Stage. It is also consistent with Pattanatrakoolsook(2002) statement that children of this age can understand reasons and know how to solve problems in concrete things. However, teachers must try to change the abstract things in mathematics into something concrete that is easier to see and can be understood quickly by using the learning process with concrete media, allowing students to experience it in explaining mathematical reasons, and choosing activities that are appropriate for the objectives will help learners connect different ideas and eventually create correct concepts.

There are many forms of learning activities to promote concepts, but the researcher is interested in organizing learning activities in the Concrete-Pictorial-Abstract (CPA) format, developed by an American psychologist named Jerome Bruner. It is a learning activity method that the Singapore Ministry of Education has included in the curriculum for developing basic mathematical concepts used in schools (Hui, Hoe and Lee, 2017). As a result, Singaporean students have the highest mathematical aptitude in the world, according to the PISA ranking in 2022 (Institute for the Promotion of Teaching Science and Technology, 2022). The learning activities start with concrete things, are presented as diagrams, and are linked to mathematical symbols, which helps students systematically understand

mathematics from concrete to abstract. They can understand and explain the overall picture and origin of complex problems, leading to problem-solving methods, and can develop deep understanding until sustainable mathematical concepts emerge. Because CPA learning is a method that creates understanding of meaning, promotes learning from easy to difficult, and is a method that is appropriate for the intellectual development according to the age of the learner.

The Concrete-Pictorial-Abstract learning management is a learning management approach that teaches from concrete to abstract. It is a learning management that emphasizes developing students' understanding of mathematics by using the students' experiences and learning patterns to practice their thinking processes and problem-solving in a sequential manner. The teacher is responsible for organizing learning in all 3 steps: concrete presentation, picture display, and symbol display (Ministry of Education Singapore, 2013) which was developed from Bruner (1960) discovery learning theory that learning is a social process in which students must act and create knowledge by themselves, based on their previous experiences or knowledge. It can be divided into 3 steps: learning from action (Enactive stage) is the doing stage is concrete. In this phase, students model problems with tangible objects. The CPA approach makes concepts come to life by letting kids interact with and handle tangible (concrete) objects, in contrast to traditional math teaching methods where teachers show how to solve a problem. Every abstract idea is first presented using tangible, interactive concrete materials when using the CPA framework., learning from thoughts (Iconic stage) is the seeing stage is pictorial. Here, problems are modeled using visual representations of actual objects. Children are encouraged to draw a mental link between the abstract images, diagrams, or models that depict the objects from the problem and the tangible object they just handled, and learning symbols and abstracts (Symbolic stage) is the children use abstract symbols to model problems during the symbolic stage. Until they have shown that they have a firm grasp of the problem's concrete and pictorial stages, students will not advance to this stage. The teacher introduces abstract concepts (like mathematical symbols) during the abstract stage. Using only numbers, notation, and mathematical symbols (such as +, -, x, and /) to represent addition, multiplication, and division, children are introduced to the idea at a symbolic level, which will promote students to develop skills in many areas, especially communication skills. In terms of problem-solving, it is teaching appropriately for each age group's development. (Hafiziani, 2015) The study concluded that the Concrete-Pictorial-Abstract (CPA) approach is effective in improving students' mathematical understanding. Students who learned through CPA were better able to: develop conceptual understanding of mathematics, represent mathematical ideas in multiple forms (concrete, visual, and abstract), and solve mathematical problems more systematically. Additionally, CPA learning helped students connect prior knowledge with new concepts, making learning more meaningful and easier to understand.

Therefore, the researcher is determined to conduct classroom action research to develop CPA learning activities that promote mathematical concepts on addition, subtraction, multiplication, and division for grade 3 students to be used in organizing teaching and learning activities. This is because organizing such learning activities is a learning management process that focuses on solving problems directly. Therefore, the researcher has brought CPA learning activities to help promote the learning management process so that students can develop mathematical concepts from abstract content to be more concrete in order to increase understanding and be able to analyze problems more easily. The researcher expects that after

students have studied through the mathematics learning activity development plan on solving problems on addition, subtraction, multiplication, and division for grade 3 students, it will help students understand mathematics more and be able to solve problems from real-life situations systematically and step by step by using mathematical operations and checking the answers obtained correctly, as well as helping students develop higher academic achievement and help students reach the desired characteristics of analytical thinking skills, critical thinking, problem solving, creativity, using technology, and communication with an emphasis on cooperation.

■ Conceptual framework and related theories

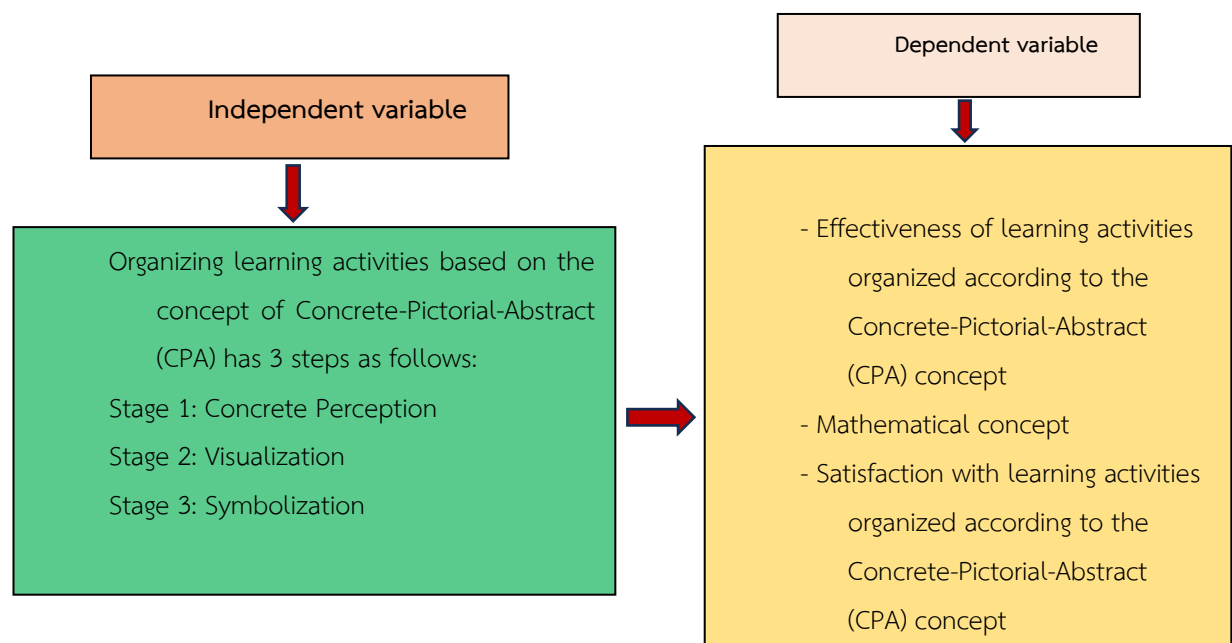


Fig 1. Research conceptual framework: The researcher used the learning activities based on the Concrete-Pictorial-Abstract concept (CPA) (Bruner ,1960)

■ Research objectives

1) To develop learning activities based on the Concrete-Pictorial-Abstract (CPA) concept that promotes mathematical concepts on problem solving, addition, subtraction, multiplication, and division for Grade 3 primary school students to be effective according to the 80/80 criteria.

2) To compare the mathematical concepts of solving problems of addition, subtraction, multiplication and division of Grade 3 students according to the Concrete-Pictorial-Abstract (CPA) concept with the 75 percent criterion.

3) To study the satisfaction of Grade 3 primary school students towards learning mathematics on solving problems involving addition, subtraction, multiplication and division.

■ methodology

Research operations

The researcher used a classroom research methodology, a mixed quantitative and qualitative research method, as a classroom experiment with the following steps:

The researcher used a classroom research methodology, a mixed research design between the population in this research were 3 grade students in schools under the Bangkok Metropolitan Administration, Dusit District Office, Semester 1, Academic Year 2024, with a total of 358 people studying Mathematics, Mathematics Learning Area Group (Revised Edition 2017) according to the Basic Education Core Curriculum B.E. 2008.

The sample group in this research was grade 3 students of (Wat Devarajkunchorn School, Dusit District Office, Bangkok, Semester 1, Academic Year 2024, consisting of 1 classroom, 10 students, mixed abilities, studying Mathematics subject, Mathematics Learning Area Group (Revised Edition 2017) according to the Basic Education Core Curriculum B.E. 2008, obtained from purposive simple.

Tools used in research

The research instruments consisted of three types: a mathematics learning activity development plan, a mathematics concept test, and a satisfaction questionnaire. The development steps were as follows:

1. Plan of learning activities based on the Concrete-Pictorial-Abstract (CPA) concept that promotes mathematical concepts on problem solving, addition, subtraction, multiplication, and division for Grade 3 primary school students. The revised learning activity plan was tested with students who were not the research sample group. The individual experiment was conducted with 3 students, consisting of 1 good student, 1 average student, and 1 weak student, to find the efficiency according to the 60/60 criteria. It was then revised and tested with 9 students, consisting of 3 good students, 3 average students, and 3 weak students, to find the efficiency according to the 65/65 criteria to find the shortcomings of time, teaching media, content, and activities. The shortcomings from the trial were then revised and corrected. The field experiment was conducted with 30 students to find the efficiency according to the 70/70 criteria, as determined by the researcher as E1/E2, where E1 is make activity sheets during lessons 1-4, and E2 is the mathematics achievement test on problem solving, addition, subtraction, multiplication, and division for grade 3 students, according to the principles of Phromwong (2013). There are 4 learning activity plans, each plan has 3 steps of learning activities as follows:

Step 1 Concrete: Perception This activity is an introduction to the lesson or content by starting with the use of objects, things, things near the learner or learning media that are concrete in nature and consistent with the content of the learning activity for the students to study, touch or see as real things.

Step 2 Pictorial: Image creation This activity is the step where students create a conceptual model by transforming something concrete into a drawing or using a virtual image to represent it. Students will be able to practice to their full potential, and the image must be consistent with the content being studied.

Step 3 Abstract: to becoming an icon This activity is the transformation of drawings or conceptual models into symbols, in this case, numbers and mathematical notations, to be used in solving problems or finding answers that students want. This step allows students to visualize and understand in an abstract form. There is a presentation to communicate and convey the students' mathematical meaning to others. For the demonstration of learning activities using the teaching method based on the Concrete-Pictorial-Abstract (CPA) concept, there are:

2. The development of a mathematics concept test on addition, subtraction, multiplication, and division for grade 3 students using the Concrete-Pictorial-Abstract (CPA) teaching method. It was a 4-choice, 40-question multiple-choice test covering the content on the problem solving. The development of the achievement test was presented to 3 experts in mathematics teaching, curriculum and instruction, and measurement and evaluation to examine the appropriateness and consistency between the test, learning objectives, and content. The experts considered and gave their opinions, and then calculated the content validity (Index of Item Objective Congruence: IOC) between 0.67-1.00. The development of the achievement test was then tested with students who were not in the tryout group. who had previously studied the content about factoring of quadratic polynomials, totaling 30 students, then took the test results to find the difficulty level (p) and discrimination value for each item then selected the test questions to be left with 20 questions, with a reliability value of 0.73, calculated using the formula according to KR-20 (Frederic Kuder, G.,1937) difficulty level between 0.25-0.76, discrimination value between 0.24-0.81, and then took the revised achievement test to with the sample group.

3. Study the method of creating a satisfaction questionnaire from the textbook on satisfaction questionnaires and related research documents. The researcher created a questionnaire to measure students' satisfaction towards the organization of a learning activity in the questionnaire for measuring satisfaction with the development of learning activities based on the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on addition, subtraction, multiplication, and division of grade 3 students is a rating scale with 5 levels of scores that reference criteria for interpreting the mean score 4.51–5.00: highest, 3.51–4.50: high, 2.51–3.50: moderate, 1.51–2.50: low, and 1.00–1.50: lowest (Srisa-ard. B, 2017) with 10 items. The questionnaire was then presented to 3 experts to examine its appropriateness and consistency with the organization of a learning activity in mathematical concepts on addition, subtraction, multiplication, and division of grade 3 students using the teaching method based on the Concrete-Pictorial-Abstract (CPA) concept. The questionnaire was revised according to the experts' suggestions and the index of item objective congruence (IOC) was calculated, which was between 0.67-1.00. The questionnaire was then presented to the advisor and used with the sample group.

Experimental conduct and data collection

After following the process of finding the quality of the research instruments as detailed above, the researcher proceeded and collected the following data:

1. From the process of studying documents related to the implementation of the development plan for mathematics learning activities, 4 plans, and then applied them to the sample group, the researcher

was the one who carried out the learning activities and collected the data by himself.

2. From the process of studying documents related to the implementation of the mathematics concept test, the researcher brought 10 questions to test the mathematics concept with the sample group, the researcher was the one who controlled the test and collected the data by himself.

3. From the process of studying documents related to the implementation of the satisfaction questionnaire, the researcher surveyed the satisfaction of the students after organizing the learning activities in 5 areas from using the development plan for mathematics learning activities, 4 plans, and collected the data by himself.

Data Analysis

The results of the mathematics concept test, which was conducted through the organization of learning activities according to the Concrete-Pictorial-Abstract (CPA) concept to strengthen mathematics concepts on problem solving, addition, subtraction, multiplication, and division of Grade 3 students after studying, were used to find the percentage, arithmetic mean (M), standard deviation (SD), and to compare the average scores of mathematics achievement with the 75 percent criterion. using the one sample t-test.

Results

Research results on the development of learning activities based on the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on problem solving, addition, subtraction, multiplication, and division of grade 3 primary school students.

1. The results of the efficiency of learning activity development based on the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on problem solving, addition, subtraction, multiplication, and division of Grade 3 primary school students are in accordance with the specified criteria as shown in Table I.

Table 1. Results of the effectiveness of learning activity development based on the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on problem solving, addition, subtraction, multiplication, and division of Grade 3 primary school students (sample group).

score	n	Full score	Average score	Percentage
Doing activity sheets 1-4 during the learning activity (E_1)	10	60	49.56	82.26
Post-Test (E_2)	10	20	16.30	81.50
$E_1/E_2 = 82.26/81.50$				

And the researcher presented the efficiency of learning activities before testing them with the sample group, which were effective according to the criteria, as shown in Table II.

Table 2. Results of the effectiveness of the development of learning activities based on the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on problem solving, addition, subtraction, multiplication, and division of Grade 3 primary school students before using with the sample group (tryout group).

Efficiency of learning activities	E ₁	E ₂	E ₁ /E ₂
Single Efficiency 60/60 (n = 3)	65.03	66.48	65.03/66.48
Group Efficiency 65/65 (n = 9)	68.45	69.76	68.45/69.76
Field Efficiency 70/70 (n = 30)	74.08	73.39	74.08/73.39

2. The mean score after learning was 16.30 points out of a full score of 20 points. When comparing the mean score after learning with the 75 percent criterion using a one sample t-test, it was found that the mean score after learning was significantly higher than the specified criterion at the .05 level as shown in Table III.

Table 3. Comparison results of mathematical concepts from organizing learning activities based on the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on problem solving, addition, subtraction, multiplication, and division of Grade 3 primary school students with the 75 percent criterion.

Experimental group	n	μ (75 percent of the full score)	M (Full score 20)	% Of mean	t	sig.
Post-Test	10	15	16.30	81.50	2.899*	p < .001

Note: * Statistically significant at the .05 level.

3. The level of satisfaction with the learning activities organized according to the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on problem solving, addition, subtraction, multiplication, and division of Grade 3 primary school students was at the highest level overall with an average value (M=4.75, SD=0.48) as shown in Table IV.

Table 5. Satisfaction level towards learning activities organized according to the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on problem solving, addition, subtraction, multiplication, and division of Grade 3 primary school students.

Items	M	SD	meaning	Order number
1. In terms of content	4.73	0.41	highest	4
2. In terms of organizing learning activities	4.81	0.46	highest	1
3. In terms of learning media	4.75	0.49	highest	3
4. On the teaching side	4.71	0.37	highest	5
5. In terms of measurement and evaluation	4.77	0.47	highest	2
Total average	4.75	0.48	highest	-

■ Discussion

From the research results of organizing learning activities based on the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on problem solving, addition, subtraction, multiplication, and division of Grade 3 primary school students, the researcher discussed the results of the research findings as follows:

1. From the analysis of the efficiency of the development of learning activities based on the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on solving problems, addition, subtraction, multiplication, and division of Grade 3 students, the efficiency was 82.26/81.50, which was in accordance with the criteria of 80/80 that the researcher had set since the beginning before the research. Because the researcher created a mathematics learning activity plan that focused on the learner at every step, which was in accordance with what the Institute for the Promotion of Teaching Science and Technology (2019) stated that the principle of learning management in mathematics that focuses on the learner is to give the learner an opportunity to think and solve problems by themselves. The teacher plays a part in organizing the content and activities to be consistent with the interests and abilities of the learner, taking into account the differences between individuals. The teacher acts as a consultant who provides advice and guidance on the shortcomings of organizing learning activities in this manner, giving the learner an opportunity to think together, solve problems, consult, discuss, and express opinions with reason, helping the learner to develop both knowledge, skills, thinking processes, and experiences. Therefore, the learning activities created by the researcher stimulate thinking and analysis so that the students can learn the skills of analyzing quadratic equations with one variable from reading and can analyze them separately. Write in what the problem gives and write the various processes in the steps in order of solving the problem using the learning management according to the CPA concept. The important highlight is that it is the organization of learning activities that allow students to learn mathematics through concrete things that can be touched. Then convert them into pictures and can be written in the form of mathematical symbols finally. The learning management according to the CPA concept also helps students to have the ability to communicate and convey mathematical meaning even more, which is consistent with Phromwong (2013) stated that before producing media or teaching activity sets, the media must be tested for efficiency to see whether the media or teaching activity sets increase learners' knowledge or not, how effective it is in helping the teaching and learning process proceed efficiently, whether it is related to the achievement or not, and to what extent learners are satisfied with the media or teaching activity sets. The producer of the media or teaching activity sets must take the media or teaching activity sets to find quality, which is called efficiency testing.

2. From the study of the development of learning activities based on the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on problem solving, addition, subtraction, multiplication, and division of Grade 3 students, it was found that students had mathematical concepts on problem solving, addition, subtraction, multiplication, and division after learning through the learning activities organized by the Concrete-Pictorial-Abstract (CPA) concept with an average score higher than the

specified criteria, which is consistent with the objectives of this research. The results of the research showed that the post-test scores of students who learned through the said activities had an average score of 16.30, accounting for 81.50 percent of the full score of 20 points. The researchers found that mathematical concepts on problem solving, addition, subtraction, multiplication, and division after learning through the learning activities organized by the Concrete-Pictorial-Abstract (CPA) concept were higher than the 75 percent criterion with statistical significance at the .05 level because the researchers used the concept of organizing activities that helped students learn the content on solving abstract problems by themselves from the teaching and learning process of the Concrete-Pictorial-Abstract (CPA), which is consistent with Makhanong (2009) said that according to the important principles of teaching mathematics, it is teaching by using concrete things, explaining abstract things, as a process of organizing learning activities so that learners can develop mathematical concepts. From organizing such activities, it is an arrangement of the development sequence of learning by letting students study information from objects and things that exist in daily life to encourage students to understand the meaning and relationship of the sequence of operations, such as solving problems, adding, subtracting, multiplying, and dividing, and then converting from real objects to pictures, gradually using pictures instead, which the simulation emphasizes the insertion of complete image data, helping to make the simulation of mathematical problems clear, making it easier to convert meanings into symbols, consistent with the research of Chotiwinayu (2021) who studied the ability to solve mathematical problems and academic achievement in the subject of linear equations, single variables through a learning activity set based on the Concrete-Pictorial-Abstract (CPA) concept, found that the academic achievement in the subject of linear equations, single variables was higher than the specified criteria. And that CPA learning is a tool for teachers to teach elementary school students to create mathematical thought representations, allowing students to connect knowledge effectively.

In addition, students also learn mathematics through such activities happily while participating in activities with friends during the time that the teacher organizes in the classroom, as the researcher has used the concept. Concrete-Pictorial-Abstract (CPA) to use research in classroom teaching management Using innovative learning techniques will help students to minimize any fears or misconceptions they may have about solving problems in addition, subtraction, multiplication, and division. In particular students' MCU and students' MR on solving problems in addition, subtraction, multiplication, and division must take priority. Therefore, allowing students to use hands-on tools to demonstrate their understanding will yield the best results (Hafiziani, 2015). And the learning should be tailored by students' cognitive development level. One of the innovative methods for teaching solving problems in addition, subtraction, multiplication, and division is called Concrete-Pictorial-Abstract (CPA) strategy. This strategy, based on Bruner's learning theory, consists of three modes of learning: "enactive-iconic-symbolic" (Leong et al., 2015). There are three stages; (1) concrete (learning through real objects); (2) pictorial/representational (learning through image representation); and (3) abstract (learning through abstract writing). These different methods can reduce the frustration students feel while learning solving problems in addition, subtraction, multiplication, and division. This strategy is highly recommended to use with elementary school students who are still in the cognitive

stage of concrete learning. Using manipulative objects is very important to their understanding.

3. The level of satisfaction with the development of learning activities according to the concept of Concrete-Pictorial-Abstract (CPA) to enhance mathematical concepts on problem solving, addition, subtraction, multiplication, and division of Grade 3 students was at the highest overall level with an average value ($M=4.75$, $SD=0.48$). When considering each aspect, it was found that the aspect of organizing learning activities was the highest with an average value ($M=4.81$, $SD=0.46$), followed by the aspect of measurement and evaluation with an average value ($M=4.77$, $SD=0.47$) and the aspect of teachers with an average value ($M=4.71$, $SD=0.37$) was the lowest, which Bruner (1993) suggested that the readiness of the learners should be taken into account in terms of organizing the learning experience to have appropriate sequences of meaning and relationships. The development of learning activities based on the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts. From the development of learning activities, students are interested and enthusiastic in asking and answering questions with teachers and students can learn with their friends in the classroom freely, making students happy and enjoy learning from the activities that teachers organize for students. In addition, teachers reinforce by giving prizes to students to encourage students to want to learn more because they receive rewards for doing good deeds. This results in learners seeing their own value, which is consistent with Skinner (1953) reinforcement theory, as positive reinforcement is giving rewards in what people want, such as giving prizes, praise, objects, etc., to motivate learners to be motivated to learn in organizing the teacher's learning activities and changing new behaviors to the learners' desired behaviors. Therefore, students are satisfied with the learning activity set this time, which is in line with the learning satisfaction theory because humans need to be praised, which will lead to success, as Maslow (1970) said that human needs are the need to be praised, the need to be successful in life. In addition, teachers provide guidance and encourage students to answer questions so that students can find the answers by themselves. Development of learning activities based on the Concrete-Pictorial-Abstract (CPA) concept. This is consistent with the research of (Chanhom et al., 2019) who studied the learning management based on the Concrete-Pictorial-Abstract concept with the Bar Model to develop the learning achievement in Mathematics for Mathayom 2 students. It was found that the satisfaction of Mathayom 2 students with the learning management based on the Concrete-Pictorial-Abstract concept with the Bar Model in Mathematics was at a high level.

■ Conclusion from the research

From the discussion of the research results of the 3 items mentioned above, the research on the development of learning activities based on the Concrete-Pictorial-Abstract (CPA) concept to enhance mathematical concepts on problem solving, addition, subtraction, multiplication, and division of Grade 3 primary school students was effective at 82.26/81.50, which was in accordance with the specified criteria. The post-study mathematics concept test score was 81.50 percent, which was higher than the specified criteria with statistical significance at the .05 level. The overall satisfaction level was at the highest level with an average value ($M = 4.75$, $SD = 0.48$) because the researcher had created a mathematics learning

activity development plan under the content and learning objectives that covered all steps and also took into account the differences between individuals. The researcher emphasized the probability situations that occurred in real life, which made the learners realize the importance of mathematics in applying it in daily life. Therefore, the researcher used the Concrete-Pictorial-Abstract (CPA) concept as a guideline for creating a mathematics learning activity development plan for teaching and learning, which resulted in the researcher being successful in this research.

■ Suggestions

Suggestions for applying the research results

1. Organizing CPA learning activities in the object use step focuses on creating an understanding of meaning, relationships, and sequences of operations. This step is an important step in creating concepts because it can be used to connect prior knowledge and develop into the creation of simulation images and interpret the meaning of images into symbols correctly. At this step, teachers should check students' understanding until they are sure that they have knowledge and understanding, and then organize learning activities in the next step so that students have correct and complete concepts and do not have misunderstandings or misunderstandings in connecting knowledge to use in the next step.

2. During classroom work, teachers must walk around to check if there are any students who do not understand the steps in solving problems. Teachers must provide additional explanations and guidance in solving problems for that student.

Suggestions for future research

1. The study should study the organization of learning activities using the Concrete Pictorial Abstract (CPA) concept that promotes mathematical communication and meaning communication. Because while teaching with the CPA model, the researcher found that when students learn from real objects and then change them to pictures to simulate mathematical problems, students will use pictures to communicate the problem and use mathematical symbols instead of simulation pictures, which may help develop mathematical communication skills and meaning communication.

2. The study should study the organization of learning activities using the Concrete Pictorial Abstract (CPA) concept with other tangible media that students are interested in that can promote students to have mathematical concepts.

References

- Angganapattarakajorn, V. (2012). *Complete with things you should know for math teachers* Charasanitwong Printing. [in Thai].
- Bruner, J. S. (1960). *The process of education*. New York: Vintage Books. Chanhom, P., Wiriyapong, R., & Suphap, W. (2019). Development of mathematical concepts with learning activities based on the Concrete-Pictorial-Abstract (C-P-A) concept on two-dimensional and three-dimensional geometric shapes of Mathayom 1 students. *Naresuan University Journal of Education*, 22(4), 144-158. [in Thai].
- Chotiwinu, N. (2021). A study of mathematical solving problem ability and academic achievement on the topic of linear equations with one variable through organizing learning activities based on the Concrete-Pictorial-Abstract (CPA) concept for Mathayom 1 students (Master's thesis). Srinakharinwirot University. [in Thai].
- Frederic Kuder, G., Richardson, G. F., & M. W., M. W. (1937). The theory of the estimation of test reliability. *Psychometrika*, 2(3), 151-160.
- Hafiziani. (2015). The influence of Concrete Pictorial Abstract (CPA) approach to the mathematical representation ability achievement of the pre-service teachers at elementary school. *International Journal of Education and Research*, 3(6), 113-126.
- Hui, C. S., Hoe, L. N., & Lee, K. P. (2017). Teaching and learning with Concrete-Pictorial-Abstract sequence: A proposed model. *The Mathematics Educator*, 17(1), 1-28.
- Institute for the Promotion of Teaching Science and Technology (IPST). (2019). *Mathematical skills and processes*. Academic Development. [in Thai].
- Institute for the Promotion of Teaching Science and Technology (IPST). (2022). *Mathematical skills and processes*. Academic Development. [in Thai].
- Isaraprida, P. (2006). *Essential educational psychology*. Klungnanatham. [in Thai].
- Leong, Y. H., Ho, W. K., & Cheng, L. P. (2015). Concrete-Pictorial-Abstract: Surveying its origins and charting its future. *The Mathematics Educator*, 16(1), 1-19.
- Makhanong, A. (2009). *Mathematical skills and processes: Development for development* Chulalongkorn University Printing House. [in Thai].
- Maslow, A. H. (1970). *Motivation and personality*. Harper & Row. Mhajakklang, S. (2011). Conceptual knowledge: The focus of mathematics teaching. *My Maths*, 70, 54-59.
- Ministry of Education Singapore. (2013). *Nurturing early learner curriculum volume 6*. Ministry of Education. [in Thai].
- Ministry of Education. (2019). *Indicators and core learning content, Mathematics subject group (revised edition 2017) according to the Basic Education Core Curriculum B.E. 2008*. Agricultural Cooperative Printing House of Thailand. [in Thai].
- National Institute of Educational Testing Service. (2022). *Report on the results of the test the national level basic O-Net Grade 6, Year 2019* (in Thai). Bangkok Public Organization. [in Thai].

- Pattanatrakoolsook, K. (2002). Why should we learn mathematics *Journal of Mathematics*, 46, 35-39. [in Thai].
- Phromwong, C. (2013). Efficiency testing of media or instructional packages. *Silpakorn Educational Research Journal*, 5(1), 7-20. [in Thai].
- Skinner, B. F. (1957). *Verbal behavior*. Appleton-Century-Crofts. <https://doi.org/10.1037/11256-000>
- Srisa-ard, B. (2017). *Basic research* (10th ed.). Bangkok: Suviriyasarn Printing. [in Thai].
- Wat Devarajkunchorn School. (2022). *Student quality assessment report Grade 3 (NT), academic year 2022*. [in Thai].