

PROPOSING A PROCESS OF DESIGNING STEAM EDUCATIONAL ACTIVITIES FOR PRE-SCHOOL CHILDREN BY 5E MODEL

Vu Kieu Anh*, Tran Trung Hieu

HPU2 - Ha Noi Pedagogical University 2

ARTICLE INFO		ABSTRACT
Received:	26/6/2023	STEAM education is a model of great interest to educators. To effectively apply this model to preschool education in Vietnam, educators have conducted research on the content, methods and forms of organizing STEAM education activities for preschool children in general and children aged 5-6 years old in particular. Among the teaching methods that have been studied, the 5E model is a suitable model to apply the design of STEAM education activities for preschool children. Therefore, in this study, we use theoretical research methods, expert consultation and product analysis to collect, analyze and discuss the use of 5E models and STEAM-based educational content to design lessons, from which proposes the process of the design of STEAM education activities for preschool children consists of 6 steps: 1) State the problem, 2) Study and find solutions, 3) Discuss and plan, 4) Design, 5) Make crafts, 6) Evaluate and present. Research results show that children can clearly understand scientific knowledge in STEAM-based activities, gain practical skills, experience and apply learned knowledge to life. This research result contributes to improving the quality of STEAM education activities for 5-6 years old children in preschool.
Revised:	31/7/2023	
Published:	31/7/2023	
KEYWORDS		
5E model		
Design		
Education		
STEAM		
Preschool children		

ĐỀ XUẤT QUY TRÌNH THIẾT KẾ HOẠT ĐỘNG GIÁO DỤC STEAM CHO TRẺ MẦM NON THEO MÔ HÌNH 5E

Vũ Kiều Anh*, Trần Trung Hiếu

Trường Đại học Sư phạm Hà Nội 2

THÔNG TIN BÀI BÁO		TÓM TẮT
Ngày nhận bài:	26/6/2023	Giáo dục STEAM là một mô hình được các nhà giáo dục rất quan tâm. Để áp dụng hiệu quả mô hình này vào giáo dục mầm non tại Việt Nam, các nhà giáo dục đã có những nghiên cứu về nội dung, phương pháp, hình thức tổ chức hoạt động giáo dục STEAM cho trẻ mầm non nói chung và trẻ 5 – 6 tuổi nói riêng. Trong số các hình thức dạy học đã được nghiên cứu thì mô hình 5E là mô hình thích hợp để vận dụng thiết kế hoạt động giáo dục STEAM cho trẻ mầm non. Vì vậy, trong nghiên cứu này, chúng tôi sử dụng phương pháp nghiên cứu lý thuyết và phương pháp tham vấn chuyên gia, phương pháp phân tích sản phẩm hoạt động để tham khảo, thu thập và phân tích mô hình 5E và nội dung giáo dục STEAM nhằm thiết kế bài học, từ đó đề xuất quy trình thiết kế hoạt động giáo dục STEAM cho trẻ mầm non gồm 6 bước: 1) Nêu vấn đề, 2) Khám phá và tìm giải pháp, 3) Thảo luận và lập kế hoạch, 4) Thiết kế, 5) Chế tạo, 6) Đánh giá và trình bày. Kết quả nghiên cứu cho thấy, trẻ có thể hiểu rõ về các kiến thức khoa học trong hoạt động STEAM, có được các kỹ năng thực thành, trải nghiệm và ứng dụng những kiến thức đã học vào cuộc sống. Kết quả nghiên cứu này góp phần nâng cao chất lượng tổ chức hoạt động giáo dục STEAM cho trẻ 5 – 6 tuổi ở trường mầm non.
Ngày hoàn thiện:	31/7/2023	
Ngày đăng:	31/7/2023	
TỪ KHÓA		
Mô hình 5E		
Thiết kế		
Giáo dục		
STEAM		
Trẻ mầm non		

DOI: <https://doi.org/10.34238/tnu-jst.8214>

* Corresponding author. Email: vukieuanh@hpu2.edu.vn

1. Introduction

Fundamental and comprehensive innovation in education and training is very necessary to mention science and technology. Therefore, Directive No. 16/CT-TTg dated May 4, 2017 of the Prime Minister on promoting the 4th Industrial Revolution clearly states: "Promoting the implementation of science, technology, engineering and mathematics (STEM) education in the general education curriculum right from the 2017-2018 school year". The directive also emphasizes "Drastic change in policies, contents and methods of education and vocational training in order to create human resources who are capable of receiving new production technology trends, in which it is necessary to focus on in promoting training in science, technology, engineering and mathematics (STEM), foreign languages, and informatics in the general education curriculum" [1, p. 3]. Early childhood education, as the first level of education in the national education system, "must also be required to make changes in both the curriculum and the organization of educational activities to meet the challenges of this time" [2]. In the current period, children need to be formed a system of skills including critical thinking, creative thinking, cooperation, communication, physics, logic and social knowledge. These skills must be integrated into the learning process and it is vital to basic early childhood learning to ensure students have learning and innovation skills, technology and media skills, and at the same time be able to study, work and develop themselves, using their skills throughout life. From those reasons, STEAM was born. STEAM is organized in schools with many different forms of teaching, however, the 5E model is an ideal form to maximize the potential of children. Some researchers in the world and in Vietnam have also had orientations on using the 5E model in STEM-based educational activities such as Nguyen Thi Hong Lam et al. [3]. Tran Viet Nhi's research also mentioned the process of designing STEAM education activities according to 5E, 6E [4]. Recently, in a study by Van Thi Minh Tu emphasized "In the process of organizing STEAM-based activities for preschool children, teachers can use STEAM educational methods such as: 5E, 6E process, 4C process, engineering design activity based (EDP) process" [5]. In addition, Anggraeni et al. "built a 5E-STEAM learning model to improve critical thinking skills in learning science" [6]. Or in a study with the theme "Mirror and light", Gülhan et al. carried out an activity based on the 5E model for STEAM education. The activity plan was designed by the researchers for the lesson "Reflection in mirrors and absorption of light" in the 7th grade science subject [7]. Besides, there are still some other studies on the design of STEAM education activities for students applying the 5E teaching model. However, the studies that have been done mainly point to the forms of 5E, 6E or the technical cycle or the application of the 5E model to primary or secondary school students without going deep into the application of 5E model in teaching children of preschool age.

Therefore, in this article, we study documents in the world and Vietnam on STEAM education and the 5E model, from which, we propose process of designing STEAM educational activities for pre-school children by 5E model.

2. Research Methods

2.1. Theoretical research methods

In this study, we collect, classify, analyze and synthesize documents in the world and in Vietnam on STEAM education and 5E model to build a theoretical basis for research.

- The essence of STEAM education
- The role of STEAM education
- Teaching model 5E
- The process of designing STEAM education activities according to the 5E model

2.2. Expert consultation method

We also consult experts on the process of applying the 5E model to the design of STEAM education activities for preschool children; Illustrated lesson plan "Anti-flood floating boathouses".

- Selecting experts: The teachers specializing in Early Childhood Education have deep expertise in the field of research, and the preschool teachers directly teach on children.

- Determining the consultation criteria: The process ensures (1) the scientific values, pedagogical values and consistency with the teaching and learning perspectives of capacity development and (2) the suitability and feasibility of the proposed procedures for the child's characteristics.

After having expert consultation, we edited and completed the process and plan of STEAM education activities in line with reality.

2.3. Product analysis method

Based on the products collected from STEAM activities that children create, we analyzed them to gather scientific information about knowledge and skills that children need to have when learning science. Hence, we assessed the feasibility of the design process of STEAM educational activities to improve the educational quality.

3. Results and discussion

3.1. The essence of STEAM education

In 1990, the term STEM started to be found in scientific research works. STEM was abbreviated in English for four words: Science - S, Technology - T, Engineering - E, Maths - M. In Vietnam, the meaning of these four terms has no clear division. It can be understood as follows:

Science: According to the Vietnamese Dictionary, science is “a system of knowledge accumulated in the historical process and proven by practice, reflecting the objective laws of the outside world as well as of spiritual activities, enabling people to transform the real world. Similarly, the concept of science in the English-Vietnamese bilingual dictionary also has the same meaning” [8].

Engineering: According to the Vietnamese Dictionary, engineering is “the general set of means and techniques of human activity created to carry out the production process and serve the non-productive needs of the society. Generally speaking, it refers to the methods used in a certain field of human activity” [8].

Technology: According to the Vietnamese Dictionary, technology is “methods of processing; manufacturing; changing the state, properties, shape of materials or semi-finished products used in the production process; to have the finished product. Technology, according to the English-Vietnamese bilingual dictionary, means “Technology, machinery/technological equipment” [9].

Mathematics is a field of natural science, a discipline that deals with problems involving numbers, spatial structure, and transformations. In other words, it is said to be the subject of "figures" and "numbers" [8]. In 2008, at a scientific conference on technology education in Salt Lake City, Utah, USA, Ms. Georgette Yakman from the Virginia Institute of Technology gave a report with a proposal for a new educational model with the combination of art elements (Art) into STEM education and call it STEAM education.

$$\text{STEAM} = \text{STEM} + \text{ART}$$

The artistic element is not limited to liberal arts, from language arts, sociological studies, physical arts, fine arts and music, etc. and this model quickly spread to many different countries like Korea. For young children, art is not only beauty but also what children "write" about life, or what they feel.

“STEAM Education” is an “integrative”, “interdisciplinary” approach to teaching academic concepts coupled with lessons about real life, where children can apply their knowledge of science, technology, and engineering and mathematics in practical classroom activities to develop thinking and problem-solving skills [10].

3.2. The role of STEAM education with preschool children

STEAM education gives preschool children the advantages, including developing skills and knowledge to help them integrate into the 21st century.

First of all, STEAM education is considered as a model of early education for children. In the study by McClure et al, “children can and must participate in STEAM learning, even in the early years of life” [11]. Children are much more likely to learn about STEM concepts and practices than expected. Furthermore, a study by Ata Aktürk et al showed that “during the very first years of a child's life, STEAM activities allow children to find learning materials with their senses” [12]. By this way, children can understand important connections between maths and science, such as the concepts of 'more or less' and 'sooner or later' from an early age.

In addition, STEAM serves children by increasing their vocabulary, encouraging collaboration, and transferring learned knowledge into their future experiences [13]. According to Anderson and Gullberg, “children are exposed to science and begin to learn the language of science to enhance their scientific knowledge and guide them to think like scientists”[14]. This interest gained by children's willingness to learn what's going on around them can grow for the rest of their lives. Therefore, in a STEAM curriculum, goals and indicators related to other areas of development, such as language, social-emotional development, and motor development can be supplemented by considering STEAM activities and practices can be planned to achieve these goals and indicators. Furthermore, “children's STEAM experiences can increase their confidence in their ability to learn STEAM; opportunities of these early years help children appreciate STEAM and its value to everyday life” [15].

STEAM education also offers many opportunities for children to be energetic, proactive and enthusiastic in their learning. Based on observational notes made by Linder et al., “a significant relationship can be found between teaching content, pedagogical knowledge, and child learning. The higher the teacher's competence in pedagogical knowledge and STEAM content are, the higher the child's level of interaction and conversation around STEAM lessons and activities is. These observations/findings are well supported by previous research, which has shown a direct relationship between teachers' learning styles and children's achievement, showing that children are more likely to learn from their teachers with higher teaching capacity” [16].

3.3. Model 5E

In 1987, Model 5E was built by Rodger W. Bybee and colleagues based on the learning model of J. Myron Atkin and Robert Karplus (1962), in order to improve the teaching curriculum of Biology subjects at primary level. “The 5E model is based on constructivist theory of learning. Accordingly, learners build knowledge from the experience process” [17].

The 5E model consists of 5 stages in a teaching process chain: Engagement, Exploration, Explanation, Elaboration and Evaluation (Figure 1) [17].



Figure 1. Stages in the 5E model

Engagement: This is the first stage of the learning cycle. The goal of this stage is to set the child's motivation and interest in learning, clarifying findings that the child has already known or has been thinking about the topic of the lesson. Through diverse activities, teachers attract children's interest, stimulate children's curiosity to learn upcoming concepts. Teachers should ask open-ended questions, reveal ideas, and then put learning in meaningful contexts so that children are able to connect with prior knowledge or experiences, and then they are ready to learn new knowledge.

Exploration: In this stage, children actively explore new concepts through specific learning experiences. Teachers provide basic knowledge or experiences, from which new knowledge can be initiated.

Explanation: At this stage, the teacher introduces new terms, new concepts, new formulas and helps children create and understand connections with previous experiences through guiding them to synthesize new knowledge as well as encouraging them to explain concepts, definitions, and newly learned contents.

Elaboration: This phase focuses on giving children the space to apply the concepts and skills learned in the previous step to new situations (ask them to explain how they did it).

Evaluation: The 5E model creates opportunities for children to consider and think about their learning, and gives them the opportunity to change their knowledge, skills, and attitudes. Teachers can assess children formally (in the form of tests, written assignments, or multiple choice exercises) and informally (in the form of quick questions), or can observe children through activities in small or large groups to consider the interaction in the learning process.

3.4. The process of applying the 5E model to the design of STEAM education activities for preschool children

In the STEAM educational program, the 5E model becomes an effective tool to help teachers and learners find out if lessons are logical, systematic, and consistent. Teachers organize STEAM education activities for preschool children according to the 5E model, paying special attention to develop learners' capabilities, which is evident in each step of the model. According to the theory of STEAM experiential activities, the Early Childhood Education Program, and based on the practical implementation of the program at pre-school institutions, in this study, we propose a process of conducting STEAM activities for preschool children as follows:

Activity 1: State the problem

In this section, teachers can offer activities such as games, music, poetry, or show children a phenomenon that increases curiosity and creates specific problems, provide meaning, aim and introduce the topic, suggest and lead the problems and discuss the solution together for the children. The goal of this phase is to generate questions to be answered or to identify specific problems that need to be addressed. Once this goal has been identified, children will be interested in participating in activities to find answers to questions posed and to find solutions to problems. This is a step into the next stage.

Activity 2: Explore and find solutions

The elements of science and technology is presented in this step. Here, children will learn more deeply about the topic, and the scientific principles related to the activities that they completed in the previous step. The purpose of this activity is to gather as much information as possible regarding the situation posed in Activity 1. Exploration activities should be designed, selected, or defined in a way that encourages active participation of children rather than learning passively under the teachers' instructions. Children actively collect information through various experiential activities under the teachers' guidance and orientation. In this activity, children will directly explore and manipulate materials that have been prepared. Teachers can participate with children in activities such as observing, doing experiments and reading books. The results of the information collection process are recorded by symbols, models, and diagrams.

In a STEAM experiential activity, a teacher may organize one or more science discovery lessons. The volume and content of science exploration lessons depends on the content of each lesson and a child's background level. Specifically, during the survey, when the teacher finds that children lack background knowledge about scientific concepts around the topic of STEAM experiential activities, the teacher carries out science discovery lessons to provide children with these concepts. If children lack understanding of materials to make products, teachers design lessons for children to learn about the characteristics and properties of materials, from which, children can master selection of suitable materials to make the final product of the STEAM experience. Or in case the child lacks both types of knowledge above, it is necessary for the teacher to design 2 periods of discovery learning to provide the child with the concept of an object and the characteristics and properties of the appropriate material to create the object. For example: In the project "Lantern" - if the child lacks knowledge about lanterns and the materials to make it, the teacher will use 2 hours for science discovery, including the first hour for the children to discover the lantern, recognize names and external structural features (parts, shapes, characteristics, functions) and the second hour for letting children explore about light, which helps them find the right materials to make lanterns.

Activity 3: Discuss and plan

In this step, the elements of Technology, Manufacturing, and Maths are applied. Here, teachers help children discuss the materials to be used; ways to achieve the goal of STEAM activities with technical factors such as size, color, shape and technical knowledge like how parts are securely connected, etc. Teachers also help children to put themselves in groups, initially know how to assign work and support each other in a groupwork. This is the stage when teachers play the role of controlling, directing and correcting children. Based on the knowledge and experiences that children have gained from Activity 2, teachers encourage and prompt children to speak out. On that basis, teachers correct scientific knowledge.

In this activity, teachers can ask each group to present their ideas verbally or with diagrams and drawings. Then, teachers instruct groups of children to exchange ideas and discuss with each other. Besides, teachers need to discuss with children about new concepts/terms if children do not understand.

The benefit of this activity is that children are always provided with an interactive learning environment in which they can actively participate in providing information instead of just passively receiving information. When children have grasped scientific concepts and knowledge, they will be able to apply these knowledge into practice.

Activity 4: Design

After planning, children basically understand the criteria and methods, as well as determine what materials are needed to conduct the task, they can design their own models and products. Children can design in many ways such as drawing, molding, tearing, and collaging to create a complete design.

With the activity of designing, depending on students' age, the teacher can organize the activities accordingly. For nursery children, they can just stop at coloring the available designed picture, drawing the dash lines of the design prepared by the teacher, or they just state the idea and the teacher will help them complete the idea on the design. For kindergarten children, designing activities are more flexible, and they help encourage children to design independently. With this activity, the teacher should conduct it as a group activity, which means that the teacher can use "jigsaw" or "spiral" teaching techniques to put students in groups and then let them support each other's knowledge. As a result, this activity helps children develop their teamwork skills.

Activity 5: Make crafts

In this step, children apply what they have learned to create products, and develop new knowledge and skills. To create products, teachers guide children to follow the technical designing process with 5 steps: Ask – Imagine – Plan – Do – Share. Children can decide to test their group's

products and create products with advanced requirements. The step of application allows children to be trial and make error to create products according to criteria from low to high. Teachers need to base on children's ability and interest to orient different criteria for each product that children create. For example, with the STEAM experience activity "Making lanterns", after letting children explore the material and structure of lanterns in Activity 2 and Activity 3, the teacher organizes the activity of making lanterns for children, the groups work together to carry out crafting activities according to the 5-step design cycle as above. With this Activity 5, children use the skills of cutting, sticking, and attaching. In the process, teachers instruct children to make their products more solid and compact, more vivid and suitable for the design.

With the crafting activity, teachers should let children learn according to the principle of trial and error (learning through mistakes). STEAM projects or activities have different difficulty levels for each age group. Therefore, during the process, teachers should carefully observe and support children by asking questions for children to think themselves to find out how to do it instead of doing it for them or showing them how to do it. The teacher intervenes only when it is absolutely necessary for children of any age.

With STEAM activities, in addition to crafting the design that children have planned, teachers should also encourage and instruct children so that they can create advanced products in many different ways. The teacher needs to always encourage children to create the most "optimal" product according to the starting situation in Activity 1.

Activity 6: Evaluate and present

Assessment activities are conducted throughout the process of children conducting STEAM activities. Teachers evaluate the process of children working in groups when children discuss, give ideas, make discoveries as well as how children take notes, present, critique, design and make products. Teachers also assess products that children have created according to the initial criteria of the technical design cycle. This activity is done by both teachers and children.

Evaluating the performance of STEM lessons is an important step that cannot be separated from the implementation process. Through different assessment methods, teachers grasp the current status of children's performance and development results (including children's strengths and weaknesses) to make timely adjustments and improvements in the development of children for the implementations of the next STEM lessons.

Teachers base on the characteristics of STEM education, the goals and contents of the pre-school educational program, the expected results at the end of the age, the goals of the 5E lesson and the development characteristics of children at each age stage to determine the evaluation criteria. With these bases, teachers often give criteria to evaluate the results of children's STEM lessons as follows: Evaluating children's attitudes and results of developing knowledge and skills, evaluating children's development results according to the goals of pre-school education (05 areas).

4. Conclusion

STEAM education helps children maximize their learning capacity, and at the same time equips them with basic knowledge and skills that will serve as a solid foundation for the next level of education and throughout life. Applying the 5E model to the design of STEAM education activities can be considered as one of the effective directions to realize the goal of reforming early childhood education in particular, meeting the needs of society for well-qualified human resources in general. The process of applying 5E model to designing STEAM educational activities for preschool children includes 06 steps: 1) State the problem, 2) Explore and find solutions, 3) Discuss and plan, 4) Design, 5) Make crafts, 6) Evaluate and present. In order to synchronously and effectively deploy STEAM education for preschool children, in addition to unifying the organization of educational activities, the propaganda, training and fostering of teachers as well as investment in school infrastructure and classroom facilities and equipment are

very important, requiring synchronous direction, synchronous investment, and compliance with the "fundamental" and "comprehensive" innovation roadmap.

Acknowledgments

This work is funded by Hanoi Pedagogical University 2 (HPU2) under Grant No HPU2.2022–UT-09.

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