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The current state of STEM education in selected lower secondary schools in Hanoi: Challenges and opportunities in implementation

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Abstract

This study investigates the current state of STEM education in lower secondary schools in Hanoi, with a focus on the challenges, opportunities, and support needs faced by teachers and administrators during implementation. Using a structured survey distributed to 77 participants, including 40 teachers and 15 school leaders, the research explores three core areas: the status of STEM integration, existing barriers, and professional development needs. Results indicate that while teachers recognize the importance of STEM education and show a willingness to adopt it, they face significant obstacles such as limited resources, inadequate training, and difficulties in interdisciplinary integration. Despite these challenges, the demand for further support and training is high, highlighting the urgent need for institutional and policy-level interventions. The findings provide practical insights for educational policymakers, school administrators, and curriculum developers aiming to promote effective and sustainable STEM teaching practices in Vietnamese schools.

Keywords:

STEM education; lower secondary schools; teacher training; implementation challenges; Vietnam education reform.

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1. Introduction

STEM education, which stands for Science, Technology, Engineering, and Mathematics, has gained significant attention worldwide as a critical approach to preparing students for the challenges of the 21st century. The integration of these disciplines not only fosters students' understanding of essential concepts but also enhances problem-solving skills, creativity, and collaborative abilities. For secondary education, particularly in middle schools, STEM is seen as a transformative method to align with the evolving educational needs of society. In Vietnam, the Ministry of Education and Training (MOET) has incorporated STEM principles into the 2018 General Education Program (GEP), emphasizing the importance of fostering critical thinking, creativity, and scientific literacy among students(T. T. H. Lê et al., 2024).

In the context of Vietnamese middle schools, particularly in Hanoi, the adoption of STEM faces both opportunities and challenges. While STEM education is progressively being introduced, its implementation remains inconsistent across schools(Hán & Đỗ, 2023; T. N. A. Lê & Lê, 2024). Many teachers face significant obstacles, including inadequate training, insufficient teaching resources, and a lack of integrated curricula. These challenges hinder the effective integration of STEM methodologies into everyday classroom practice(Apollo & Mbah, 2021; Bybee, 2013). Additionally, there is a lack of systematic research on how STEM is being applied at the middle school level in Hanoi, which necessitates further exploration to understand the real-time experiences of educators and the structural barriers they face.

This study aims to investigate the current state of STEM education in middle schools in Hanoi, focusing on the challenges faced by teachers and the opportunities for improvement. The research will examine the extent to which STEM is implemented, identify the difficulties encountered, and assess the needs of teachers and administrators regarding professional development and resource availability. Understanding these factors is crucial for formulating strategies that can enhance the effectiveness of STEM teaching and learning in Vietnamese schools.

The primary research questions guiding this study are as follows:

- What is the current state of STEM education in Hanoi’s middle schools?
- What challenges do teachers face when implementing STEM education in their classrooms?
- What factors influence the successful integration of STEM education in these schools?

2. Literature review

STEM education: Concept and global development

STEM education is an interdisciplinary approach that integrates the study of science, technology, engineering, and mathematics in a way that encourages problem-solving, critical thinking, and the application of knowledge in real-world contexts(Arshad, 2021; Batdi et al., 2019). The concept of STEM has evolved from the need to equip students with the skills

necessary for success in the 21st century, where technological and scientific advancements are central to economic growth and societal development(Bozkurt Altan & Tan, 2021; T. T. H. Lê et al., 2024). STEM education fosters inquiry-based learning and project-based activities that bridge theoretical knowledge with practical applications, thus preparing students for future careers in various STEM fields.

Globally, countries have increasingly prioritized STEM education due to the demand for a workforce skilled in these disciplines. In the United States, the National Science Foundation (NSF) has been instrumental in promoting STEM education at all levels of schooling, focusing on enhancing students' understanding and engagement with these subjects (Cheng et al., 2024; Egarievwe, 2015). Similarly, nations such as Singapore, Finland, and South Korea have reformed their education systems to better integrate STEM, achieving notable success in raising student achievement in these fiel(Chai, 2019).

STEM education in Vietnam

In Vietnam, the government has made significant strides toward integrating STEM into the national curriculum, particularly with the introduction of the General Education Program in 2018(T. N. Nguyễn et al., 2022). The program emphasizes the development of core competencies in science, technology, engineering, and mathematics, aligning with global trends to enhance students' analytical, creative, and problem-solving abilities. The Vietnamese Ministry of Education and Training (MOET) recognizes that STEM education is crucial for preparing students to meet the demands of modern industries and the rapidly changing technological landscape (T. T. H. Lê et al., 2024, 2024; T. T. Nguyễn et al., 2023).

However, despite these advancements, the implementation of STEM in Vietnamese schools, particularly in middle schools, remains inconsistent. Teachers often lack specialized training in STEM pedagogy, and schools face challenges related to the adequacy of resources, such as laboratory facilities and teaching materials (Nguyen & Le, 2020). Furthermore, the traditional curriculum structure in Vietnam, which tends to compartmentalize subjects, can hinder the seamless integration of STEM concepts. As a result, many teachers are hesitant to adopt interdisciplinary teaching methods, relying on conventional subject-based instruction(T. N. Nguyễn et al., 2022; T. T. Nguyễn et al., 2023).

Challenges in implementing STEM education

The challenges associated with the implementation of STEM education in middle schools are widely documented. One major barrier is the insufficient training of teachers in STEM pedagogy. Researchs highlights that effective STEM teaching requires teachers to have not only content knowledge but also the skills to integrate subjects creatively. However, many teachers in Vietnam still struggle with these competencies, lacking exposure to project-based or inquiry-based learning methods that are fundamental to STEM education.

Additionally, the lack of adequate teaching resources is another significant obstacle. A other notes that many schools in Hanoi and across Vietnam do not have sufficient infrastructure to support hands-on STEM activities, such as science labs equipped with modern tools and

materials. This limitation restricts the ability of teachers to implement interactive and practical learning experiences, which are vital for developing students' problem-solving and critical thinking skills.

Furthermore, time constraints often prevent teachers from dedicating sufficient time to STEM subjects. The standard curriculum in many schools is packed with content, leaving little room for the cross-disciplinary projects that are central to STEM education (Akcan et al., 2023; Chai, 2019). This time pressure is compounded by large class sizes, making it difficult for teachers to engage each student in individual or group-based STEM activities.

Opportunities in STEM education

Despite the challenges, there are several opportunities for the successful implementation of STEM in Vietnam's middle schools. First, the ongoing reforms in the national curriculum provide a strong foundation for integrating STEM education into schools. By aligning the curriculum with STEM principles, the Vietnamese education system can create a more coherent and relevant learning experience for students, ensuring that they are equipped with the necessary skills for future careers.

Additionally, technological advancements offer new avenues for enhancing STEM education(Bizami et al., 2023; Christensen et al., 2014). The widespread availability of digital tools and online resources can help bridge the resource gap in schools. Teachers can use virtual simulations, online experiments, and collaborative platforms to supplement traditional teaching methods and create more engaging and interactive STEM lessons(Bush, 2019; Chai, 2019). Moreover, the growing interest in STEM careers among students and parents presents an opportunity for schools to further promote STEM education as a path to future success.

Another opportunity lies in teacher professional development. Several initiatives, both from the government and private sector, have been launched to provide teachers with the training and resources needed to enhance their STEM teaching skills. Programs such as the Vietnam STEM Education Alliance (VSEA) offer workshops, online courses, and peer collaborations to support educators in adopting innovative STEM teaching methods.

3. Methodology

This study adopts a descriptive survey design to explore the state of STEM education in middle schools in Hanoi, focusing on the challenges faced by teachers and administrators, as well as the opportunities and needs for support. The research involves two main groups of participants: 40 STEM teachers and 15 administrators from selected middle schools in Hanoi. These participants were chosen due to their experience with STEM teaching or involvement in STEM-related initiatives.

Data will be collected using a structured questionnaire with both quantitative and qualitative elements. The questionnaire consists of three sections: demographic information, current practices in STEM education and the challenges and support needs for STEM teaching. Responses will be measured using a 5-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree." Additionally, open-ended questions will capture qualitative insights into

specific challenges and suggestions for improvement. The survey will be distributed both online and offline. The online version will be sent via email or school communication platforms (Zalo), while paper copies will be provided to those with limited internet access. The survey period is set from March 3 to March 15, 2025. To ensure clarity and reliability, the questionnaire will be pre-tested with a small group of educators before full distribution.

Data analysis will involve both descriptive and inferential statistics. Descriptive statistics, such as frequencies and means, will summarize trends in responses, while inferential statistics will be used to examine differences in responses based on demographic variables. Thematic analysis will be employed to analyze open-ended responses, identifying key themes related to challenges and support needs.

4. Survey results

4.*1. Survey subjects*

Table 1. Classification of survey subjects by gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	27	35.1	35.1	35.1
	female	50	64.9	64.9	100.0
	Total	77	100.0	100.0	

The data presented in Table 1 indicate that the majority of survey participants are female (64.9%), while male participants make up 35.1%. This gender distribution is reflective of the gender representation in the teaching profession in Vietnam, where female teachers are generally more numerous. This gender balance is important because it provides a diverse range of perspectives in understanding the implementation of STEM education, ensuring that the survey results reflect a comprehensive view of the challenges and opportunities faced by educators in Hanoi’s middle schools.

Table 2. Classification of survey subjects by level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor's	59	76.6	76.6	76.6
	Master's	18	23.4	23.4	100.0
	Total	77	100.0	100.0	

Table 2 shows that a significant proportion of the respondents hold a Bachelor's degree (76.6%), with a smaller group possessing a Master's degree (23.4%). The fact that the majority of teachers have a Bachelor's degree highlights the importance of providing further specialized training in STEM education to enhance their pedagogical skills. Teachers with higher qualifications, such as Master's degrees, may have a deeper understanding of the subjects, yet the results suggest that additional training in STEM methodology is still

necessary across the board to fully support the implementation of this interdisciplinary approach in the classroom.

Table 3. Classification of survey subjects by number of years of work

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Under 5 years	27	35.1	35.1	35.1
	From 5 to 10 years	13	16.9	16.9	51.9
	Overs 10 years	37	48.1	48.1	100.0
	Total	77	100.0	100.0	

The results in Table 3 demonstrate that a substantial portion of respondents have over 10 years of teaching experience (48.1%), followed by those with less than 5 years of experience (35.1%), and a smaller group with 5 to 10 years of experience (16.9%). This distribution is significant because it shows a wealth of experience among the respondents, which is beneficial for understanding the practical realities of STEM implementation. Teachers with more experience may have faced evolving educational trends and can offer valuable insights into the adaptation of STEM practices over time. This mix of experience levels is crucial in identifying common challenges and determining how STEM can be integrated more effectively within existing educational frameworks.

4.2. Assessment of scale reliability

Table 4. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.767	.763	77

Table 4 illustrates that the scale used in this survey has acceptable reliability, with a Cronbach’s Alpha of .767, indicating that the items in the survey are internally consistent and reliable. This reliability supports the validity of the survey results, ensuring that the insights derived from the responses are robust and can be confidently used to assess the current state of STEM education in Hanoi’s middle schools. The consistency in responses suggests that the participants have a clear understanding of the issues surrounding STEM education, which will be essential for formulating targeted recommendations to address the identified challenges.ß

Table 5. Item Statistics

	Mean	Std. Deviation	N
Q1	4.0519	1.09900	77
Q2	3.1169	1.22447	77
Q3	3.9091	1.00239	77
Q4	3.3896	1.01509	77
Q5	4.1429	.85400	77
Q6	3.8182	.99641	77
Q7	3.7532	1.05326	77
Q8	4.3766	.68899	77
Q9	3.7143	1.16819	77
Q10	4.0519	.94446	77
Q11	4.1818	.79019	77
Q12	4.2727	.75457	77
Q13	4.3636	.74178	77

Table 6. Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q1	47.0909	32.557	.406	.684	.728
Q2	48.0260	34.184	.222	.388	.754
Q3	47.2338	32.787	.442	.655	.723
Q4	47.7532	37.162	.054	.189	.767
Q5	47.0000	34.211	.392	.553	.730
Q6	47.3247	32.670	.456	.607	.722
Q7	47.3896	32.241	.461	.699	.721
Q8	46.7662	35.339	.372	.477	.734
Q9	47.4286	33.117	.326	.584	.739
Q10	47.0909	32.242	.534	.653	.713
Q11	46.9610	33.406	.529	.646	.718
Q12	46.8701	34.062	.480	.613	.723
Q13	46.7792	35.543	.313	.515	.738

The overall analysis of Tables 5 and 6 indicates that respondents generally show a high level of agreement with statements related to both the current state of STEM implementation and the need for further support. Several items achieved mean scores above 4.0, particularly those reflecting teachers' needs for professional development, teaching resources, and improved infrastructure. This trend suggests that while there is a positive orientation toward STEM teaching among educators, substantial systemic and institutional support is still required.

The internal consistency of the instrument, as evidenced by Cronbach's Alpha (.767), and the corrected item-total correlations presented in Table 6 confirm the reliability and coherence of the survey items. Most items show moderate to high correlations, indicating that each statement contributes meaningfully to the overall construct being measured. Notably, items with the lowest correlation values, such as Q4 (regarding school facilities), still reflect a widespread concern, demonstrating that infrastructure limitations remain a pressing issue across many schools.

These results are significant for the study as they provide empirical evidence of both enthusiasm for and barriers to STEM implementation in middle schools in Hanoi. They also serve as a foundational reference for developing targeted interventions, especially in the areas of teacher training, curriculum integration, and resource provision. The alignment between high agreement levels and strong internal reliability reinforces the validity of the identified needs and challenges, thus strengthening the study's implications for policy and practice in STEM education.

The survey items presented in Table 5 align with three thematic groups outlined in Section 8 of the questionnaire: (1) current implementation of STEM teaching, (2) challenges in STEM education, and (3) support and training needs. Analyzing the results by these groups allows for a more structured understanding of the key issues faced by educators.

4.2. Survey results categorized by question groups

In the first group (STEM implementation status: Q1–Q4), responses reveal a moderately positive outlook. The item with the highest mean, Q1 (M = 4.05), indicates that many teachers have received some form of STEM training. Similarly, Q3 (M = 3.91) reflects relatively high student engagement in STEM-related activities. However, lower mean scores in Q2 (M = 3.12) and Q4 (M = 3.39) suggest limited access to teaching resources and insufficient infrastructural support from schools. This implies that while there is growing interest and foundational awareness of STEM, systemic limitations continue to hinder consistent implementation across classrooms.

The group: challenges in STEM education: Q5–Q8 highlights the most pressing barriers. The highest-rated items—Q5 (M = 4.14) on difficulty in sourcing teaching materials and Q8 (M = 4.38) on challenges in interdisciplinary integration—underscore the complexity of applying STEM in practice. Teachers also expressed concerns about time constraints (Q6: M = 3.82) and inadequate facilities (Q7: M = 3.75), reflecting structural and curricular barriers. These findings indicate that teachers are aware of what STEM entails but face logistical and contextual constraints that limit effective execution.

In the group: support needs: Q9–Q13, responses indicate a strong and unified call for support. Items Q11 (M = 4.18), Q12 (M = 4.27), and Q13 (M = 4.36) show a clear demand for further training, access to updated teaching materials, and technological skill development. Additionally, Q10 (M = 4.05) and Q9 (M = 3.71) reveal the need for more preparation time and infrastructural investment, respectively. The high mean values across all items in this

group emphasize the urgent necessity for targeted professional development programs and institutional backing to empower teachers to apply STEM education effectively.

Collectively, the results illustrate a coherent pattern: teachers possess a foundational understanding of STEM and express a willingness to engage with this educational model, but they are constrained by inadequate resources, insufficient time, and a lack of ongoing support. These findings provide crucial evidence to inform the design of future training programs, curriculum revisions, and resource allocation strategies that can strengthen STEM integration in Vietnam's lower secondary schools.

5. Discussion

The findings of this study reveal both alignment and contrast with previous research on STEM education implementation in Vietnamese secondary schools. Consistent with earlier studies (Nguyen & Le, 2020; T. T. Nguyễn et al., 2023), the current results confirm that teachers demonstrate a positive attitude toward STEM teaching and recognize its importance in fostering student engagement and skill development. However, similar to findings reported by Hán & Đỗ (2023), this study highlights persistent barriers such as insufficient teaching resources, limited interdisciplinary integration, and inadequate infrastructure. The high demand for further training and support is also in line with the conclusions of Apollo & Mbah (2021), who emphasized the critical role of teacher preparedness in effective STEM integration.

A key contribution of this study lies in its detailed examination of the reasons behind these challenges. The lack of collaboration across subject departments, time constraints due to a rigid curriculum structure, and a shortage of teaching materials are not only technical issues but also systemic in nature. These obstacles suggest a need for broader institutional change rather than isolated teacher efforts. Furthermore, while many educators reported participating in initial STEM training (Q1), the need for continuous, practice-oriented professional development remains pressing, especially in areas such as technological integration and interdisciplinary pedagogy.

Opportunities, however, emerge alongside these challenges. The willingness of teachers to engage with STEM practices, as reflected in high mean scores for items on student engagement and demand for training (Q3, Q11–Q13), indicates a fertile ground for capacity-building initiatives. These results suggest that, with appropriate policy interventions—such as providing open-access STEM teaching materials, promoting co-teaching models, and establishing dedicated time blocks for project-based learning—schools can significantly enhance the implementation of STEM education.

External factors also play a crucial role. The ongoing education reform under the 2018 General Education Program (GEP) offers a strategic policy window to incorporate structural adjustments that support STEM teaching. Support from school leaders, increased investment in laboratory facilities, and incentives for interdisciplinary collaboration are all critical to the sustainability of STEM programs. Moreover, partnerships with external stakeholders such as

universities, NGOs, and the private sector can help provide the necessary resources and expertise to overcome current limitations.

6. Conclusion

This study provides valuable insights into the current state of STEM education in lower secondary schools in Hanoi. The findings highlight a growing interest and foundational understanding of STEM among teachers, alongside significant challenges such as limited resources, lack of interdisciplinary coordination, and insufficient training. Despite these barriers, educators show strong motivation and a clear demand for support in implementing STEM effectively. To promote sustainable STEM integration, it is essential to invest in professional development, enhance infrastructure, and adopt supportive educational policies. Future research should expand the scope of the study to other regions and explore the long-term impacts of STEM education on student learning outcomes.

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8. Appendices

SURVEY ON THE CURRENT SITUATION OF STEM EDUCATION IN LOWER SECONDARY SCHOOLS IN HANOI

Dear Teachers,

We are conducting a research study on the current situation of STEM education in lower secondary schools in Hanoi, aiming to identify the challenges, opportunities, and needs of teachers in implementing STEM teaching approaches. The information you provide will help us improve STEM teaching practices in schools. Your responses will be kept strictly confidential and used solely for research purposes. We commit not to disclose any personal information.

This survey includes several questions related to your experience in STEM teaching. We kindly ask you to spend a few minutes completing the questionnaire. Thank you for your cooperation!

2. Personal Information

The following information is optional and intended for research purposes only. Please fill in what is applicable.

- Full name (optional): _____
- Gender:
  ☐ Male ☐ Female ☐ Other
- Years of teaching experience: _____
- Educational qualification:
  ☐ Bachelor's ☐ Master's ☐ Doctorate ☐ Other (please specify): _____

3. Main Content

The following questions are designed to help us better understand the current state of STEM education at your school. Please respond using the 5-point Likert scale below:

1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree

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Group 1: Current status of STEM teaching implementation

1. I have been trained in STEM teaching methods.
2. I have sufficient materials and teaching aids for STEM instruction.
3. My students actively participate in STEM activities in the classroom.
4. My school provides adequate infrastructure and equipment for STEM teaching.

Group 2: Challenges in STEM teaching

5. I find it difficult to locate appropriate teaching materials for STEM lessons.
6. I lack time to fully implement STEM activities in class.
7. My school's infrastructure is insufficient to support effective STEM teaching.
8. I find it challenging to integrate different subjects when teaching STEM.

Group 3: Needs for support and training in STEM

9. I need further training in STEM teaching methods.
10. I need additional teaching materials related to STEM.
11. I would like support in using technology in STEM teaching.
12. The school needs to enhance facilities to support STEM teaching.
13. I would like to have more time to prepare and conduct STEM activities in class.

Thank you for taking the time to complete this survey!