

Towards A Competency Framework for Organizing STEAM Education Activities in Pre-Service Early Childhood Teacher Education: A Literature Review

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ABSTRACT: In the context of the Fourth Industrial Revolution and the trend of educational innovation oriented towards competency development, the formation and development of professional competencies for learners has become a central goal of many education systems worldwide. According to the General Education Program (Ministry of Education and Training, 2018a), education aims to develop the qualities and competencies of learners, enabling them to effectively apply knowledge, skills, and experience to solve tasks in their studies and lives. In this context, developing the capacity to organize STEAM educational activities has become an essential requirement in preschool teacher training, helping future preschool teachers meet the needs of educational innovation and international integration. Although STEAM education has been included in the preschool teacher training program, the capacity of students to organize STEAM educational activities remains limited. More importantly, there is currently no comprehensive competency framework that can serve as a foundation for training, assessing, and developing this competency. Therefore, this study examines the theoretical foundation of competency in organizing STEAM educational activities and proposes a competency framework comprising five competency domains and nineteen assessment criteria for Early Childhood Education students. These findings are expected to contribute to improving competency-based teacher training programs and provide valuable reference material for teacher training institutions in designing and implementing professional development programs to enhance the competency in organizing STEAM educational activities.

KEYWORDS: Competency framework; STEAM education activities; Early Childhood Education students.

I. INTRODUCTION

The ability to organize STEAM educational activities plays a crucial role in improving the quality of teaching and learning in educational institutions. According to Dinh Thi Kim Thoa (2019), this ability includes not only the ability to design, plan, and implement educational activities but also the ability to evaluate and adjust these activities based on feedback from learners and teachers. Developing this ability requires teachers to have good management, leadership, and communication skills to create an effective learning environment and promote the holistic development of learners (Dinh, 2019).

STEAM education has been implemented in universities in recent years. However, the ability of Early Childhood Education (ECE) students to organize STEAM educational activities is still limited. Many students have not yet mastered the basic principles of STEAM education and are confused in identifying appropriate learning objectives, designing educational content, and choosing teaching methods suitable for the developmental characteristics of young children. Furthermore, the integration of STEAM components is often superficial, lacking creativity and practical application. In addition, the shortage of facilities, teaching materials, and supporting equipment has limited the effectiveness of STEAM educational activities (Hoang, 2020; Hoang & Dang, 2021).

Currently, there is no standardized tool to assess the organizational capacity of Early Childhood Education (ECE) students in STEAM educational activities. Review of existing literature reveals that both theoretical and empirical studies on developing this capacity in ECE students are still limited. Similarly, research on the implementation of STEAM education for preschool children in teacher training programs at universities, aimed at preparing future preschool teachers to meet the needs of modern society, is also scarce. Therefore, this study examines the theoretical foundations of STEAM education and proposes a competency framework for organizing STEAM educational activities for ECE students. The proposed competency framework comprises five

Towards A Competency Framework for Organizing STEAM Education Activities in Pre-Service Early Childhood Teacher Education: A Literature Review

competency components and nineteen assessment criteria, designed to support learners in achieving the educational goals and expected learning outcomes of the Bachelor of Early Childhood Education program at Thu Dau Mot University

II. RESEARCH METHODS

This study employed a combination of theoretical research methods to establish the conceptual and theoretical foundation for the study. These methods involved the systematic analysis, synthesis, evaluation, and interpretation of existing theories, scholarly perspectives, and research findings to gain a comprehensive understanding of the research problem. Specifically, the following methods were employed:

- **Theoretical Analysis:** This method was used to examine and critically analyze theories relevant to the research topic, particularly those concerning STEAM education, in order to identify their fundamental concepts, characteristics, and educational implications.
- **Theoretical Synthesis:** This method facilitated the integration of relevant theories to develop the theoretical framework of STEAM education, the process for designing STEAM lessons and thematic activities, and the competency framework for organizing STEAM educational activities. It also enabled the formulation of new conceptual frameworks and procedural models through the integration, extension, and refinement of existing theories.
- **Theoretical Evaluation and Interpretation:** This method focused on evaluating the applicability of existing theories and interpreting the STEAM education competency as well as the development of competencies for organizing STEAM educational activities. The findings served as the theoretical basis for the present study.
- **Logical Reasoning and Analytical Method:** This method was employed to classify, organize, analyze, and synthesize information collected from academic publications, research articles, and other relevant sources in order to support the development of the study's theoretical framework.

III. RESEARCH FINDINGS

A. The concept of STEAM education

STEAM education has been defined and interpreted from various perspectives. According to Yakman and Lee, STEAM education is regarded as an evolving educational model in which the traditional disciplines of Science, Technology, Engineering, Arts, and Mathematics (STEAM) are integrated into a comprehensive educational program. The integration of these five disciplines can be interpreted in different ways (Yakman & Lee, 2012). Yakman and Lee proposed two principal perspectives on STEAM education:

- From the traditional perspective, STEAM education may be represented as S–T–E–A–M, emphasizing each discipline as a distinct field of knowledge. Accordingly, educational institutions may interpret and develop STEAM curricula in different ways depending on their educational philosophy and instructional context.
- From a more contemporary perspective, STEAM education is understood as an integrated approach to teaching and learning in which multiple disciplines are purposefully combined. In designing an integrated curriculum, one discipline may serve as the primary focus while the others provide complementary support, or all five disciplines may be equally emphasized throughout the learning process.

In their review of 44 published studies on STEAM and STEAM education conducted between 2007 and 2018, Elaine Perignat and Jen Katz-Buonincontro (2019) found that STEAM is generally defined as the integration of Science, Technology, Engineering, Arts, and Mathematics. Their review further revealed that although STEAM education has been conceptualized in various ways, most definitions can be categorized into four major approaches: transdisciplinary STEAM education, interdisciplinary STEAM education, multidisciplinary STEAM education, and cross-disciplinary STEAM education (Perignat & Katz-Buonincontro, 2019). Based on the perspectives discussed above, this study defines STEAM education as an interdisciplinary approach to teaching and learning in which theoretical knowledge and fundamental principles are meaningfully integrated with authentic, practice-oriented learning experiences. Within this approach, educators create learning environments and provide opportunities for learners to apply knowledge and skills from science, technology, engineering, arts, and mathematics to solve real-world problems. Depending on the learning objectives and context, one or more disciplines may serve as the central focus while the remaining disciplines function as complementary components. Through this integrated learning process, learners are expected to develop both general competencies and disciplinary competencies, thereby enhancing their ability to address real-life challenges effectively.

The concept of STEAM education competency

According to Bui Minh Duc (2013), competency refers to the capacity that is developed and nurtured to enable individuals to achieve success in physical, intellectual, or professional activities. It is demonstrated through an individual's ability to perform tasks and effectively accomplish specific responsibilities (Bui, 2013).

According to Huynh Lam Anh Chuong, STEAM education competency is defined as the integrated set of attributes that educators either possess or acquire through professional training, enabling them to effectively implement and meet the requirements of

Towards A Competency Framework for Organizing STEAM Education Activities in Pre-Service Early Childhood Teacher Education: A Literature Review

STEAM educational activities. This competency ensures the successful implementation of STEAM education by promoting learners' thinking skills through the process of designing and creating learning products based on the application of knowledge from science, technology, engineering, arts, and mathematics (Huynh et al., 2023).

Based on a review of the literature on competency and consultations with experts in STEAM education, this study defines STEAM education competency as the ability to effectively integrate and apply knowledge, skills, and attitudes related to STEAM education in order to design instructional plans and organize high-quality STEAM-themed educational activities and lessons.

The concept of competency in organizing 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” (Le, 2021).

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.

Accordingly, this study defines the competence to organize STEAM educational activities in Early Childhood Education students as the ability to integrate and apply knowledge, skills, and attitudes from two or more STEAM domains (science, technology, engineering, art, and mathematics) harmoniously to design, implement, and evaluate STEAM educational activities effectively. This competency enables early childhood education students to organize experiential activities that are appropriate for children's development, meeting the cognitive, psychological, and physiological characteristics of preschool-aged children.

B. Developing competency in organizing STEAM educational activities for early childhood education students

Development is a fundamental philosophical concept referring to the process of progressive change through which an entity evolves from a lower to a higher level, from simplicity to complexity, and from a less complete to a more advanced state. This process occurs through both gradual and transformative changes, resulting in the emergence of new qualities that replace previous ones. Development is therefore regarded as the outcome of cumulative quantitative changes that eventually lead to qualitative transformation. It follows a spiral pattern, in which each developmental cycle revisits previous stages while reaching a higher level of advancement.

Drawing upon studies on STEAM educational activities in early childhood education and the characteristics of Early Childhood Education (ECE) students, researchers have identified several core competencies that ECE students should possess to effectively organize STEAM educational activities (Dinh, 2024). These competencies include:

- ✓ 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 planning STEAM educational activities for preschool children.
- ✓ Skills in implementing STEAM educational activity plans.
- ✓ Skills assessment and conducting evaluations in STEAM educational activities.

Foundations for developing the competency framework for organizing STEAM educational activities for Early Childhood Education students

During the course of this study, the development of the competency framework for organizing STEAM educational activities among Early Childhood Education (ECE) students was informed by several national and international competency frameworks. The most relevant frameworks are summarized below.

(1) Early Childhood Teacher Competency Framework of Southeast Asia

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 (UNESCO & SEAMEO, 2016). 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.

Towards A Competency Framework for Organizing STEAM Education Activities in Pre-Service Early Childhood Teacher Education: A Literature Review

- 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

Early Childhood Teacher Competency Framework developed by the Michigan Department of Education (Warren et al., 2014) identifies the following competencies.

- 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

According to Circular No. 26/2018/TT-BGDĐT, the professional standards for preschool teachers comprise five standards related to professional competency (Ministry of Education and Training, 2018b)

- 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 serve not only as a basis for evaluating and classifying preschool teachers at the end of each academic year but also as a foundation for designing teacher professional development programs. Furthermore, they provide an important reference for teacher education institutions in developing competency frameworks for organizing STEAM educational activities within Early Childhood Education teacher preparation programs.

C. Proposed competency framework for organizing STEAM educational activities among Early Childhood Education students at Thu Dau Mot university

Based on the theoretical foundations and the review of relevant competency frameworks, this study proposes a competency framework for organizing STEAM educational activities for Early Childhood Education (ECE) students at Thu Dau Mot university. The proposed framework consists of the following five competency domains (Tran & Nguyen, 2021; Le, 2023):

1. Cognitive competency related to the theoretical foundations of organizing STEAM educational activities.
2. Competency to design STEAM educational activity plans
3. Competency to create a safe and friendly environment for the organization of STEAM educational activities
4. Competency to organize STEAM educational activities
5. Competency in evaluating STEAM educational activities

Towards A Competency Framework for Organizing STEAM Education Activities in Pre-Service Early Childhood Teacher Education: A Literature Review

Table 1. Competency framework for organizing STEAM educational activities for ECE students

No.	Component Competency	Indicator(s)
1	Cognitive competency related to the theoretical foundations of organizing STEAM educational activities.	- 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 and the relationship between elements in STEAM education activities. - Describe the organizational process of STEAM education activities.
2	Competency to design STEAM educational activity plans	- 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.
3	Competency to create a safe and friendly environment for the organization of STEAM educational activities	- Create a physical environment that ensures the safety of children. - Create a psychological environment that fosters a friendly relationship between teachers and children. - Mobilize materials, tools, and toys from various sources (self-prepared, parents, colleagues, community, etc.).
4	Competency to organize STEAM educational activities.	- Organize activities STEAM according to theme. - Skills in managing children during the organization of STEAM educational activities. - Apply information technology in STEAM education (know how to use software in STEAM educational activities, interactive whiteboards, Kidmart games, electronic lectures, simple technological devices, etc.). - Solve situations in the organization of STEAM educational activities. - Demonstrate a positive attitude during the organization of STEAM educational activities.
5	Competency in evaluating STEAM educational activities	- Competency in evaluating children's progress in participating in STEAM educational activities. - Competency in adjust the next STEAM education activity plan.

(Source: Adapted from Dinh (2024) and Huynh et al. (2023))

• **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:** The student does not meet the minimum requirements for the competency. Immediate support and further development are required to establish the competency.
- **Level 2 – Basic:** The student demonstrates only a basic level of competency, partially meeting the required performance criteria. Continued improvement is necessary to achieve the expected level of competency.
- **Level 3 – Medium:** The student meets the required performance criteria for the competency and demonstrates an adequate level of knowledge and skills. Ongoing practice is recommended to maintain and further strengthen competency.
- **Level 4 – High:** The student demonstrates a high level of competency, consistently meeting the required performance criteria with effectiveness and confidence. Continuous professional growth is encouraged to sustain competency.
- **Level 5 – Very high:** The student demonstrates outstanding competency, consistently exceeding the required performance criteria. The competency is well established and should be continuously maintained and further enhanced.

Based on the initial analysis and description of these basic levels, we present a table detailing the levels of “Competence in organizing 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.

Towards A Competency Framework for Organizing STEAM Education Activities in Pre-Service Early Childhood Teacher Education: A Literature Review

Table 2. Detailed performance descriptors for the assessment levels of competency in organizing STEAM educational activities for Early Childhood Education students

Component Competency	Level of expression and evaluation of criterias				
	Level 1 (None)	Level 2 (Basic)	Level 3 (Medium)	Level 4 (High)	Level 5 (Very high)
1.Cognitive competency related to the theoretical foundations of organizing STEAM educational activities.	The theoretical issues regarding the organization of STEAM educational activities were not presented or explained.	The presentation lacks explanation for several theoretical issues regarding the organization of STEAM educational activities.	The presentation, while not fully explaining, addresses several theoretical issues regarding the organization of STEAM educational activities.	This section presents and explains almost all the theoretical issues regarding the organization of STEAM educational activities.	Present and fully explain the theoretical issues regarding the organization of STEAM educational activities.
2.Competency to design STEAM educational activity plans	STEAM educational activities have not yet been designed.	The design lacks comprehensive STEAM educational activities.	The design outlines comprehensive but unclear STEAM educational activities.	The design is comprehensive and clear, but the STEAM educational activities are not yet logical or feasible.	Designing educational activities that are complete, clear, logical, and feasible.
3.Competency to create a safe and friendly environment for the organization of STEAM educational activities	A safe and friendly physical and psychological environment has not yet been established.	While a safe and friendly physical and psychological environment has been created, it is not yet complete.	Creating a suitable physical and psychological environment that ensures safety and friendliness is important, but this is not yet complete or clear.	Creating a suitable physical and psychological environment that ensures safety and friendliness is still unclear.	Construct a rational, clear, and comprehensive physical and psychological environment that ensures safety and friendliness.
4.Competency to organize STEAM educational activities.	STEAM education activities have not yet been implemented.	Partially implemented according to the STEAM education activity plan.	Most of the STEAM education activity plan has been implemented.	Successfully implement STEAM education activities.	Ensure that the STEAM education activity plan is implemented correctly.
5.Competency in evaluating STEAM educational activities	Don't know how to assess children's progress. Don't adjusted their STEAM educational activity plans.	Observation and assessment of children's progress, it is not proactive enough. The STEAM educational activity plan is not regularly adjusted.	Observation and assessment of children's progress, it is not done regularly. There is a lack of flexibility in adjusting STEAM educational activity plans.	Observation and assessment of children's progress but lack flexibility in adjusting STEAM educational activity plans.	Observation and assessment of children's progress and being flexible in adjusting STEAM educational activity plans.

(Developed by the authors)

IV. CONCLUSIONS

Competency in organizing STEAM educational activities plays a pivotal role in the professional preparation of Early Childhood Education (ECE) students. This competency enables future preschool teachers to effectively achieve educational objectives and successfully implement STEAM educational activities in accordance with curriculum requirements and children's developmental characteristics. STEAM education competency is gradually developed through teacher education programs, professional training, and continuous self-directed learning.

This study proposed a competency framework for organizing STEAM educational activities among ECE students, comprising five competency domains and nineteen assessment criteria. The proposed framework provides a theoretical and practical foundation for the design, implementation, and evaluation of teacher education and professional development programs in STEAM education for preschool teachers.

Towards A Competency Framework for Organizing STEAM Education Activities in Pre-Service Early Childhood Teacher Education: A Literature Review

Furthermore, the competency framework serves as a valuable reference for teacher education institutions and faculties of education in developing competency-based curricula, refining learning outcomes, and updating teacher preparation programs. Ultimately, it contributes to preparing future preschool teachers with strong professional competencies, enabling them to respond effectively to current educational reforms and to enhance the quality of teaching and learning in early childhood education.

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