The development of early childhood students’ creative thinking problem solving abilities through STEM Education learning activities

Suriyan Sangngam
Faculty of Education, Chaiyaphum Rajabhat University, Chaiyaphum, Thailand
E-mail: teacher.dance12341@cpru.ac.th

Abstract. The purpose of this research was to study changes in early childhood students’ creative problem solving abilities comparing between before and after the intervention of STEM education learning activities. The sample group were male and female early childhood aged between 5-6 years studying in Soonthornwattana School, Chaiyaphum Province, 2nd semester, academic year of 2017. Methodology was the quasi-experiment design. The STEM education activities provided students to organize the nine square grid movement activities. Early childhood children’s creative thinking and problems solving ability was collected by the behavior observation form of creative problem solving skills (FCPS). The FCPS items consists of 12 items that represent the 3 items of access to problems, 3 items of thinking of a solution, 3 items of selection and preparation of problem solving, and 3 items of planning for solving problems. Then, each item of the FCPS was analysed for descriptive statistics. The results showed that early childhood who have been organized activities according to STEM Education’s theoretical concepts have developed more creative problem solving skills, with an average score of 14.63 and after the event will have a score of 24.27. When considering each aspect of the experiment, it was found that early childhood have creative problem-solving skills. Which has higher scores each week Shows that early childhood who have organized activities according to STEM Education’s theoretical concepts have higher creative problem-solving skills which is in accordance with the assumptions set forth.

Key words: development of problem solving abilities, STEM Education's theoretical concepts

1. Introduction
There are factors affecting the need of practicing science, mathematics, and other knowledge in the early childhood classroom. First, early childhood students need to be developed understanding and recognition of the power of children’s early thinking and learning. Early childhood settings should provide the challenging environments for learning. These included, for examples, guided by skillful teachers, children’s experiences in the early years can have significant impact on their later learning. Science learning in early childhood not only supports a basis for future scientific understanding but also to build important skills and attitudes for learning. Science and mathematics may provide early childhood students to move quickly in obtaining more complex skills. They may do some inquiring activities and mathematical problem solving that foster them to extend the borders of the learning in which children are already actively engaged [1], [2].

Value of science and mathematics understanding in early education is increasing. They need to be provided to manipulate of and experience with objects, materials, phenomena, and making something
through playing or helping parents to work on something. These allow children to construct experiences in investigation and problem solving and developing for way of knowing in science, mathematics, and other knowledge [3], [4]. The conceptions of STEM education could be viewed as STEM content and practices. STEM education pedagogy could be defined through content and practices of one or more content of science and mathematics and the engineering practices and engineering design of technologies. The STEM education pedagogy needs to provide the development of 21st century skills is emphasized; and the context of instruction requires solving a real-world problem or task through teamwork. The teaching strategies focus on the processes of structuring student activity including problem based, project based, inquiry, and design. STEM Education activities should provide students to identify the problems of issues or situations in student context in order to enhance students to make prototypes or products as solutions. The ways of fining solutions required practicing science, mathematics, and process of technology and engineer. Organizing of STEM education could provide holistic and integration of knowledge in school setting [5], [6]. This kind of learning management helps students see the benefits of science and mathematics knowledge that students use in class. School administrators must be serious. Encourage all concerned teachers to be aware of the importance of education and must have proper knowledge and understanding about STEM Education [7]. Regarding on the view of STEM education, the early childhood students probably could learn to practice science, mathematics, and others in everyday life.

There are some movements for STEM education in Thailand. The Thailand Office of Basic Education Commission (OBEC) has launch the STEM education teacher training for basic education across the nation during year of 2016 – 2017. Like OBEC, other educational government agencies also have launch the STEM education teacher training. These included the promotion of teaching science and technology (IPST), the office of higher education commission (OHEC), the ministry of energy, the Electricity Generating Authority of Thailand (EGAT), the chevron enjoy science project, and the schools and universities STEM education projects [8]. To obtain the goal of STEM education in Thailand, therefore, the researcher interested in researching the effects of early childhood students’ creative problem solving abilities by organizing STEM Education.

Enhancing students to do activity about STEM education require students who hold creative problem solving abilities. Creativity may support students who are designed to think to solve problems and create new things in learning. Creativity is a feature of people in the 21st century. Creativity will be able to can do and develop new things in the world. Lateral and vertical thinking are part of creativity. Vertical thinking is about students’ understanding about science, mathematics, and other knowledge regarding on school curriculum. Lateral thinking is about thinking outside the box that could foster students to come up with new ideas for innovations or inventions. Creative people tend to have high self-confidence, self-reliance, risk-taking, energy, enthusiasm, adventure, curiosity, flexible, playful and humorous [9].

The literatures suggested that creative problem solving abilities are about ways of student structuring features of solving problem. The researchers analysed theoretical framework about creative thinking, problem solving ability and creative problem-solving ability in order to draw the framework of creative problem solving ability. Laopidet [10] suggested a framework of teaching strategy for creative problem solving ability. This consisted of six stages including (1) stage of engagement and identifying problem, 2) collect various kinds of data for understanding about context of problem, 3) creatively listing possible solutions, 4) selecting a possible solution, 5) doing something regarding on the selected solution, 6) evaluating the solution and presenting the completion solution. Meanwhile, Supthathamawit [11] developed also a framework of teaching strategy for creative problem solving ability. This consisted of five stages including (1) providing various kinds of activities for engagement of identifying problems, (2) investigating related knowledge, (3) sharing new knowledge for developing possible solutions, and (4) discussion for conclusion of an appropriate solution of problem solving. Regarding on the literature review, this study draw the possible teaching approach for enhancing students’ problem solving ability and creative problem-solving ability through STEM
education activities. This approach consists of 4 stages including (1) access to problems, (2) thinking of a solution, (3) selection and preparation of problem solving, and (4) planning for solving problems.

2. Methodology

Methodology was the quasi-experiment design. Research objectives included (1) to study the creative thinking problem solving ability of early childhood before and after intervention of STEM Education, and (2) to compare creative thinking and problem solving abilities of early childhood before and after intervention of STEM Education.

2.1. Sample

The sample group was selected from a specific model. This has been carried out in the following steps. Specify 1 classroom type, 1 classroom, 37 classrooms, and organize activities according to STEM Education theory. The sample was the 72 early childhood children aged between 5 - 6 years studying in kindergarten 2, 2nd semester, academic year 2018, Soonthorn Wattana School, Nai Mueang Subdistrict, Mueang District, Chaiyaphum Province under the Office of Primary Educational service area 1.

2.2 Variables used in the study

The initial variable is activities based on the STEM Education theory. The dependent variable is creative thinking and problem solving ability, divided into 4 areas as follows: access to problems, thinking of a solution, selection and preparation of problem solving, and planning for solving problems.

2.3 Intervention of STEM education for enhancing early childhood children’s creative thinking and problem solving ability

The intervention of STEM education for enhancing early childhood children’s creative thinking and problem solving ability was developed by the researchers through the following steps.

- Study of early childhood education program, 2017, 2003
- Review teaching and learning about STEM Education pedagogy
- Create a plan to organize teaching and learning activities, STEM Education, determine objectives, content, activities, learning materials and evaluation.

Finally, the STEM education activities provided students to organize the nine square grid movement activities.

2.4 Data collection and analysis

Early childhood children’s creative thinking and problem solving ability was collected by the behavior observation form of creative problem solving skills (FCPS). The FCPS was developed pool items to represent children behaviors of creative problem solving skills. The pool items were synthesized from the literatures related to creative problem solving skills [10], [11]. Finally, the FCPS items were developed to represent four aspects about creative problem solving skills including access to problems, thinking of a solution, selection and preparation of problem solving, and planning, solving problems. Totally, the FCPS items consists of 12 items that represent the 3 items of access to problems, 3 items of thinking of a solution, 3 items of selection and preparation of problem solving, and 3 items of planning for solving problems. Then, each item of the FCPS was analyzed for descriptive statistics.
3. Research result
In this study the researcher proposed the results of data analysis in the following order.

1. Studying students’ creative problem-solving skills score in prior and post intervention of teaching-learning activities for STEM Education could be seen in the table 1.

Table 1: Students’ creative problem-solving skills score in prior and post intervention of teaching-learning activities for STEM Education

| N  | Full score | Prior intervention score | Post intervention score |
|----|------------|--------------------------|-------------------------|
| 37 | 36         | 19.21                    | 28.10                   |

According to the table 1, early childhood children have the ability to think and solve problems creatively. It was found that the average score after organizing STEM Education activities was higher than before the teaching and learning activities for STEM Education was 28.10

2. Compare creative thinking and problem solving abilities of early childhood before and after receiving STEM Education teaching activities.

Table 2 Comparison of creative problem solving skills of early childhood before and after receiving STEM Education teaching activities

| period of time | N  | \(\bar{x}\) | S.D. | t     | p-value |
|----------------|----|-------------|------|-------|---------|
| Before learning | 37 | 19.21       | 2.07 | 27.73* | .000    |
| After learning  | 37 | 28.10       | 2.28 |       |         |

*\(p<.05\)

According to the table 2, it showed that early children have the ability to solve creative problems. After organizing activities higher than before the activities with statistical significance at the level of .05, indicating that organizing teaching and learning activities for STEM Education makes early children more creative in problem solving skills. It seems that the intervention of STEM education could help early childhood to change their ability in creative problem solving skills as shown in Table 3.

Table 3 Creative problem-solving abilities of early childhood receiving STEM Education teaching Activities.

|            | Mean of creative problem solving abilities | Changing of score | Percentage of changing |
|------------|--------------------------------------------|-------------------|------------------------|
| Prior intervention | 19.21                                      | 8.86              | 35.33                  |
| Post intervention  | 28.10                                      |                   |                        |

The results of the analysis according to Table 3, it could be seen that early childhood students’ creative problem-solving abilities could be improved. There are big changing of score between prior intervention score and post intervention score. And, students have got high level of score in each aspect of creative problem-solving abilities. This could be viewed in the Table 4.
Table 4: Students’ score in each aspect of creative problem-solving abilities

| creative problem-solving abilities | \( \bar{x} \) | S.D | Level comments | Level |
|-----------------------------------|--------------|-----|----------------|-------|
| Access to problems                | 3.91         | 0.52| Much           | 4     |
| Thinking of a solution            | 4.23         | 0.75| The most       | 1     |
| Selection and preparation of solving problems | 4.02 | 0.58| Much           | 3     |
| Planning for solving problems     | 4.10         | 0.67| Much           | 2     |
| Total                             | 4.21         | 0.41| Much           | (4)   |

According to the table 4, it was found that the average score of problem-solving skills for early childhood children who had received experience organizing the nine square grid movement activities before and after studying the overall aspect is equal (\( \bar{x} = 4.21, S.D = 0.41 \)) respectively, when considered as the average score of each aspect, respectively, high to low, equal to the thinking of problem solving method (\( \bar{x} = 4.23, S.D = 0.75 \)). The problem solving plan is equal (\( \bar{x} = 4.10, S.D = 0.67 \)). The selection and preparation of the solution is equal to (\( \bar{x} = 4.02, S.D = 0.58 \)) and the aspect of access to problems (\( \bar{x} = 3.91, S.D = 0.52 \)) respectively.

The purpose of this research was to study and compare creative problem solving skills of early childhood receiving teaching-learning activities for STEM Education before and after organizing activities based on the results of the research, who have been teaching activities for STEM Education. Before and after the experiment, there was a significant difference in creative problem solving skills at the level of .05 which was consistent with the hypothesis of this research showing that early childhood children who received nine square movements and rhythmic activities helping children to be able to solve problems more creatively and change.

4. Conclusion and discussion

STEM Education activities are organized in a variety of processes. The purpose of learning management according to the STEM Education guidelines is to encourage learners to love and appreciate the value of science, technology, engineering and mathematics. See that those subjects are close to those that can be used every day. Must be collected and selected for learning content for early childhood. STEM Education teaching activities create familiarity to children first because children are not familiar with activities, which during the first week may do activities that do not achieve the goal as expected. We should give time to children to familiarize themselves first as follows: should allow time for children to adjust to create familiarity before organizing teaching activities for STEM Education, which is always included in the content of learning management.

Suggestions for further study, it increase the selection of plans for experience in accordance with social and cultural contexts for organizing STEM Education teaching activities in order to have more knowledge and complete in accordance with the development of early childhood in 4 areas. In this research, the researcher organized a variety of activities. There is a difference of ability and experience in organizing STEM Education activities. Therefore, such activities can be used to extend the previous knowledge related to the performance of early childhood towards STEM Education management. Through the activities of all 6 main activities of early childhood will have more different educational results. The duration of this research has a better time to see changes. It may not be enough to make use of supplementary methods to increase creative thinking skills of early childhood. In the next research, it may take a period of 1 semester or 1 academic year. The results may be more obvious.
References

[1] Bowman, B. T.; Donovan, M. S.; & Burns, M. S. (Eds.). 2001. Eager to learn: Educating our preschoolers. Washington, DC: National Academy Press.

[2] Kongpa, M., Jantaburom, P., Byne, D., Obmasuy, N. and Yuenyong, C. 2014. Kindergarten’s Scientific Concepts and Skills in the Tree Unit. Procedia - Social and Behavioral Sciences. 116: 2120 – 2124

[3] Worth K 2010. Science in Early Childhood Classrooms: Content and Process. SEED Papers, Fall 2010. Available: http://ecrp.uiuc.edu/beyond/seed/worth.html

[4] Yuenyong, C. and Narjaikaew, P. 2009. Scientific Literacy and Thailand Science Education. International Journal of Environmental and Science Education, 4(3): 335 – 349

[5] Mordeno IC, Sabac AM, Roullo J, Bendong HD, Buan A & Yuenyong C 2019 Developing the Garbage Problem in Iligan City STEM Education Lesson Through Team Teaching. Journal of Physics: Conference Series, 1340 (1), 012046

[6] Sutaphan, S &Yuenyong C 2019. STEM Education Teaching approach: Inquiry from the Context Based. Journal of Physics: Conference Series, 1340 (1), 012003

[7] The Institute for the Promotion of Science and Technology (IPST) 2015 STEM education. Bangkok: Succession Co., Ltd. Chantana Parkbongkoch.

[8] Yuenyong C. 2019. Lesson learned of building up community of practice for STEM education in Thailand. AIP Conference Proceedings. 2081, 020002-1 – 020002-6.

[9] Doppelt, Y. 2009. Assessing creative thinking in design-based learning. The International Journal of Technology and Design Education, 19:55 –65

[10] Laopidet A. 2013. Development of learning achievement and problem solving ability creatively on social problems of Thailand of Mathayom Suksa 6 students by learning management using problems as a base. (in Thai)

[11] Suphathamawit S. 2014 Development of the use of tablet learning activity sets according to the learning principles. By using the brain as a base to promote creative problem solving ability of elementary school students. Educational electronic journal. 9 (4), 138-150. (in Thai)