DONG THAP UNIVERSITY JOURNAL OF SCIENCE
Tạp chí Khoa học Đại học Đồng Tháp
Social Sciences and Humanities Issue
ISSN 0866-7675 | e-ISSN 2815-567X

DOI: https://doi.org/10.52714/dthu.14.7.2025.1563

PERCEPTIONS OF PRE-SERVICE TEACHERS AT DONG THAP UNIVERSITY ON STEM EDUCATION

Le Thi Ngoc Tu* and Truong Thi Bach Yen

Faculty of Natural Sciences Teacher Education, School of Education, Dong Thap University, Vietnam

**Corresponding author, Email: ltntu@dthu.edu.vn*

Article history

Received: 13/02/2025; Received in revised form: 29/5/2025; Accepted: 11/6/2025

Abstract

The general education curriculum issued by the Ministry of Education and Training in 2018, is being implemented with many advantages in integrating STEM education into subjects and topics. This helps develop students' skills and qualities. STEM is also a growing trend in many countries around the world. However, there are still different ways of understanding it, leading to various approaches in applying it. In developing countries like Vietnam, challenges such as economic limitations, lack of facilities, and teachers' skills need to be addressed. To apply STEM effectively and consistently, it is important to have a clear understanding of this model, especially among educators and future teachers. This article presents a survey of education students at the Faculty of Natural Sciences Teacher Education, School of Education, Dong Thap University. The aim is to find a common understanding of STEM, providing a practical basis for improving STEM teaching methods and enhancing teacher training quality. The results indicate that Natural Sciences Pedagogy students (Physics, Biology, Chemistry, Technology) at the Faculty of Natural Sciences Teacher Education, School of Education, Dong Thap University are interested in, knowledgeable about, and desire to apply STEM in the future.

Keywords: *Natural Sciences pedagogy, perceptions, students, STEM education.*

Cite: Le, T. N. T., & Truong, T. B. Y. (2025). Perceptions of pre-service teachers at Dong Thap University on STEM education. *Dong Thap University Journal of Science, 14*(7), 47-61. https://doi.org/10.52714/dthu.14.7.2025.1563

QUAN ĐIỂM CỦA SINH VIÊN CÁC NGÀNH SƯ PHẠM TRƯỜNG ĐẠI HỌC ĐỒNG THÁP VỀ CÁC HOẠT ĐỘNG GIÁO DỤC STEM

Lê Thị Ngọc Tú* và Trương Thị Bạch Yến

Khoa Sư phạm Khoa học Tự nhiên, Trường Sư phạm, Trường Đại học Đồng Tháp, Việt Nam

**Tác giả liên hệ, Email: ltntu@dthu.edu*

Lịch sử bài báo

Ngày nhận: 13/02/2025; Ngày nhận chỉnh sửa: 29/5/2025; Ngày duyệt đăng: 11/6/2025

Tóm tắt

Chương trình giáo dục phổ thông được Bộ giáo dục và Đào tạo ban hành năm 2018 đang được triển khai với nhiều ưu điểm trong việc tích hợp giáo dục STEM vào các môn học và chủ đề, góp phần phát triển phẩm chất và năng lực của học sinh. Giáo dục STEM cũng đang là một định hướng giáo dục được hầu hết các nước trên thế giới quan tâm. Tuy nhiên, hiện nay, vẫn còn nhiều cách hiểu khác nhau về giáo dục STEM, từ đó dẫn đến định hướng triển khai các hoạt động giáo dục STEM cũng rất đa dạng, muôn hình muôn vẻ và chưa thống nhất. Đặc biệt ở bối cảnh là các nước đang phát triển như Việt Nam với những hạn chế nhất định về kinh tế và cơ sở vật chất và năng lực của đội ngũ giáo viên thì vẫn là những vấn đề đang được quan tâm và cần được nghiên cứu và tìm hiểu. Do đó, để có thể triển khai dạy học STEM đạt hiệu quả và có tính đồng bộ thì việc nhận định rõ về mô hình giáo dục STEM của các nhà giáo dục và đặc biệt là các nhà giáo dục tương lai là rất cần thiết. Bài viết này trình bày ý kiến khảo sát sinh viên các ngành sư phạm tại Khoa Sư phạm Khoa học Tự nhiên, Trường Sư phạm, Trường Đại học Đồng Tháp, nhằm có thể tìm ra được tiếng nói chung, sự đồng nhất trong cách hiểu và nhận định về giáo dục STEM, cung cấp cơ sở thực tiễn cho việc triển khai hướng dẫn giảng dạy STEM phù hợp, hiệu quả hơn và góp phần nâng cao hiệu quả đào tạo. Kết quả cho thấy sinh viên sư phạm các ngành Khoa học Tự nhiên (Vật lý, Sinh học, Hóa học, Công nghệ) tại Khoa Sư phạm Khoa học Tự nhiên, Trường Sư phạm, Trường Đại học Đồng Tháp có sự quan tâm, hiểu biết và mong muốn áp dụng giáo dục STEM trong tương lai.

Từ khóa: *Giáo dục STEM, quan điểm, sinh viên, Sư phạm Khoa học Tự nhiên.*

1. Introduction

The term STEM (S: Science; T: Technology; E: Engineering; M: Mathematics) was introduced by the National Science Foundation (NSF) to describe the combination of four fields: science, technology, engineering, and mathematics. According to the U.S. Department of Education, STEM is a program that supports and strengthens education in these subjects from elementary school to higher education (U.S. Department of Education, 2007). Tsupros and Hallinen (2009) and Sanders (2009) explained that STEM is an interdisciplinary learning approach that connects and combines these subjects. In this approach, students not only learn theory but also apply their knowledge of Science, Technology, Engineering, and Mathematics to real-life situations. The United States has led the way in promoting STEM by linking theory with practice. According to a report from the U.S. Department of Education, this connection has helped improve workforce quality, especially in high-tech and engineering fields (Gunn, 2017).

The purpose of STEM is to equip learners with: (i) Knowledge and skills related to Science, Technology, Engineering, and Mathematics while they are still in school, enabling them to apply scientific and mathematical knowledge to solve real-world problems, as well as access, manage, and use technology effectively; (ii) Preparation for both opportunities and challenges in the globally competitive economy of the 21st century; (iii) Fundamental knowledge and skills for further education at higher levels and future careers, contributing to the development of a skilled and high-quality workforce to support national growth and development.

In Vietnam, STEM has been introduced through an interdisciplinary approach, as stated in the General Education Program (Ministry of Education and Training, 2018) and Instruction No. 3089/BGDĐT-GDTrH (Ministry of Education and Training, 2020). It has been researched and applied in subjects like Chemistry, Physics, Biology, and Technology to help students develop skills and qualities as required by the 2018 curriculum. This means students need to take more responsibility for their learning, using their knowledge, skills, and abilities to complete tasks and reach learning goals. Teachers are not only responsible for teaching knowledge but also for guiding students on how to search for, select, and process information (Dau, 2018). Teacher role is valued based on their knowledge and experience in helping students learn independently (Tran & Nguyen, 2021). Additionally, under the 2018 curriculum, teachers must not only teach academic content but also guide students on how to learn effectively. This helps students develop a scientific worldview, continuously improve their intellectual abilities, and enhance their problem-solving skills in real-life situations. Therefore, STEM model is essential to meet the objectives of the 2018 General Education Program.

From the reality of teaching under the 2018 General Education Program in recent years, an important question arises regarding teachers' preparedness and their need for further training in STEM. While the critical role of teachers in successful STEM implementation is widely acknowledged, much of the existing literature tends to focus on in-service teachers or the impact of STEM programs on students (Johnson & Fargo, 2014; Stohlmann et al., 2012). There is a significant research gap concerning the perceptions, attitudes, and readiness of pre-service teachers - the future educators, towards STEM, particularly within the Vietnamese context and specific institutions like Dong Thap University. Understanding the perspectives of these future teachers is crucial, as their foundational knowledge and beliefs about STEM will directly influence their pedagogical practices. Addressing this gap will provide valuable insights for refining teacher training programs and ensuring future educators are adequately equipped to deliver effective STEM instruction.

This study is underpinned by Shulman's (1986, 1987) theory of Pedagogical Content Knowledge (PCK) and theories related to teacher attitudes and beliefs. PCK provides a comprehensive lens through which to examine how pre-service teachers understand and prepare to teach STEM content, integrate disciplines, and apply specific pedagogical strategies. Concurrently, investigating their attitudes and beliefs about STEM is essential, as these factors significantly influence their intention and capacity to implement STEM effectively in their future teaching careers.

This article aims to investigate the perceptions of pre-service teachers majoring in Natural Sciences (Physics, Chemistry, Biology, and Technology) at the Faculty of Natural Sciences Teacher Education, School of Education, Dong Thap University regarding STEM education. Specifically, this study seeks to answer the following research questions:

- What are the pre-service teachers' perceptions of the core concepts of STEM education and the interdisciplinary connections among Science, Technology, Engineering, and Mathematics?

- How do pre-service teachers perceive and understand specific STEM pedagogical approaches and strategies (e.g., project-based learning, problem-based learning, engineering design process)?

- What are the pre-service teachers' attitudes towards applying STEM in their future professional careers?

- What is the level of self-efficacy among pre-service teachers in designing and implementing effective STEM educational activities in the classroom?

- What factors (e.g., academic experiences, resources, lecturer support) influence pre-service teachers' perceptions and attitudes toward STEM?

The findings of this study will provide a practical basis for guiding and improving STEM education training for future teachers, ensuring that they are prepared in an effective and appropriate way to meet the demands of the 2018 General Education Program in Vietnam.

Moreover, the results offer valuable information for School of Education, Dong Thap University and teacher training institutions in adjusting curricula and developing STEM professional development activities aligned with students' perspectives and needs. The study also contributes to raising students' awareness of the importance of STEM, guiding school-supported activities, and providing a reference for STEM education policy development at local and national levels, aiming to prepare a teaching workforce capable of meeting educational innovation demands.

2. Data and research methods

2.1. Research method

This study adopted an interpretive research approach, which emphasizes understanding how individuals construct meaning from their experiences (Creswell, 2014). To achieve this, a descriptive quantitative survey design was employed, allowing the researchers to gather systematic and representative data on pre-service teachers' perceptions of STEM education (Fraenkel et al., 2012).

2.2. Participants and sampling

The participants comprised 302 pre-service teachers from the Faculty of Natural Sciences Teacher Education, School of Education, Dong Thap University, distributed across the following majors: Natural Sciences (77 students), Physics (56 students), Chemistry (123 students), Biology (14 students), and Technology (28 students). A convenience sampling technique was employed to recruit participants from various academic years and majors within the Faculty of Natural Sciences Teacher Education, School of Education, Dong Thap

University. Specifically, students from different cohorts participated as follows: 4th-year (Cohort 2021) – 14 students; 3rd-year (Cohort 2022) – 47 students; 2nd-year (Cohort 2023) – 187 students; and 1st-year (Cohort 2024) – 50 students. Demographic data collected included gender, year of study, and subject major, enabling detailed subgroup analysis. The sample comprised 167 male and 135 female students.

2.3. Research instrument

A structured questionnaire, comprising multiple-choice items and 5-point Likert-scale statements ranging from "*Strongly disagree*" to "*Strongly agree*" was developed for this study. The instrument included three sections: 3 items collecting demographic information, 10 items assessing knowledge and skills related to STEM education, and 15 items evaluating attitudes toward STEM education. The items were carefully designed to be interrelated, thereby complementing and clarifying one another to ensure the reliability and internal consistency of responses.

The questionnaire underwent content validation by a panel of subject-matter experts. Data collection was conducted during regular class sessions with the approval of course instructors. Participants were fully informed about the study's purpose and assured of confidentiality and voluntary participation. Completed questionnaires were collected immediately after completion. The average time required to complete the survey was approximately 25 minutes.

2.4. Data analysis

The collected data were entered and processed using Excel software. Descriptive statistics, including frequencies and percentages, were computed to summarize the participants' responses. Additionally, where applicable, subgroup analyses based on demographic variables such as gender, academic year, and major were performed to explore potential differences in perceptions.

3. Results and discussion

3.1. Students' perspectives on STEM education

To assess students' self-perceived understanding of STEM, the survey included the question: "*How would you rate your knowledge of STEM?*" As presented in Table 1, over half of the pre-service teachers (52.91%) rated their understanding as "*Good*" or "*Very Good*". This indicates a generally positive self-perception of STEM knowledge among the surveyed students, which is a crucial aspect of a teacher's Pedagogical Content Knowledge (PCK), influencing their readiness to teach interdisciplinary subjects (Shulman, 1986). However, a notable proportion of students (46.69%) rated their knowledge as "*Average*" or "*Poor*". Further analysis revealed that these lower self-assessments were predominantly from first- and second-year students. This pattern suggests that early-year students may have had limited exposure to integrated STEM concepts within their initial university curriculum. Furthermore, student engagement in extracurricular or informal STEM activities (e.g., STEM day events, teaching competitions, internships) appears to significantly enhance both knowledge acquisition and interest. Conversely, a strong academic focus on specific major subjects, potentially at the expense of broader STEM integration, might contribute to lower overall self-perceived STEM readiness. These findings highlight the importance of promoting interdisciplinary STEM experiences across all academic years to foster a more comprehensive understanding among future educators.

To assess students' understanding of the fundamental components of STEM education, participants were asked: *"In your opinion, what fields does STEM education include?"*. While

46.20% of pre-service teachers correctly identified all four STEM components, over half (53.80%) demonstrated an incomplete understanding. A significant 27.24% only recognized one field, with nearly 20% showing considerable confusion or lack of clarity about STEM integration. These findings corroborate the self-perceived knowledge results, underscoring that many students' lower confidence stems from a fundamental misunderstanding of STEM's interdisciplinary core. This highlights a critical need for clearer conceptual definition and integrated instruction in pre-service teacher training curricula.

When asked, "*In your opinion, what fields does STEM education include?*", most students (46.2%) correctly selected all four components: Science, Technology, Engineering, and Mathematics. However: 6.9% of students chose only three fields and 27.24% selected just one field. These results align with the findings from the first survey question on students' knowledge of STEM, showing that many students still have an incomplete understanding of STEM education.

To assess students' deeper understanding of STEM's unique pedagogical aspects, participants were asked: "*In your opinion, what characteristics make STEM education different from other educational methods?*". The collected responses are presented in Table 1.

Table 1. Survey results on STEM education characteristics according to students' opinions

No.	STEM education characteristics	Number of responses	Percentage (%)
1	Associated with reality, experiments, practice, and experiences	220	72.8%
2	Application of technology, engineering, and modern teaching tools	188	62.3%
3	Emphasizes creativity	179	59.3%
4	Creates specific products	130	43.0%
5	Applies engineering in teaching and develops students' technical skills	147	48.7%
6	Integrates Science – Technology – Engineering – Mathematics (STEM) subjects	152	50.3%
7	Combines multiple teaching methods	127	42.1%
8	Visual, dynamic, and enhances students' learning interest	164	54.3%
9	Characterized by Mathematics	59	19.5%
10	Characterized by Science	116	38.4%
11	Characterized by Science and Technology	93	30.8%
12	Characterized by Technology and Engineering	66	21.9%
13	Other opinions (please specify): Diverse	01	0.3%

The survey results indicate that pre-service teachers predominantly conceptualize STEM education through its practical and experiential dimensions. A considerable majority (72.8%) identified the core attribute of STEM as being "*Associated with reality, experiments,* *practice, and experiences*". This finding reflects a pedagogical orientation that prioritizes experiential learning, highlighting students' awareness of the importance of moving beyond theoretical instruction toward hands-on, real-world application. Such perceptions align with the foundational objectives of STEM education, wherein knowledge is rendered tangible and applicable, thereby fostering deeper conceptual understanding.

In addition, 54.3% of respondents selected the feature "*Visual, dynamic, and enhances students' learning interest*", suggesting that they view STEM as an engaging and motivational approach to teaching and learning. The integration of technology and engineering principles was also prominently recognized: 62.3% of participants chose "*Application of technology, engineering, and modern teaching tools*", while 48.7% acknowledged STEM's role in "*Applying engineering in teaching and developing students' technical skills*". These responses reflect an emerging understanding among pre-service teachers of the central role of engineering design thinking and technological fluency within STEM instruction.

Furthermore, 42.1% of respondents noted that STEM "*Combines multiple teaching methods*", indicating a recognition of the pedagogical flexibility and interdisciplinary integration required to effectively implement STEM curricula. This underscores the perception of STEM as a dynamic and adaptable educational approach, particularly relevant in the context of the digital era.

Creativity and product-oriented learning also featured prominently in students' responses. Specifically, 59.3% identified "*Emphasizing creativity*", and 43.0% indicated that STEM "*Creates specific products*". These findings suggest that participants associate STEM education with fostering innovation and culminating in tangible outcomes - an understanding consistent with project-based and problem-based learning models that are widely employed in STEM contexts.

Lastly, between 19.5% and 38.4% of respondents selected individual STEM disciplines (e.g., "*Characterized by Mathematics*", "*Science and Technology*") as defining features of STEM education. This disciplinary-based perspective implies that a portion of pre-service teachers still interpret STEM not as an integrated, interdisciplinary model but rather as a collection of separate domains. This insight reinforces the necessity of enhancing teacher education programs to emphasize the interconnected and holistic nature of STEM, thereby promoting a more accurate and pedagogically sound understanding of the approach.

To gain a deeper understanding of the opinions of education students on the relevance of STEM subjects (Science, Technology, Engineering, and Mathematics) and their reasoning behind these views, a set of questions on "*... the relevance of STEM subjects, including science, technology, engineering, and mathematics*" and "*Why did you choose that level*?" was surveyed. The results are presented in the graph in Figure 1.

The survey results reveal that a significant majority of students (64.2%) perceive a strong or very strong relevance among STEM subjects, reflecting a general awareness of the interconnected nature of science, technology, engineering, and mathematics. Their reasoning emphasizes the complementary roles these disciplines play in explaining real-world phenomena and supporting practical applications, such as the use of mathematics in data calculation and prediction within scientific and engineering contexts. This awareness suggests that many students recognize STEM as an integrated framework rather than isolated subjects, which is crucial for effective interdisciplinary teaching and learning.

However, the responses also highlight a notable portion of students (28.6%) who rated the relevance as moderate to low. These students often cited limited practical experience or a fragmented understanding of how these disciplines interact. For instance, some expressed the view that mathematics may not need to be closely linked with engineering or technology, reflecting a more compartmentalized perception of STEM. Others noted that certain scientific theories do not always involve experimentation, which may contribute to perceiving science as somewhat disconnected from applied fields. The absence of opinions from 3.6% of participants - primarily early-year students - further points to developmental differences in conceptual grasp, likely influenced by the level of exposure and curriculum design in prior education.

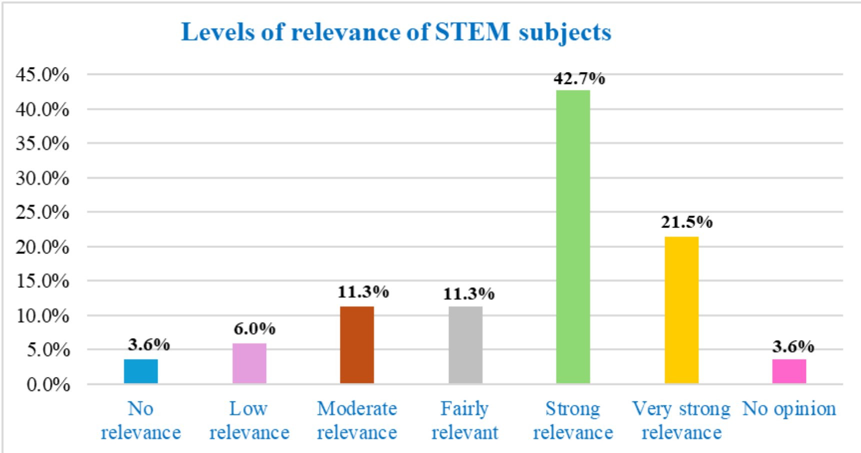


Figure 1. Students' opinions on the relevance of STEM subjects

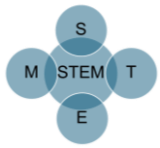
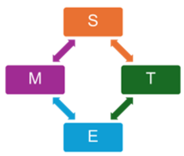
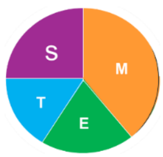
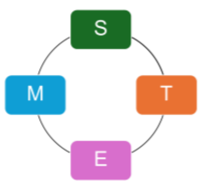
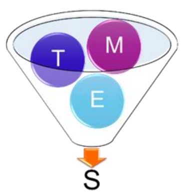
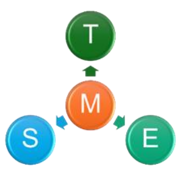
These variations underscore the persistent challenges in STEM education, particularly the difficulty of fostering a truly integrated understanding among learners. The gap between theoretical knowledge and hands-on experience appears to impede some students' ability to fully appreciate interdisciplinary connections. Such findings align with previous research (Do & Nguyen, 2018) indicating similar patterns of fragmented understanding in STEM fields among education students.

In light of these insights, the study incorporated visual concept map models of STEM education based on frameworks by Bybee (2013) and Radloff and Guzey (2016), which categorize STEM integration into various types such as Nested, Transdisciplinary, Interconnected, and Sequential. The inclusion of six distinct visual models - Transdisciplinary, Sequential, Combination, Interconnected, Science-Centered, and Math - Centered - in the survey was intended to probe students' conceptualizations of STEM's structure more deeply. This approach aims to identify whether students lean towards viewing STEM as a cohesive interdisciplinary system or as separate disciplines with varying degrees of overlap, providing actionable information to guide curriculum development and pedagogical strategies that better cultivate holistic STEM competencies.

Overall, the findings call for enhanced experiential and integrative learning opportunities within teacher education programs to bridge theoretical concepts with real-world applications. Emphasizing project-based learning, interdisciplinary collaboration, and contextualized problem-solving can help mitigate fragmented perceptions and equip future educators with the comprehensive understanding necessary to effectively deliver STEM education.

The results from the set of questions: "*If using the characters: S (Science), T (Technology), E (Engineering), M (Math) to illustrate the connection between these subjects, which diagram would you choose?*" and "*Why did you choose that?*" are presented in Table 2 below.

Table 2. Student perspectives on the relations between components of S, T, E, and M

No.	Relations between S, T, E, M	Number of responses	Percentage (%)	Representative explanations for the corresponding choices
1	No opinion due to no perceived connection.	22	7.3%	
2	Transdisciplinary 	88	29.1%	In my opinion, all subjects S, T, E, M should be included because they are closely related, support each other, and cannot be separated.
3	Sequential 	28	9.3%	In my opinion, the subjects will complement each other, one subject will be integrated into another, knowledge will be interconnected, and they will have mutual influence.
4	Combination 	59	19.5%	All subjects S, T, E, and M are integrated to form a solid foundation.
5	Interconnected 	60	19.9%	In my opinion, they have a logical relationship, starting with scientific problems and ending with specific scientific products.
6	Science-centered 	29	9.6%	In my opinion, Science (S) is the center of the other fields because science enables the application and development of the other subjects (T, E, M) and related fields.
7	Math-centered 	16	5.3%	In my opinion, Mathematics (M) must be the foundation for all scientific fields because most sciences today use mathematics as a tool, and as science advances, technology and engineering also develop.
8	Other opinions:	0	0.0%	

The survey results from Table 2, along with the representative explanations for the choices, indicate that the perception of the types of connections between the S-T-E-M components varies among the surveyed students. No single perspective dominates, and the responses tend to be distributed across the proposed connection types. Specifically, the distribution includes *Multidisciplinary* (29.1%), *Combination* (19.5%), *Interconnected* (19.9%), *Sequential* (9.3%), *Science-centered* (9.6%), and *Math-centered* (5.3%). This suggests significant differences in students' understanding of the connections between S-T-E-M components, highlighting the need for a deeper understanding of future educators' perceptions to develop appropriate educational orientations. These findings align well with the study conducted by Radloff and Guzey (2016) on the types of connections between S-T-E-M components. However, in the research by Do and Nguyen (2018), the results showed a significant concentration in the basic "*Interconnected*" model, with a rate of 52.97% .

3.2. Students' attitudes toward STEM education

Questions: "*Do you find subjects or activities related to STEM interesting*?" and "*Have you ever studied or participated in activities related to STEM education?*". The survey results are illustrated in the graph in Figure 2 below.

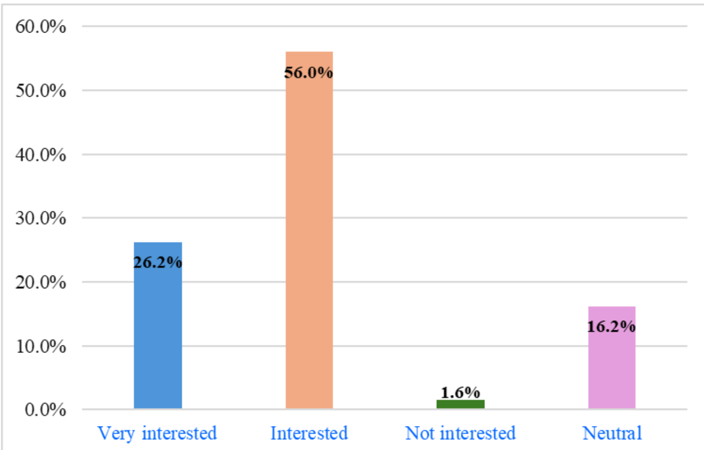


Figure 2. Students' opinions on the level of interest and participation in STEM-related subjects or activities

Figure 2 shows that the majority of students feel "*Very interested*" (26.2%) and "*Interested*" (56.0%) in STEM-related subjects or activities, corresponding to 18.9% of students selecting "*Yes, many times*" and 66.6% choosing "*Yes, sometimes*" in terms of participation. These results indicate that students in education majors are highly enthusiastic about STEM subjects and activities. This is an important factor to consider when adjusting the teaching methods of certain subjects towards a STEM approach and enhancing activities that create opportunities for students to engage in STEM education.

Additionally, 1.6% of students reported feeling "*Not interested*" while 16.2% felt "*Neutral*" corresponding to 14.5% of students who answered "*Never participated*" in STEM activities. The possible reasons for this could be that they have not yet developed an interest in these activities or that the activities themselves have not been engaging enough for them.

For the set of questions: "*Do you find STEM subjects accessible and interesting?*" and "*In your opinion, is STEM education important for developing your future career skills?*", the results are presented in Table 3 below.

Table 3. Students' opinions on the level of interest in accessing STEM and its importance for future career development

No.	The level of interest in accessing STEM education	Number of responses	Percentage (%)
1	Very accessible and interesting	62	20.5%
2	Accessible but not interesting	71	23.5%
3	Difficult to access but interesting	155	51.3%
4	Difficult to access and not interesting	14	4.6%
No.	**Awareness of the importance of STEM education for future career skill development**	**Number of responses**	**Percentage (%)**
1	Very important	110	36.4%
2	Important	159	52.6%
3	Neutral	31	10.3%
4	Not important	02	0.7%

The survey results on the level of engagement in Table 3 show that the majority of students find STEM education "*Interesting*" (71.8%) when engaging in related activities. However, despite this positive perception, only 20.5% stated that it is "*Very accessible*" while 51.3% found it "*Difficult to access*". This suggests that STEM education can be likened to a complex puzzle initially challenging, but once students understand the rules and approach, it becomes highly engaging and captivating. Additionally, 23.5% of respondents selected "*Accessible but not interesting*" which may indicate that students have participated in STEM-related courses but only received knowledge transmission without practical applications. As a result, despite being accessible, the learning experience lacks stimulation, curiosity, and creativity, making it less engaging. Furthermore, 4.6% of students found STEM education "*Difficult to access and not interesting*". This could stem from various factors, including content, teaching methods, learning environments, and even individual student psychology.

Regarding the question on the perceived importance of STEM education, the results from Table 3 indicate that the majority of surveyed students (89.0%) recognize its significance in developing future career skills. Specifically, 36.4% of respondents consider it "*Very important*" while 52.6% view it as "*Important*". This suggests that students understand STEM as a key factor for success in education careers, especially in the context of rapid technological advancements.

3.3. Students' proposals for STEM education activities

This set of questions is designed to make STEM education activities more engaging, interesting, practical, and accessible, allowing students to develop their professional skills in the best possible way for the future.

The question "*In your opinion, what methods can be used to teach STEM*?" received various suggestions from the survey, which are presented in Table 4 below.

Table 4. Students' opinions on proposed STEM teaching methods

No.	Proposed STEM teaching methods	Number of responses	Percentage (%)
1	Application-based teaching: Applying knowledge to practice, exercises, and product design.	163	54.0%
2	Context-based teaching: Integrating real-life situations into lessons and providing students with hands-on experiences through field trips.	197	65.2%
3	Activity-based teaching: Encouraging students to conduct experiments and participate in hands-on activities.	148	49.0%
4	Exploration-based teaching: Allowing students to independently explore and discover problems.	100	33.1%
5	Visual teaching: Using models, samples, virtual experiments, videos, and images.	127	42.1%
6	Problem-solving teaching: Assigning problem-solving tasks to students.	107	35.4%
7	Integrated teaching: Combining multiple subjects into lessons.	97	32.1%
8	Game-Based teaching: Embedding knowledge and learning content into games, allowing students to engage actively and creatively.	138	45.7%
9	Developing critical thinking: Using open-ended questions and scenarios that stimulate thinking.	102	33.8%
10	Encouraging creativity: Organizing STEM fairs and science innovation competitions.	128	42.4%
11	Academic clubs: Establishing academic clubs for students.	85	28.1%
12	Applying digital technology and engineering: Utilizing projectors, computers, mobile devices, and online learning platforms.	125	41.4%
13	No opinion	0	0.0%

The results from Table 4 indicate a diverse range of STEM teaching methods proposed by students. The two most favored methods are "*Teaching using real-world contexts: integrating practical situations into lessons and allowing students to experience reality through field trips outside of school*" (65.2%) and "*Teaching through knowledge application: incorporating practice, exercises, and student-designed projects*" (54.0%). Other methods received more evenly distributed responses. This suggests that education students recognize the core principle of STEM education-learning through experience, enhancing real-world applications, fostering creative thinking, and developing problem-solving skills, as opposed to traditional theoretical teaching. These approaches enable students to engage with STEM in a more interactive, dynamic, and effective manner. However, 28.2% of students proposed STEM education through "*Academic clubs: organizing academic clubs*". This relatively lower preference could be attributed to the fact that academic clubs tend to focus more on theoretical discussions and lectures rather than hands-on problem-solving and creativity. The survey results align with findings from Radloff and Guzey (2016), who identified a variety of STEM teaching approaches, including application-based learning, contextual learning, creativity stimulation, critical thinking development, discovery-based learning, hands-on activities, problem-based learning, student-centered approaches, and teamwork. These results also correspond with those of Do and Nguyen (2018).

For the question: "*In your opinion, how applicable is the STEM education model in teaching subjects in the field of Natural Sciences (Physics, Chemistry, Biology, Technology, Natural Science)?*", the survey results are illustrated in the chart in Figure 3.

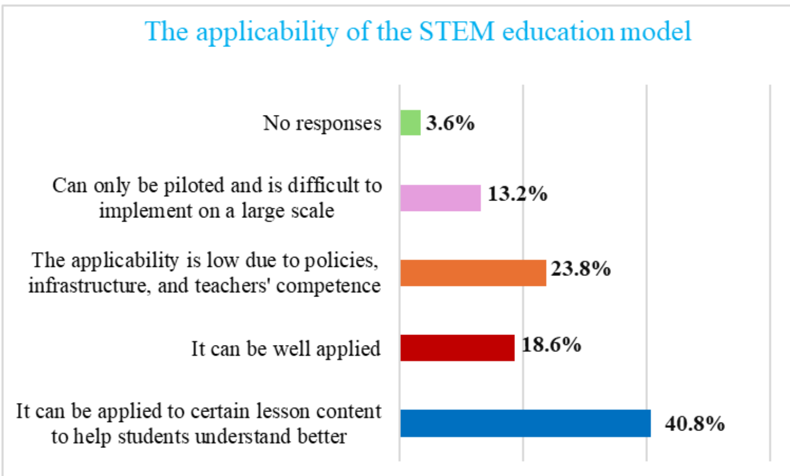


Figure 3. Students' opinions on the applicability of the STEM model

The results from Figure 3 show that 40.8% of students responded, "*It can be applied to certain lesson content to help students understand better*" while 18.6% selected "*It can be well applied*". Overall, a majority of students (59.4%) believe that the applicability of the STEM education model in teaching Natural Sciences is either good or can be selectively applied to specific lesson content. However, 23.8% of students expressed that "*The applicability is low due to policies, infrastructure, and teachers' competence*" while 13.2% stated that the model "*Can only be piloted and is difficult to implement on a large scale*". These responses align with the current limitations in infrastructure and the lack of professional development opportunities for teachers in STEM education.

Regarding the question, "*Do you want to teach using the STEM model*?" the results are quite promising, with 74.2% of students responding "*Very much*" (24.2%) and "*Yes*" (50.5%).

This indicates that many students have an innovative mindset and a desire to adopt more effective teaching methods rather than relying solely on traditional approaches. Teaching through the STEM model allows them to be creative, making learning more engaging and accessible for students. However, 19.9% of respondents were "*Not sure*" while 2.0% answered "*No*" and 4.0% did not provide an opinion. This hesitation may stem from a lack of exposure or training in STEM education, concerns about practical conditions, or anxiety over the pressures of adopting new teaching methods. To address these challenges, more STEM training and hands-on practice programs should be introduced for pre-service teachers to boost their confidence in implementing this model.

4. Conclusion

Overall, students majoring in education specifically in Natural Sciences, Physics, Biology, Chemistry, and Technology at the Faculty of Natural Sciences Teacher Education, School of Education, Dong Thap University demonstrate a certain level of interest and understanding of STEM education. They also express a strong desire to apply this educational model in their future careers. However, most students perceive STEM education as being closely linked to real-world applications, experimentation, hands-on activities, and engaging, visual, and experiential learning, all aimed at developing learners' competencies. Additionally, there is diversity in their perspectives on the connections between the S-T-E-M components, including interdisciplinary, sequential, integrative, and connected approaches, as well as Math-centered and Science-centered models. At the same time, students acknowledge that implementing STEM education in teaching Natural Science subjects is entirely feasible.

Therefore, understanding the perspectives of pre-service education students on STEM education is the first step toward deeper research on the orientation and implementation of STEM in teacher training. This approach ensures alignment with the current educational context and goals in Vietnam. Additionally, these findings can assist higher education educators in designing and enhancing STEM-related courses, activities, and training programs tailored to education students.

References

Bybee, R. W. (2013). The case for STEM education: Challenges and opportunities. *National Science Teachers Association - NSTA Press.* Arlington, 116 pages.

Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches (4th ed.). *SAGE Publications*.

Dau, T. H. (2018). Developing teaching competencies for teachers toward competency-based education. *Vietnam Journal of Education*, (426), 17–20. https://baigiang.edu.vn/boi-duong-nang-luc-day-hoc-cho-giao-vien-tieu-hoc-theo-huong-phat-trien-nang-luc-hoc-sinh-526/

Do, T. P. T., & Nguyen, T. T. H. (2018). Views on STEM education from Students in Physics Pedagogy of Can Tho University. *Can Tho University Journal of Science*, *54*(9), 94–103. https://doi.org/10.22144/ctu.jvn.2018.165

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). How to design and evaluate research in education (8th ed.). *McGraw-Hill*.

Gunn, L. M. J. (2017). The Evolution of STEM and STEAM in the U.S. Retrieved at https://resilienteducator.com/classroom-resources/evolution-of-stem-and-steam-in-the-united-states/

Johnson, C. C., & Fargo, J. D. (2014). A study of the impact of transformative professional development on Hispanic student performance on state mandated assessments of science in elementary school. *Journal of Science Teacher Education*, *25*(7), 845–859. https://doi.org/10.1007/s10972-014-9396-x

Ministry of Education and Training. (2018). General Education Program - Master Program (issued together with Circular No. 32/2018/TT-BGDĐT dated December 26, 2018 by the Minister of Education and Training).

Ministry of Education and Training. (2020). Official Dispatch No. 3089/BGDĐT-GDTrH on the implementation of STEM education in secondary education, dated August 14, 2020.

Radloff, J., & Guzey, S. (2016). Investigating preservice STEM teacher conceptions of STEM education. *Journal of Science Education and Technology*, *25*, 759–774. https://doi.org/10.1007/s10956-016-9633-5

Sanders, M. (2009). STEM, STEM education, STEM mania. *Technology Teacher*, *68*(4), 20–26. http://hdl.handle.net/10919/51616

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4–14. https://doi.org/10.3102/0013189X015002004

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, *57*(1), 1–22. https://doi.org/10.17763/haer.57.1.j463w79r56455411

Stohlmann, M., Moore, T. J., & Roehrig, G. H. (2012). Considerations for teaching integrated STEM education. *Journal of Pre-College Engineering Education Research*, *2*(1), 28–34. https://doi.org/10.5703/1288284314653

Tran, T. L., & Nguyen, T. K. (2021). Fostering civic education teachers at high schools on the methods of examining and evaluating learning results in the "Economic education" section towards developing the quality and capacity of students. *TNU Journal of Science and Technology, 226*(04), 92–100. https://jst.tnu.edu.vn/jst/article/view/4363/0

Tsupros, N., Kohler, R., & Hallinen, J. (2009). STEM education: A project to identify the missing components. Intermediate Unit 1: Center for STEM Education and Leonard Gelfand Center for Service Learning and Outreach.

U.S. Department of Education. (2007). Report of the Academic Competitiveness Council. *Education Publications Center: Washington*. https://files.eric.ed.gov/fulltext/ED496649.pdf