

DEVELOPING COMPETENCY FRAMEWORK FOR ORGANIZING STEAM EDUCATION ACTIVITIES FOR EARLY CHILDHOOD EDUCATION STUDENTS

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Abstract. The ability to organize STEAM education activities plays an important role in preparing students majoring in Early Childhood Education (ECE) to meet the requirements of their training program and the general development trend of modern society. Therefore, the development of a specific STEAM educational competency framework for Early Childhood Education students is an essential step in improving the quality of teaching and preparing for the challenges of the contemporary educational environment. This paper presents constructing a competency framework for organizing STEAM education activities tailored to preschool education students. The article ultimately contributes to supporting schools in establishing and improving training programs, aiming at training preschool teachers capable of effectively organizing STEAM education activities, in response to the increasingly demanding requirements of the education sector.

Keywords: Competency framework, STEAM educational activities, students, early childhood education.

1. Introduction

The competency to organize educational activities plays a crucial role in enhancing the quality of teaching and learning at educational institutions. According to the research by Dinh Thi Kim Thoa (2019), this competency not only includes the ability to design, plan, and implement educational activities but also involves the ability to assess and adjust these activities based on feedback from learners and teachers [1]. This requires educators to possess strong management, leadership, and communication skills to create an effective learning environment and stimulate the comprehensive development of learners.

Studies on the development of the capacity to organize STEAM educational activities for students in the ECE sector focus on improving and enhancing students' teaching capacity and the ability to integrate innovative teaching methods. Several researchers have mentioned this issue, such as the research by Awang et al. (2020) [2], which explores the STEAM teaching strategy according to the Fred Rogers approach, helping students choose and implement appropriate methods based on expert opinions. The results of the study identified important factors such as inquiry-based learning, hands-on activities, fun and systematic teaching methods, and relevance to children's development. The research findings provide value for ECE students in organizing STEAM activities effectively [1], [2]. In the study by Jamil et al. (2018), which aims to highlight teachers' success after participating in the STEAM Education Organizational Capacity Development Conference, the author provides different perspectives on the approach and impact of STEAM education in the ECE

curriculum [4], [3]. The “Next Generation Science Standards” (NGSS) project, which was implemented in six countries, explored the integration of STEAM at the preschool level. It emphasizes the use of creative methods such as drama, learning through games, and physical education that create a balance between cognitive, emotional, and social development [6].

Currently, there is no accurate scale for the competency to organize STEAM educational activities for students in early childhood education. The development of this scale is not only of theoretical value but also of profound practical significance. This scale will be an important support tool in assessing and measuring the capacity to organize STEAM education activities, by the requirements of the current early childhood education curriculum. In addition, it will also provide transparent guidelines for training and developing this competency for lecturers and students of early childhood education, thereby improving the quality of education and better meeting the needs of modern education.

2. Content

2.1. STEAM Educational Activities in Early Childhood Education

Numerous studies by Geary et al. (2013) and Brunton & Thornton (2010) have shown that if children begin to develop STEAM concepts and skills during their preschool years, these early STEAM experiences play a crucial role in enhancing their knowledge and skills. This preparation helps children explore more complex and abstract concepts as they enter elementary school and guides their future career orientation by equipping them with the necessary skills to face complex problems (Chesloff, 2013; DeJarnette, 2018; McClure et al., 2017) [5-10].

Park et al. (2017) and Simoncini & Lasen (2018) analyze the importance of STEAM in early childhood education, highlighting the positive role of STEAM as a foundation for children's future career concepts, knowledge, and skills. Nguyen Thanh Hai (2019), in his book “STEM/STEAM Education: From Practical Experience to Creative Thinking,” emphasizes the role of STEM education in early education, stating that children's experiences with STEM knowledge make science surprising, interesting, approachable, and easy to implement. In her article “Integrating STEAM Education for Preschool Children through Literature Projects,” Van Thi Minh Tu (2020) asserts that integrating STEM (STEAM) in early education is a trend in modern education [11]-[14].

In the article “Characteristics of STEAM Education for Preschool Children,” educator Hoang Thi Phuong (2020) analyzes the importance of STEM/STEAM education for preschoolers, the basic characteristics of STEM education for preschool children, and their ability to approach STEM elements and integrate STEAM elements into their activities. The research group Hoang Quy Tinh and Dang Ut Phuong, in their article “STEAM Education Awareness Competency among Preschool Teachers to Meet the Requirements of Early Childhood Education Innovation,” identify five characteristics: STEAM activities focus on practical issues, the structure of educational activities is designed according to the scientific research process or engineering design process, or a combination of both; and the STEAM content primarily utilizes knowledge from scientific exploration activities and early mathematics familiarization activities [15-16].

At the preschool level, teachers are not highly trained in the S, T, E, A, and M elements and are rarely guided on how to approach STEAM. Therefore, if early childhood education majors are guided and trained in organizing STEAM educational activities while still in college or university, they will be more confident. This perspective is also shared by many authors such as Moomaw, S. and Davis, J.; Jamil, Linder, and Stegeline (2010); Aldemir & Kermani [17-18].

2.2. Capacity to organize STEAM educational activities for early childhood education students

According to Le Thi Kim Loan, pedagogical students are “People who are studying college-level teacher training programs, university-level teacher training programs at colleges and universities” [19].

ECE students also share common characteristics with general pedagogical students, most of whom are between the ages of 18 and 22 – the age at which they have a certain biological and social maturity, and are legally qualified to take responsibility for their actions. In addition, ECE students must go through the selection process of educational institutions with ECE code training. This proves that students in ECE have achieved a certain cultural level, capable of participating in vocational training programs to achieve a college or university diploma.

In addition to having similar characteristics to students in other majors, ECE students also have their characteristics: (a) Love for the profession and children. (b) Patience, (c) Creativity, (d) Adequate attention to children's health and development, (e) Organisation and planning skills, (f) Communication skills, (g) Knowledge of early childhood education, (h) Professional ethics

Based on studies on STEAM educational activities in early childhood education and the characteristics of early childhood education students, the researchers determined that the students who are capable of organizing STEAM educational activities must possess the following attributes:

- ✓ Knowledge of basic issues related to STEAM education, understanding of the components and their relationships within STEAM education, and ability to describe the design process.

- ✓ Skills in creating environments for STEAM educational activities.

- ✓ Skills in using technology in STEAM educational activities.

- ✓ Skills in planning STEAM educational activities for preschool children.

- ✓ Skills in implementing STEAM educational activity plans.

- ✓ Skills in designing assessment tools and conducting evaluations in STEAM educational activities.

Therefore, we define the competency of organizing STEAM educational activities for early childhood education students as a system of necessary knowledge, skills, and attitudes required for early childhood education students to design, implement, and integrate the fields of science, technology, engineering, mathematics, and the arts in children's education. This ensures alignment with the children's cognitive abilities, needs, and interests.

2.3. Basis for Developing a Competency Framework for Organizing STEAM Educational Activities for Early Childhood Education Students

The competency framework for organizing STEAM educational activities for early childhood education students is based on: (1) The Early Childhood Teacher Competency Framework of Southeast Asia; (2) The STEAM Education Competency Framework of the state of Michigan, USA; (3) The Professional Standards for Early Childhood Teachers.

(1) Early Childhood Teacher Competency Framework of Southeast Asia [20]

Based on Bronfenbrenner's competency framework, the competencies are identified in the current guidelines by UNESCO and SEAMEO (2016), and the perspectives of educators and experts in the field of early childhood education presented at the consultation workshops for the competency framework held in Thailand in August 2017. This framework centers on the standard-compliant teacher and proposes that early childhood educators can demonstrate competencies through four main areas:

- Area 1: Competencies related to knowledge of teaching content, pedagogical practices, and assessment of early childhood educators.

- Area 2: Competencies related to the learning environment.

- Area 3: Competencies related to engagement and collaboration.

- Area 4: Competencies related to professional development.

Embedded within these four areas are seven general competencies or core competencies that encompass the overall responsibilities of early childhood educators and the supplementary competencies. These include specific knowledge/tasks that early childhood educators should be able to perform or demonstrate to support each of the general competencies.

(2) *STEAM Education Competency Framework of the State of Michigan, USA (2014) [21]*

- Competency A: Demonstrates knowledge of child development and learning.

- Competency B: Demonstrates knowledge of how young children differ in their development and approaches to learning.

- Competency C: Demonstrates knowledge of the impact of the environment on children's growth, development, and learning.

- Competency D: Demonstrates knowledge of the impact of developmental delays, disabilities, and special needs to ensure that all children achieve their full potential.

- Competency E: Demonstrates knowledge of the impact of language and culture on a child's development, and promotes a climate of acceptance, inclusion, and engagement.

- Competency F: Demonstrates knowledge of cognitive development to support children in using information in increasingly complex ways.

- Competency G: Demonstrates knowledge of language acquisition and literacy skills.

- Competency H: Demonstrates knowledge of physical development, including gross and fine motor skills.

- Competency I: Demonstrates knowledge of how children develop socially and emotionally through interactions with adults and peers.

- Competency J: Demonstrates knowledge of how young children develop mathematical skills and scientific reasoning through exploration, investigation, interactions, materials, and problem-solving.

(3) *Professional Standards for Early Childhood Teachers (2018) [22]*

According to the Ministry of Education and Training (issued under Circular No. 26/2018), professional standards for early childhood teachers are defined as “a system of qualities and competencies that teachers need to achieve to perform the tasks of nurturing, caring for, and educating children in early childhood education institutions” [148]. These professional standards include criteria and standards. Standards refer to the requirements for qualities and competencies in each field of the professional standards for teachers. Criteria refer to the requirements for the component qualities and competencies of the standards. Accordingly, the professional standards for early childhood teachers comprise 5 standards and 15 criteria, including:

- Standard 1: Teacher's qualities

- Standard 2: Professional development

- Standard 3: Creating an educational environment

- Standard 4: Developing relationships between schools, families, and communities

- Standard 5: Using foreign languages (or ethnic languages), applying information technology, and demonstrating artistic abilities in nurturing, caring for, and educating children.

These professional standards for early childhood teachers serve as an important foundation for the effort to develop a competency framework for organizing STEAM educational activities

for early childhood education students.

2.4. Principles for developing the capacity to organize STEAM educational activities for early childhood education students

To develop the capacity to organize STEAM (Science, Technology, Engineering, Arts, Mathematics) educational activities for ECE university students, it is necessary to ensure the following principles:

First, ensuring educational goals: STEAM education activities need to be associated with and support the implementation of the goals of the current Early Childhood Education Program, and focus on developing necessary skills for citizens in the new era. The objectives of this educational activity need to be clearly defined according to each specific area of STEAM so that the monitoring and evaluation process can take place easily and accurately.

Second, ensure interdisciplinary integration: STEAM education emphasizes the principle of interdisciplinary learning, which means that the curriculum should be designed to integrate science, technology, engineering, art, and mathematics concepts in a coherent and meaningful way. The alignment of these disciplines helps students understand how different concepts can connect and support each other in a practical context.

Third, ensuring appropriateness and practicality: In the teaching process, lecturers should guide students to select STEAM educational content based on real-life and relatable issues to enhance the applicability of knowledge. This approach helps students easily access and deeply understand the concepts while encouraging exploration and creativity. Educational activities should be adjusted to fit the abilities and understanding levels of each individual, ensuring that all students have the opportunity to maximize their skill development.

Fourth, professional development: Lecturers need to be fully equipped with the knowledge and skills to teach STEAM subjects effectively. This includes regularly updating the latest teaching methods and participating in intensive training courses.

Fifth, focus on personal development: The curriculum should be designed to not only develop professional skills but also develop students' life skills and confidence, helping them better prepare for the role of future educators.

Sixth, continuous evaluation: An ongoing evaluation system is needed to monitor students' learning progress and ensure that they are achieving their academic goals. Evaluation should include both periodic and performance-based evaluations, focusing on both the student's process and the final product.

Seventh, collaboration and networking: Collaboration between departments within the university and with external organizations is important. Not only does this help to share resources and knowledge, but it also expands opportunities for students to participate in STEAM activities in a more diverse environment

By adhering to these principles, the university can help early childhood education students develop their capacity to effectively organize STEAM education and meet the growing demand for quality education for young children.

2.5. Proposal for the structure of the framework for organizing STEAM educational activities for ECE students

2.5.1. Process of Developing a Competency Framework for Organizing STEAM Educational Activities for ECE students

Based on the characteristics of STEAM educational activities and the specific features of educational activities for early childhood education students, the authors propose a process for

developing a competency framework for organizing STEAM educational activities, consisting of the following five basic steps (see Figure 1).

Step 1-Literature Review: We conducted a review and research of domestic and international documents and literature related to the development of competencies for organizing STEAM educational activities for early childhood education students. The objective is to build a competency framework structure that is appropriate for the educational context in Vietnam while aligning with international trends. These documents form the basis for identifying the component competencies in organizing STEAM educational activities for early childhood education students.



Figure 1. Process for developing a competency framework for organizing STEAM educational activities for ECE students

Step 2-Identify Component Competencies: Based on the reviewed documents, we identified the core and component competencies necessary for developing the ability to organize STEAM educational activities for ECE students.

Step 3-Develop Indicators for Each Competency: We described the indicators for each relevant competency. The draft competency framework, including these indicators and criteria, was sent to experts, including lecturers and researchers with expertise in developing competencies for organizing STEAM educational activities for ECE students. After receiving feedback from the experts, the draft framework was adjusted and sent back for further review. This process was repeated until a high level of consensus was reached among the experts.

Step 4-Detailed Description of Competency Levels Corresponding to Indicators: To facilitate the design of assessment tools for organizing STEAM educational activities, we proposed a system of standards and criteria that describe the competency levels corresponding to each indicator. This system of standards and criteria was also reviewed and adjusted based on expert opinions.

Step 5-Finalize the Competency Framework: After achieving broad agreement and consensus from the experts, we finalized the competency framework for the organization of STEAM educational activities by ECE students. To facilitate the design of assessment tools for students, we proposed a system of standards and criteria that describe the competency levels corresponding to each indicator. This system of standards and criteria was also reviewed and adjusted based on expert opinions.

2.5.2. Framework for organizing STEAM educational activities for ECE students

We propose a framework for organizing STEAM educational activities including the following competencies: (1) Research competency concerning the organization of STEAM educational activities; (2) Competency to create a favorable environment for the organization of STEAM educational activities; (3) Competency to use technology in the organization of STEAM educational activities; (4) Competency to plan STEAM educational activities; (5) Competency to implement the plan to organize STEAM education activities; (6) Assessment Competency during the organization of STEAM educational activities, specifically:

Table 1. Framework for organizing STEAM educational activities for ECE students

No.	Component Competency	Indicator(s)
1	Research Competency concerning the organization of STEAM educational activities	<ul style="list-style-type: none"> - Justify the importance of STEAM education activities to the development of preschool children - Identify the nature of the organization of STEAM educational activities - Analyze the content of components in STEAM education - Identify the relationship between elements in STEAM education activities - Describe the organizational process of STEAM education activities
2	Competency to create a favorable environment for the organization of STEAM educational activities	<ul style="list-style-type: none"> - Establish interaction and promote positivity between teachers and learners - Establish a close and mutually supportive relationship between learners and learners - Arrange a safe learning space for learners - Choose school supplies to ensure the safety of learners - Mobilize materials, utensils, and toys from different sources (self-preparation, parents, colleagues, community,...)
3	Competency to use technology in the organization of STEAM educational activities	<ul style="list-style-type: none"> - Use software to design STEAM educational activities (canvas, powerpoint , scratch,...) - Use technology devices in STEAM education activities (tablets, televisions, cameras, robots,...) - Use learning technology games in STEAM education activities - Use technical tools in STEAM educational activities (technical boxes, assembly kits,...)
4	Competency to plan STEAM educational activities	<ul style="list-style-type: none"> - Identify the goals of the STEAM education organization - Develop the content of organizing STEAM educational activities in accordance with the objectives - Identify the form of organizing STEAM educational activities in accordance with the content - Identify the method of organizing STEAM educational activities
5	Competency to implement the plan to organize STEAM education activities	<ul style="list-style-type: none"> - Organize activities according to the plan - Demonstrate positivity in the process of organizing STEAM educational activities - Establish an open question system in the organization of STEAM educational activities - Solve situations in the organization of STEAM educational activities
6	Assessment Competency during the organization of STEAM educational activities	<ul style="list-style-type: none"> - Analyze the role of assessment in the organization of STEAM educational activities - Present the principles of assessment in STEAM education activities - Choose the form of assessment in STEAM education activities - Design assessment tools in STEAM education activities - Use the assessment tool in STEAM education activities

● **Determine the level for each component competency**

According to the general competency framework, each competency is measured with 5 levels. For each ECE student, the levels are determined as follows:

- Level 1: **None** - Completely fail to meet the requirements for competency formation needs to be remedied immediately for competency development.

- Level 2: **Basic** – Barely meet the requirements of competency formation but still insufficiently, need to maintain competency development.

- Level 3: **Medium** - Properly meet the formation and development of competency, need to maintain competency development

- Level 4: **High** - Fully meet the requirements of competency formation and development, need to maintain competency development

- Level 5: **Very high** - Excellently meet the requirements of competency development, need to maintain competency development Based on the initial analysis and description of these basic levels, we present a table detailing the levels of “Research competency concerning the Organization of STEAM Educational Activities”. This table includes clearly-stated and specific criteria, categorized from none to very high, which aims to provide a comprehensive and transparent assessment tool.

Table 2. Rubric of the research competency concerning the organization of STEAM educational activities

Indicator Expression	Level				
	1	2	3	4	5
Justify the importance of STEAM education activities to the development of preschool children	Fail to justify the importance of STEAM education activities to the development of preschool children	Point out the importance of STEAM education activities for the development of preschool children but not enough, still struggle with, embarrassment and need help	Correctly and fully justify the importance of STEAM education activities to the development of preschool children	Analyze and synthesize the importance of STEAM education activities for the development of preschool children	Assess the importance of STEAM education activities for the development of preschool children
Identify the nature of the organization of STEAM educational activities	The nature of the organization of STEAM educational activities is not determined	Identify the nature of the organization of STEAM educational activities yet inadequately, still struggle, confused, and need help	Correctly and fully summarize the nature of the organization of STEAM educational activities	Analyze the nature of the STEAM educational organization	Evaluate the nature of the STEAM educational organization
Analyze the Component content analysis in STEAM education	Fail to analyze component content in STEAM education	Present the content of elements in STEAM education yet insufficiently, still struggle, confuse and need help	Correctly and fully analyze in detail the components of STEAM education	Synthesize, analyze in detail, and fully the components of STEAM education	Evaluate the components of STEAM education
- Identify the relationship between elements in STEAM	Fail to show the relationship between elements in	Point out the relationship between elements in STEAM education	Properly explain the relationship between elements in	Analyze in detail the relationship between elements in	Evaluate the relationship between elements in STEAM

education activities	STEAM education activities	activities is not enough, it is still difficult, embarrassing and needs help	STEAM education activities	STEAM education activities	education activities
Describe the organizational process of STEAM education activities	Fail to describe the organizational process of STEAM education activities	Describe the organizational process of STEAM education activities yet insufficiently, still struggle, confuse it is still difficult, confusing and need help	Properly analyze the organizational process of STEAM education activities	Summarize and analyze the organizational process of STEAM education activities	Evaluate the organizational process of STEAM education activities

3. Conclusions

This paper has detailed STEAM educational activities at the preschool level, emphasizing the importance of integrating S-T-E-A-M elements to enhance the knowledge and skills that prepare children to explore more complex and abstract concepts, thus allowing them to confidently enter elementary school. We have analyzed and clarified the competencies necessary for organizing STEAM educational activities for early childhood education students, confirming that these competencies not only support the teaching process but also play a crucial role in enhancing students' thinking and skills. Ultimately, we have developed a competency framework for organizing STEAM educational activities for early childhood education students. This competency framework includes component competencies and specific indicators, enabling students to apply them effectively in practical teaching. Implementing this competency framework promises to improve the quality of training for early childhood education students while meeting the increasing demands of modern education.

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