Developing early childhood students’ creative thinking ability in STEM Education

Achara Somwaeng  
Faculty of Education, Chaiyaphum Rajabhat University, Chaiyaphum, Thailand  
E-mail: achara.so@cupu.ac.th

Abstract. This research is a quasi-experimental research. The research aimed to compare the development of creative thinking of kindergarten 2 students before and after learning management according to STEM Education. The intervention of STEM education was developed in order to enhance the kindergarten 2 students to practice STEM knowledge related to their experiences. The intervention consists of 4 units including happy season, the wonderful trip, the colourful little butterflies, and soil-rock-sand as need resources for life. STEM education intervention was organized for 4 weeks. The sample was derived from group randomization. The sample consists of 30 Kindergarten 2 students, Phumvithaya School, Phu Khiao District, Chaiyaphum Province, 1st semester, academic year 2018. Students’ creative thinking was evaluated by the creative measurement form. Data analysis was to use frequency, percentage, mean, standard deviation and testing the t-results. The results revealed that students held mean score of post intervention creative thinking score (approximately 70 percentages) higher than mean score of prior intervention (approximately 50 percentages) at 0.05 statistical significantly. It indicates that the intervention of STEM education for kindergarten 2 could improve students’ creative thinking.

Key words: creative thinking ability, early childhood, STEM Education

1. Introduction  
The human resources development is crucial resources of developing the nation. The young children should be prepared to become the 21st century citizen which required people who could able to practice science, mathematics, and other knowledge in everyday life. Early childhood students need to be developed understanding and recognition of the power of children’s early thinking and learning [1], [2]. Early childhood settings should provide the challenging environments for learning. Science and mathematics learning in early childhood would be a basis for future scientific understanding, skills and attitudes for learning, and move quickly in obtaining more complex skills [3], [4]. Organizing learning experiences for early childhood organized in the form of integrated activities through play in order to learn from direct experience, knowledge, skills, morality and ethics, including the development of 4 aspects. Therefore, teachers must understand early childhood learning and enhance the experience and nature of learning for early childhood. The early childhood activities in each day should be different that must be aligned with important experiences learning material and content. Then, it should be learned as required by the curriculum [5]. STEM education should be provided in the early childhood school. It probably provided attitudes of problem solving in everyday life [6].
There are some movements for STEM education in Thailand. The Thailand Office of Basic Education Commission (OBEC) has launched the STEM education teacher training for basic education across the nation during the years 2016–2017. Like OBEC, other educational government agencies also have launched 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 [7]. STEM education needs to be prepared for citizens in the 21st century. The teaching and learning in STEM education should be organized for practicing knowledge and soft skills. 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 [7], [8].

The STEM pedagogy usually was provided through problem-based, project-based, engineering design process or any designing process. It should be provided for the development of 21st century skills that emphasized; and the context of instruction requires solving a real-world problem or task through teamwork. Organizing of STEM education could provide holistic and integration of knowledge in school setting. 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 [9], [10]. The IPST [8] recommended the engineering design process (EPD) in order to foster students to find the ways of developing solutions. This EPD included 6 steps including 1) identify the problem; 2) collect information and concepts related to problem; 3) design possible solutions; 4) plan and implement solutions of problems; 5) test, evaluate, and improve tasks or methods of problems, and 6) present the tasks or results of problem solving.

Enhancing students to do activity about STEM education require students who hold creative thinking [11]. Regarding on the view of STEM education, the early childhood students probably could learn to practice science, mathematics, and others in everyday life. To obtain the goal of STEM education in Thailand, therefore, the researcher interested in researching the effects of early childhood students’ creative thinking abilities by organizing STEM Education.

Creative thinking could be viewed as the key competencies for the 21st century. It allows humans to develop the new ideas for technology. Creativity could not only be required in science and arts but also used for problem solving in everyday life. Through the problem solving, the creative thinking allows us to remain flexible. Cognitive flexibility suggests us to deal with the changes and challenges that part of our complex and fast-changing world. Creative thinking, therefore, is important role in developing the innovation and creation of new ideas [12].

Creative thinking skills are classified as high-level thinking skills with characteristics of originality, flexibility, fluency, and elaboration. The think creatively originally proposed by Torrance [13] that consist of three elements including (1) fluency, (2) originally, and (3) elaboration. Meanwhile, the literature in Thailand, creative thinking widely applied for 4 elements including (1) originality thinking, (2) fluency thinking, (3) flexible thinking, and (4) elaborative thinking [14]. To provide the indicators of assessing students’ creative thinking, the characteristics of creative thinking skills related to cognition include: thinking fluently, thinking flexibly, thinking original, thinking in detail (elaboration) and think to assess (evaluation). Thinking fluently referred to produce a lot of ideas in problem-solving, give many choices of answers, provide many suggestions for doing various things, and work faster comparing to others. Think flexible is about generating various ideas of solving problems, seeing a problem from different views, and presenting concepts of problem solving in different ways. Think originally, referred to provide new ideas of answers, and could be able to combine unusual parts or elements. Think in detail (elaboration) is about developing further other people ideas, and add up ideas or improve more quality of ideas [15].
Regarding on the literature review, this study draw the possible teaching approach for enhancing students’ creative thinking through STEM education activities. The STEM education learning activities were provided regarding on the 6 engineering design processes [8]. The results of this research will be a guideline for teachers, administrators, as well as those involved in educational management for young children in the development of creative thinking of early childhood.

2. Methodology

This research is a quasi-experimental research. The research aimed to compare the development of creative thinking of kindergarten 2 students before and after learning management according to STEM Education.

2.1 Samples

The sample group used in the research was 30 kindergarten students from Phoom Witthaya School, Phu Khiao District, Chaiyaphum Province, in the first semester of academic year 2018 and acquired by cluster random sampling. Each class has a mix of capabilities, with variables that are used in research.

2.2 Intervention of STEM education

The intervention of STEM education was developed in order to enhance the kindergarten 2 students to practice STEM knowledge related to their experiences. The intervention consists of 4 units including happy season, the wonderful trip, the colorful little butterflies, and soil-rock-sand as need resources for life. The intervention has been organized 5 days a week for 4 weeks. The STEM education learning activity was provided for 40 minutes a day.

STEM education is an educational management approach that integrates knowledge in 4 areas, including science, engineering technology and mathematics. To enhance students to practice STEM knowledge related their experiences, the learning activities were provided regarding on the 6 engineering design processes [8]. These steps included 1) identify the problem; 2) collect information and concepts related to problem; 3) design possible solutions; 4) plan and implement solutions of problems; 5) test, evaluate, and improve tasks or methods of problems, and 6) present the tasks or results of problem solving. The intervention of STEM education was carried out in the early childhood classroom in order to enhance students’ creative thinking as the conceptual framework in the figure 1.

There is an assessment of the quality of the learning management plan using the suitability assessment form. There is a rating scale of 5 levels, which is the highest, the most, the medium, the least. It found that the result of the evaluation was very appropriate for implementing because the average score was 4.23 (between 3.51-4.50 score).

| Six step of EDP for STEM education |
|-----------------------------------|
| 1. Identify the problem           |
| 2. Collect information and concepts related to problem |
| 3. Design possible solutions,     |
| 4. Plan and implement solutions of problems, |
| 5. Test, evaluate and improve tasks or methods of problems, |
| 6. Present the tasks or results of problem solving |

| Creative thinking ability         |
|----------------------------------|
| 1. Originality thinking          |
| 2. Fluency thinking              |
| 3. Flexible thinking             |
| 4. Elaborative thinking          |

Figure 1: Conceptual framework of research
2.3 Data collection and analysis

Students’ creative thinking was evaluated by the creative thinking measurement form that adopted from the TCT-DP (The test for Creative Thinking-Drawing Production of Jellen and Urban). The TCT-DP is a standard creative thinking measurement. It consists of 11 criteria including the addition of new created images, connecting with lines, continuation that makes the story, writing a boundary line, crossing the boundary line, depth display, near-far the distance of the image, humor, new thinking, and speed. It found that there was a value of confidence in the creative measure using the method finding cronbach’s alpha coefficient is 0.80 [16]. The creative thinking measurement form was carried out for the prior and post intervention. Data analysis was to use frequency, percentage, mean, standard deviation and testing the t-results.

3. Research result

The results revealed that the mean score of prior intervention creative thinking was 35.57 (approximately 50 percentages). And, the mean score of post intervention creative thinking was 49.73 (approximately 70 percentages). It showed that students held mean score of post intervention creative thinking higher than mean score of prior intervention at 0.05 statistical significantly as showed in the table 1. It indicates that the intervention of STEM education for kindergarten 2 could improve students’ creative thinking.

| Creative thinking ability       | n  | x  | S.D. | p       |
|--------------------------------|----|----|------|---------|
| Prior intervention             | 30 | 35.57 | 4.44 | .000    |
| Post intervention              | 30 | 49.73 | 2.72 |         |

* 0.05 statistical significantly

4. Conclusion and discussion

The comparison of the creative ability of the kindergarten 2 students found that early childhood who received organize learning experiences according to the STEM Education concept have the ability to creative thinking after studying higher than before studying. It probably the intervention of STEM education provided children to apply knowledge to solve real-life problems to develop knowledge and understanding. Practicing science, mathematics and technology skills and bringing knowledge to design pieces or create works to find needs or solve problems related to daily life.

Through early childhood education, observation, research and practice, which teachers give guidance help for early childhood at all times and in developing and promoting young children to be creative, in addition to providing early childhood education in and outside the classroom for early childhood children to draw pictures according to their imagination without using an eraser to erase the drawing. Develop and encourage early childhood to be creative, especially in the areas of originality because of the fact that the early childhood has designed the piece as imagined as make early childhood the originality fluent thoughts. Flexible thinking and thoughtful thinking especially thoughtful early childhood will focus, concentrate, work finely, calmly, and relieve tension. And each early childhood draws a unique picture. This similar to what Kettlekha & Jongkonklang [17] argued that promoting the right creativity should give extra strength and stimulating inspiration in thinking, including drawing, illustration, explanation. This could be viewed also in Amanda's research [18] that indicated that early childhood could be able to think creatively or design new and unique pieces.
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