



Developing STEM Education Learning Activities for Thai Kindergarten School Students

Mantana Kongpa, Arunothai Koonphatee, and Porntipa Thongsook
 Khon Kaen University Demonstration Kindergarten School, Khon Kaen, Thailand,
 Email: mantko@kku.ac.th

Received: 26 Jul 2024

Revised: 26 Aug 2024

Accepted: 30 Aug 2024

Abstract. This paper aimed to clarify the developing STEM education learning activities for kindergarten school students (4-5 years old). In order to visualize how to provide STEM learning activities for kindergarten school students, the unit of how we can build Khon Kaen Central Plaza shopping center will be clarified. Then, the developing STEM education unit will be clarified through the 7 steps of Sutaphan and Yuenyong (2019) STEM pedagogy. These steps include (1) Identification of social issues, (2) Identification of potential solution, (3) Need for knowledge, (4) Decision-making, (5) Development of prototype or product, (6) Test and evaluation of the solution, and (7) Socialization and completion decision stage. The paper will clarify details of what and how to organize kindergarten school student learning activities regarding on 7 steps of STEM pedagogy. Based on the local issue, the learning activities may allow students to practice from everyday life and careers as what they play or find the way of construction. On the way of their playing, they will learn not only science, technology, engineering and mathematics but also language, art and music. Students also will be enhanced to gain their communication, analytical thinking, social, technological, mathematical and scientific skills.

Keywords: STEM education; kindergarten; art; music

1. Introduction

A multitude of reasons now impacting the early childhood community justify the need to prioritize science and mathematics education in early childhood classrooms. The quantity and diversity of children attending childcare facilities, as well as the amount of time each child spends there, are rising while there is a growing appreciation for the importance of science and mathematics in early education. A growing proportion of kids are impoverished. A growing number of children are being raised in homes with just one parent or in which both parents work. The very young now regularly interact with the media. As a result, activities like playing in the sink, taking care of a pet, or traveling to the playground that involve direct manipulation and experience with items, materials, and phenomena are less likely to take place at home. This type of interaction with the natural world is becoming increasingly necessary in early childhood classrooms, since it enables all kids to develop their investigative and problem-solving skills and lays the groundwork for their comprehension of fundamental science ideas (Kongpa et.al., 2014; Worth, 2010).

Improving early childhood exposure to the natural world as way of knowing could help children later form a scientific mindset (Yuenyong and Narjaikaew, 2009). For

example, Kongpa et.al. (2014) engaged young children to generate meaning from their knowledge of the tree. They provided kindergarten activities with explaining the function, classification, and benefit of a tree can help kids acquire scientific knowledge and abilities. Given the emphasis currently placed on teaching STEM subjects—science, technology, engineering, and mathematics—it appears that STEM education in the USA has had an influence on STEM education in Thailand. One excellent illustration of the necessity of integrating technology into math and scientific instruction is found in the USA national standards for both science and mathematics. The multidisciplinary and integrated approaches to scientific education and learning have been reinforced by the Next Generation scientific Standards (NGSS, 2013) in the USA.

According to NGSS (2013), the STEM education was raised by preparing standards of practicing knowledge. Three dimensions make up this framework's organization: (a) methods used by scientists and engineers to study models and theories; (b) cross-cutting ideas that connect various scientific domains, like patterns and cause and effect; and (c) core concepts that describe the way science content is arranged. A new set of learning standards for mathematics education has also been introduced in the United States. These standards support practices that mirror not just the themes that mathematics as a field covers but also the ways in which students access and apply these topics. The core elements of student learning are problem solving, reasoning and proof, communication, representation, and connections, according to the USA National Council of Teachers of Mathematics' process standards. The standards also cover the following areas of mathematical competency: conceptual comprehension, procedural fluency, strategic competence, adaptive reasoning, and productive attitude. (NGACBP, 2010). The International Society for Technology Education standards and practices also call for students to be critical thinkers, problem solvers, and good decision makers and emphasize engaging students in collaborating and communicating their understandings (Leiva et.al., 2016). STEM education teaching and learning should provide to practice knowledge about science, mathematics, and others through problem-solving in the real world (Yuenyong, 2019).

Unfortunately, there are various pedagogy for STEM education. However, three common topics of dispute surround STEM education are (a) how it should be taught; (b) how it should be considered as a collection of integrated or related disciplines; or (c) how much it depends on the stakeholders or context in which it is understood or perceived. We will use Moore et al.'s (2015) definition of STEM education for teacher enhancement in this study. They characterize it as "the integration of engineering practices and engineering design of appropriate technologies with the teaching and learning of the content and practices of disciplinary knowledge which include science and/or mathematics."

They believe that integrated STEM education differs from other teacher pedagogies in five ways: The main learning objectives are defined by (a) the practices and content of one or more anchor science and mathematics disciplines; (b) the engineering practices and engineering design of technologies serve as the integrator; (c) the engineering practices or design related to relevant technologies necessitates the use of mathematical and scientific concepts through design justification; (d) the emphasis is on developing 21st century skills; and (e) the context of instruction calls for working in a team to solve a real-world problem or task. The notion of STEM is based on studies on learning.

This study tries to provide STEM education learning activities for kindergarten through growth mindset of engineering practices and designing. The literature about development of STEM education learning regarding Sutaphan and Yuenyong (2019) STEM pedagogy suggested that students should be engaged in the local issues to ask students to develop ideas of designing the solutions. Sutaphan and Yuenyong (2019) STEM pedagogy framework consists of 7 stages of teaching. These stages included (1) Identification of social issues, (2) Identification of potential solution, (3) Need for

knowledge, (4) Decision-making, (5) Development of prototype or product, (6) Test and evaluation of the solution, and (7) Socialization and completion decision stage. By following the 7 stages of teaching, it suggests teachers how to motivate students to solve problems through developing prototypes (Adita and Yuenyong, 2021; Koes-H et.al., 2021; Nugraheni and Yuenyong, 2022; Theerasan and Yuenyong, 2019; Villaruz et.al., 2019). In this study, the STEM education activities will be engaged by the inquiry about how we can build Khon Kaen Central Plaza shopping center. The Khon Kaen Central Plaza shopping center was brought to the unit because it was the local place and every young child in Khon Kaen city knew this place very well. Engineering practices and designing activities will be introduced through STEM pedagogy framework of Sutaphan and Yuenyong (2019).

2. Story about Khon Kaen Central Plaza Shopping was generated for STEM Education Unit

Learning activities about having fun in Khon Kaen Central Plaza shopping center was provided from students in kindergarten 1/2 which align to the learning objective of students learning to enhance their learning experience about Khon Kaen.

In this learning arrangement, the teacher provided STEM Learning management by concerning on providing conditions for students to learn. with emphasis on actual practice and creating experiences through playing. The activities were developed regarding on 5 aspects including:

1. Organize integrated learning in language, art, music, science, Mathematics, technology and engineering processes.
2. Connect the content of thinking skills, mathematics skills, technology and engineering processes with daily life and career
3. Develop 21st century skills (thinking skills, mathematical skills, scientific process skills knowledge acquisition skills, communication skills, analytical thinking skills, technology skills and social skills)
4. Organize activities to challenge students' thinking.
5. Give students an opportunity to explore, express opinions, answer questions, and present work

The learning activities were developed by concerned core contents and practices as follows. For science focus, the activities were provided for scientific observation (observe the shape of the central plaza from the picture, asking questions, and experiments on tilted floors from the block building activity as showed in the picture 1.



Picture 1: asking questions and block building activity

In aspects of technology, the activities were provided for learning central shapes from the computer and central design using a computer program as showed in the picture 2.



Picture 2: Students' learning on designing and using computer

For engineering mindsets, students were engaged in 1) creating a central plaza according to the equipment specified by the teacher, 2) joining wooden blocks to form a center and learning about sloping floors, and 3) creating a central plaza with coffee straws. These were shown in the picture 3.



Picture 3: Students' creating a central plaza

Mathematics activities were engaged in counting numbers about floors of central plaza, learning about location, creating a model central, learning shapes, learning about glowing colors, and learning to classify categories.



Picture 4: students' learning shape, creating model, glowing colors, and classifying

3. STEM Learning Activities

The having fun at Khon Kaen Central Plaza shopping center STEM education unit was provided regarding Sutaphan and Yuenyong (2019) STEM pedagogy framework that consists of 7 stages of teaching. These stages included (1) Identification of social issues, (2) Identification of potential solution, (3) Need for knowledge, (4) Decision-making, (5)

Development of prototype or product, (6) Test and evaluation of the solution, and (7) Socialization and completion decision stage.

The activities of identification of social issues stage

The activity was generated when students and teachers asked what your interesting animals are. Students and teachers discuss animals that interest them together. Therefore, the question arose: “If talking about Khon Kaen Province? What important places do the children think of?” This question received the most answers was Khon Kaen Central Plaza. Then the teacher and students discussed together, “In 3 weeks there will be an open house of KCU demonstration school activity. The theme was Khon Kaen Province. Therefore, what kind of activities will the kindergarten 1/2 classroom organize? After that, there was a discussion together on topics that the students were interested in and wanted to study further. By having students draw a picture of the subject they want to study. Then make a picture chart. Survey results show that most of the students are interested in Khon Kaen Central Plaza. Therefore, teachers organized STEM learning on having fun in Khon Kaen Central Plaza shopping center. The activities were concerned about students' learning interests, practicing and exchanging experiences in the classroom, and organizing various activities appropriate for their ages.

The activities of identification of potential solutions stage

Students observe and explore the materials/equipment given by the teacher. Then, they talked about building a central in what form will it be created. Based on the equipment that the teacher has specified, student may think about “can it be used to create a central or not? And how?”

The activities of need for knowledge stage

Teachers and students discuss the shape and structure of the Central Plaza. To guide students' ideas, the teacher brought pictures of Central Plaza for the students to observe. Students wondered what it would take to become a Central Plaza, what would be required to build it?

The students wanted to build the center themselves. The teacher specifies the materials/equipment for building the center plaza. These materials included 1) Flowerpot, 2) Plastic loop, 3) Clay, 4) Ice cream stick, 5) Masking tape, 6) Coffee Straw, 7) Scissors, and 8) Wooden block

Students observe the structure and appearance of the central plaza on the computer and look at the pictures. Then, students shared their opinions about the central plaza. They could share “What did the students notice?” for following issues: 1) there are stairs going up all around, 2) there are 5 floors, 3) there are layers of different colored lights around, 4) it has a central plaza name plate, 5) there are trees, 6) there is a fountain, and 7) there is a Khon Kaen sign. They could share “What is the shape of the center?” for the following issues: 1) it's a tall building, 2) it's big, 3) it's like a round shape, 3) it's like a rice bowl in the glowing garden.

The activities of decision-making stage

Students shared their ideas and discussed in groups which pieces of equipment to use, where and for what reason to build their center.

The activities of development of prototype or product stage

Students plan and follow the plan by drawing designs for building the central as discussed about using materials/equipment. The teacher had determined to create in the form that has been drawn. The students then told the teacher what happened while they were bringing the materials/equipment to build the center. The teacher records every student's speech. Students worked together to build the central plaza according to the drawing until it was completed.



Picture 5: Students' developing prototypes

The activities of Test and evaluation of the solution stage

Students helped each other observe the work to see if there were any materials/equipment that were durable, beautiful, or follow the design or not. Then, they adjusted the prototype until everyone in the group agreed. This showed how they were satisfied with the work.

At this stage, there were some groups of students who did not create work that was not in accordance with the design. This was a result of observing the work of other groups of friends and wanting to follow suit, so they adjusted their work. Additionally, one group's attempt to construct a Central Plaza failed due to their inability to keep the equipment intact, so they decided to construct a garbage instead.



Picture 6: students' test their prototypes

The activities of Socialization and completion decision stage

Each group of students presented their work. Students must present "What is the method of creating the center? What materials/equipment were used to create it? What are problems that occur on the way and how do they find ways to solve them?"

Each group of students can explain the steps and methods of their own group's work. Take pride in your own work. Including telling about the success of the work, such as fun activities, would like to do this again. I practiced thinking about what to do to create it. Students mentioned that we helped each other work and friends help each other do it.

Students could mention problems with unsuccessful work, such as equipment unable to be installed at all and must be replaced. They reflect how friends refuse to follow the pattern because they want to be like other groups. Example of students mentioned "My friends didn't share it with me because I would do it myself."

After each group of students presented their work. The teacher gave students an opportunity to go back and make additional corrections. Students asked "Will you add materials/equipment or remove any items? They were satisfied with the work when all the group members agreed.

Finally, the completed versions of prototypes were presented in the Open class of KKU kindergarten demonstration school.



Picture 7: Students' presentation of their prototypes at the open class of school.

4. Conclusion

In conclusion, the Khon Kaen Central Plaza shopping center served as the focal point of the STEM teaching unit, which demonstrated an extensive and captivating learning process for kindergarten pupils. Students engaged in practical tasks that sparked their creativity and curiosity by integrating a variety of courses, including science, technology, engineering, mathematics, language, and the arts. In addition to discovering their interests and looking into possible solutions, students who adhered to the seven stages of STEM pedagogy may improve their critical thinking abilities and collaborated to build their prototypes. Students' learning experience was further enhanced by the reflective presentation, which gave them the opportunity to recognize and celebrate their accomplishments as well as their obstacles. All things considered; this endeavor enhanced the pupils' comprehension of their immediate surroundings while also cultivating vital abilities that are critical for success in the twenty-first century.

References

- Adita, A and Yuenyong, C (2021). STEM Learning Activity through Tempeh Making Process. *Journal of Physics: Conference Series* 1835 (1), 012050
- Koes-H, S, Latifa, BRA, Hasanati, A, Fitriana, A, Yuenyong, C, and Sutaphan, S (2021). STEM education learning activity: making simple tool to produce analog rice. *Journal of Physics: Conference Series* 1835 (1), 012045
- 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
- Leiva, C. L., Roberts-Harris, D. and Toll, E. V., 2016. Meaning Making With Motion Is Messy: Developing a STEM Learning Community. *Canadian Journal of Science, Mathematics and Technology Education*, 16:2, 169-182, DOI: 10.1080/14926156.2016.1166293
- Moore T.J., Johnson C.C., Peters-Burton E.E., Guzey, S.S., 2015. The need for a STEM road map. In: Johnson CC, Peters-Burton EE, Moore TJ (eds) STEM road map: a framework for integrated STEM education. Routledge, p 1.
- National Governors Association Center for Best Practices, Council of Chief State School Officers (NGACBP), 2010. Common core state standards for mathematics-CCSSM. Washington DC:Author.
- NGSS Lead States, 2013. Next generation science standards. Washington, DC: Achieve, Inc.

- Nugraheni, A. R. E. ., & Yuenyong, C. (2022). Developing the Smog Problem in Indonesia STEM Education Learning Activity. *Asia Research Network Journal of Education*, 2(3), 127–134.
- Sutaphan, S. Yuenyong, C. (2019). STEM Education Teaching approach: Inquiry from the Context Based. *Journal of Physics: Conference Series*, 1340 (1), 012003
- Theerasan, C. and Yuenyong, C. (2019). Developing the Floating Restaurant STEM Education Learning Activities for Thai Secondary School Students. *AIP Conference Proceedings*. 2081, 030023-1– 030023-6.
- Villaruz, E.J., Cardona, M.C.F., Buan, A.T., Barquilla, M.B., and Yuenyong, C. (2019). Ice Cream STEM Education Learning Activity: Inquiry from the Context. *Journal of Physics: Conference Series*, 1340 (1), 012092
- Worth, K. (2010). Science in Early Childhood Classrooms: Content and Process. SEED Papers, Fall 2010. Available: <https://ecrp.illinois.edu/beyond/seed/worth.html>
- Yuenyong, C. (2019). Lesson learned of building up community of practice for STEM education in Thailand. *AIP Conference Proceedings*. 2081, 020002-1 – 020002-6.
- Yuenyong, C. and Narjaikaew, P. (2009). Scientific Literacy and Thailand Science Education. *International Journal of Environmental and Science Education*. 4 (3): 335 – 349.