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EVALUATION OF THE CURRENT STATE OF STEMS EDUCATION IN HIGH SCHOOLS: A SURVEY ON TEACHERS' PERSPECTIVES

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Abstract

This study aims to evaluate the current state of STEM education in high schools from the perspective of teachers, with a focus on identifying strengths, weaknesses, and challenges in current teaching practices. The primary objective is to gather insights into teachers' perceptions of STEM education and to provide recommendations for enhancing its effectiveness. A cross-sectional survey design was employed, targeting high school teachers who teach STEM-related subjects across Vietnam. The survey has collected 50 survey votes to ensure the conditions for inclusion in the analysis. The survey, administered online via Zalo and email from June 30 to July 30, 2024, consisted of five sections: demographic information, attitudes towards STEM education, current teaching practices, challenges in STEM education, and open-ended questions for additional comments. The survey utilized a Likert scale to measure teachers' attitudes and perceptions, with data analyzed using SPSS 20.0. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated to summarize the responses. A Cronbach's Alpha value of 0.886 indicated high internal consistency and reliability of the survey items. Key findings reveal that teachers generally have positive perceptions of STEM education, recognizing its importance and benefits for student development. However, significant challenges were identified, including difficulties in accessing adequate resources, time-intensive preparation, and the need for better assessment tools. Additionally, there is a strong demand for professional development and greater institutional support. The study's implications suggest that educational institutions should increase investment in high-quality STEM teaching materials and tools, enhance professional development programs, develop robust assessment methods, and foster a supportive school environment. Addressing these challenges can improve the quality and consistency of STEM education, ultimately benefiting both teachers and students.

Keywords:

STEM education; high school teachers; survey; teaching methods; educational challenges

Introduction

Background and Significance of STEM Education

STEM education, encompassing Science, Technology, Engineering, and Mathematics, is crucial for preparing students to meet the demands of the 21st-century workforce and to solve complex global challenges. Integrating STEM into educational curricula fosters critical thinking, creativity, and problem-solving skills, which are essential for innovation and economic growth (Yeh & Hsu, 2019). In recent years, there has been a significant emphasis on the importance of STEM education at various educational levels, from elementary to higher education. For instance, Đỗ và Hồng (2024) highlighted the role of STEM in enhancing students' engagement and learning outcomes in natural and social sciences. Furthermore, STEM education encourages interdisciplinary learning and equips students with the skills needed to navigate and contribute to an increasingly technological society (Hsu & Fang, 2019).

Objective of the Study

The primary objective of this study is to evaluate the current state of STEM education in high schools, focusing on teachers' perspectives and practices. By surveying high school teachers who are actively involved in STEM education, this research aims to identify the strengths and weaknesses of current STEM teaching practices, the challenges faced by educators, and their perceptions of the benefits of STEM education. Additionally, this study seeks to provide recommendations for improving STEM education practices based on the insights gathered from teachers. The findings will contribute to the development of strategies and policies that support the effective integration of STEM education in high schools.

Scope and Novelty of the Research

This study is conducted within high schools across Vietnam, targeting teachers who teach STEM-related subjects. The novelty of this research lies in its comprehensive approach to understanding the multifaceted aspects of STEM education from the educators' viewpoint. Unlike previous studies that may focus solely on specific STEM disciplines or student outcomes, this research encompasses a broad range of factors, including teaching practices, resource availability, and the challenges encountered in implementing STEM education (Do & Hong, 2024; Le & Do, 2023).

The study employs a Likert scale-based survey to provide a detailed quantitative analysis of teachers' experiences and challenges. This approach allows for a nuanced understanding of the current state of STEM education and identifies specific areas where support and improvements are needed. The inclusion of questions about the social aspects of STEM education, as noted by Đỗ và Hồng (2024), introduces a unique dimension to the research, highlighting the societal context's role in shaping educational practices.

Overall, this study aims to contribute to the ongoing discourse on STEM education by offering valuable insights for educators, policymakers, and stakeholders, ultimately enhancing the quality and effectiveness of STEM education in high schools.

Materials and Methods

The Survey Design and Methodology

The study employed a cross-sectional survey design to evaluate the current state of STEM education in high schools from the perspective of teachers. The survey was designed to capture a comprehensive range of data, including demographic information, teachers' perceptions of STEM education, the frequency and effectiveness of STEM teaching practices, and the challenges faced in implementing STEM education. The survey consisted of five main sections: demographic

information, attitudes towards STEM education, current STEM teaching practices, challenges in STEM education, and open-ended questions for additional comments and suggestions.

Details on the Sample Population (Teachers)

The survey targeted high school teachers who teach subjects within the STEM fields, including Science, Technology, Engineering, and Mathematics. A total of over 1000 teachers from various high schools across Vietnam were invited to participate in the survey. The selection criteria ensured a diverse sample in terms of gender, years of teaching experience, and educational qualifications to provide a broad perspective on STEM education. Ultimately, 50 teachers responded to the survey, yielding a response rate of 5%. The sample included 27 male teachers (54%) and 23 female teachers (46%), with teaching experience ranging from less than 5 years to over 10 years. The educational qualifications of the respondents varied, with 74% holding a bachelor's degree and 26% holding a master's degree.

The Likert Scale Used for Data Collection

The survey utilized a Likert scale to measure teachers' attitudes and perceptions towards various aspects of STEM education. The Likert scale ranged from 1 to 5, with 1 indicating strong disagreement or very low frequency, and 5 indicating strong agreement or very high frequency. This scale was chosen for its effectiveness in capturing the intensity of respondents' attitudes and the frequency of their behaviors. The Likert scale was used for questions related to the necessity of STEM education, teachers' enthusiasm for STEM teaching, the perceived benefits of STEM education for students, and the challenges encountered in STEM teaching.

Procedures for Data Collection and Analysis

The survey was administered online through Zalo and email, ensuring easy access and convenience for the respondents. The data collection period spanned from June 30 to July 30, 2024. During this time, reminder messages were sent periodically to encourage participation and ensure a high response rate.Upon completion of the data collection period, the responses were compiled and processed using SPSS 20.0, a statistical software package widely used for data analysis in social sciences. The data analysis involved several steps:

- Data Cleaning: The collected data were reviewed to identify and rectify any inconsistencies or missing values.
- Descriptive Statistics: Basic descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated to summarize the demographic information and responses to the Likert scale questions.
- Reliability Analysis: Cronbach's Alpha was computed to assess the internal consistency and reliability of the survey items. A Cronbach's Alpha value of 0.886 indicated a high level of reliability.

Results and Discussion

Demographic Data Analysis

The demographic analysis of the survey respondents provides a comprehensive understanding of the sample population, which is crucial for interpreting the results and ensuring the representativeness of the findings.

Table 1. Statistics of survey subjects by gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	27	54.0	54.0	54.0
	Female	23	46.0	46.0	100.0
	Total	50	100.0	100.0	

The survey included responses from 50 high school teachers, with a gender distribution of 27 males (54%) and 23 females (46%), as shown in Table 1. This relatively balanced gender representation ensures that the perspectives of both male and female teachers are adequately captured in the study. The gender distribution aligns with the general demographic trends in the teaching profession in Vietnam, where there is a nearly equal representation of male and female educators. This balance is significant as it allows the study to explore whether gender influences teachers' perceptions and experiences with STEM education.

Table 2. Statistics of survey subjects by number of years of work

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 5 years	4	8.0	8.0	8.0
	From 5 to 10 years	11	22.0	22.0	30.0
	Over 10 years	35	70.0	70.0	100.0
	Total	50	100.0	100.0	

Table 2 illustrates the distribution of respondents based on their years of teaching experience. The majority of the participants (70%) have over 10 years of teaching experience, 22% have between 5 to 10 years, and only 8% have less than 5 years of experience. This distribution indicates that the survey predominantly reflects the views of seasoned educators who have extensive experience in teaching. The high proportion of experienced teachers adds credibility to the findings, as these respondents are likely to have a deeper understanding and more substantial insights into the implementation and challenges of STEM education. Their extensive experience can also provide valuable context for interpreting the effectiveness of current STEM teaching practices and the practical challenges faced in classrooms.

Table 3. Statistics of survey subjects by education level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor	37	74.0	74.0	74.0
	Master's Degree	13	26.0	26.0	100.0
	Total	50	100.0	100.0	

The educational qualifications of the respondents are detailed in Table 3. The majority of the participants hold a bachelor's degree (74%), while the remaining 26% have a master's degree. The presence of both bachelor's and master's degree holders in the sample provides a diverse range of educational backgrounds. This diversity is important for understanding how different levels of academic preparation might influence teachers' attitudes towards STEM education and their ability to implement STEM teaching practices effectively. The fact that a significant proportion of respondents

have advanced degrees suggests that they are well-equipped with theoretical knowledge and pedagogical skills, which can be beneficial for the adoption and integration of STEM education in their teaching.

Overall, the demographic analysis of the survey respondents reveals a well-balanced and experienced sample population with varied educational backgrounds. This diversity enhances the robustness and generalizability of the study findings, providing a solid foundation for assessing the current state of STEM education in high schools and identifying areas for improvement. The demographic data also highlight the potential influence of gender, teaching experience, and educational qualifications on teachers' perceptions and practices, which can be explored further in the subsequent sections of the study.

Reliability Analysis

To ensure the reliability and internal consistency of the survey instrument, a Cronbach's Alpha analysis was conducted. Cronbach's Alpha evaluates the correlation among survey items to determine their consistency.

Table 4. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.886	.886	14

The survey included 14 items assessing various aspects of STEM education from the teachers' perspective. The overall Cronbach's Alpha for the survey was 0.886, indicating high internal consistency. A value above 0.70 is considered acceptable, and a value above 0.80 is considered good, making 0.886 an excellent reliability score. This high reliability suggests that the survey items are well-correlated and measure the intended constructs consistently across different respondents. The analysis also showed that removing any individual item would not significantly improve the overall reliability, confirming that each item contributes positively to the survey's consistency.

In summary, the Cronbach's Alpha of 0.886 confirms that the survey instrument is highly reliable, ensuring the credibility and accuracy of the collected data for analyzing teachers' perceptions and practices in STEM education.

Overall evaluation of survey results

Table 5 highlights teachers' overall attitudes towards STEM education and their implementation of STEM teaching practices. The mean scores for the items range from moderate to high, indicating a generally positive perception of STEM education among teachers. The high level of student engagement in STEM activities suggests that when STEM projects are implemented, they effectively capture students' interest and participation. However, the variability in responses points to inconsistencies in how frequently and effectively STEM education is applied across different classrooms. This suggests a need for more uniform support and resources to ensure that all teachers can integrate STEM concepts into their teaching consistently and effectively.

Table 5. Item Statistics

	Mean	Std. Deviation	N
Q1	3.8600	1.10675	50
Q2	3.8400	.99714	50
Q3	3.9800	1.02000	50
Q4	4.0400	1.02936	50
Q5	3.7400	1.06541	50
Q6	3.6000	1.14286	50
Q7	4.2400	.84660	50
Q8	3.6000	1.22890	50
Q9	3.8800	1.08119	50
Q10	4.1200	.91785	50
Q11	4.1200	1.00285	50
Q12	4.2800	.85809	50
Q13	3.7200	1.17872	50
Q14	4.3400	.74533	50

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	51.5000	71.235	.567	.869	.879
Q2	51.5200	71.275	.640	.909	.875
Q3	51.3800	71.302	.622	.880	.876
Q4	51.3200	72.753	.526	.896	.880
Q5	51.6200	71.342	.588	.654	.878
Q6	51.7600	72.104	.497	.722	.882
Q7	51.1200	73.985	.573	.627	.879
Q8	51.7600	70.349	.543	.760	.880
Q9	51.4800	69.316	.698	.758	.872
Q10	51.2400	71.533	.688	.819	.874
Q11	51.2400	71.370	.630	.801	.876
Q12	51.0800	72.524	.670	.838	.875
Q13	51.6400	71.092	.532	.602	.881
Q14	51.0200	81.122	.102	.312	.895

Table 6 focuses on the challenges teachers encounter in STEM education. The mean scores for these items are relatively high, indicating significant difficulties in areas such as resource availability, student assessment, preparation time, and the need for professional development and institutional support. These challenges highlight the barriers that teachers face in delivering effective STEM education. The consistent need for better support and resources underscores the importance of addressing these issues to improve the quality and consistency of STEM teaching. The high demand for professional development suggests that ongoing training and support are crucial for equipping teachers with the skills and confidence needed to implement STEM education successfully.

Teachers' Perceptions of STEM Education

The survey responses related to teachers' perceptions of STEM education provide valuable insights into their attitudes and beliefs about the importance and effectiveness of STEM teaching. Table 5 summarizes the responses to four key questions, using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

The first question (Q1) asked teachers whether they believe STEM education is necessary for students. The mean response was 3.86, with a standard deviation of 1.11, indicating that most teachers agree on the importance of STEM education, though there is some variation in their level of agreement. This consensus reflects a broad recognition of the role STEM education plays in preparing students for future challenges and careers.

The second question (Q2) assessed teachers' enthusiasm for teaching STEM subjects. The mean score was 3.84, with a standard deviation of 0.997, showing that teachers generally feel positively about incorporating STEM into their teaching practices. However, the slight variability suggests that while many teachers are enthusiastic, there are still some who may feel less confident or interested in STEM teaching.

The third question (Q3) evaluated teachers' beliefs about the benefits of STEM education for student development. With a mean score of 3.98 and a standard deviation of 1.02, the results indicate strong agreement that STEM education helps students develop valuable skills and qualities. This positive perception underscores the belief that STEM education contributes significantly to students' overall growth and learning outcomes.

The fourth question (Q4) explored teachers' views on the future growth of STEM education. The mean response was 4.04, with a standard deviation of 1.03, reflecting a high level of optimism about the continued expansion and impact of STEM education. This optimism suggests that teachers see potential for STEM education to become more integrated and influential in the educational landscape.

Overall, the analysis of survey responses reveals that teachers generally hold positive perceptions of STEM education, recognizing its necessity, benefits, and potential for growth. However, the variation in responses also highlights areas where additional support and resources may be needed to enhance teachers' confidence and enthusiasm for STEM teaching. Addressing these areas could further strengthen the implementation and effectiveness of STEM education, ultimately benefiting both teachers and students.

These findings provide a strong foundation for developing targeted strategies to support and promote STEM education in high schools, ensuring that teachers are well-equipped and motivated to deliver high-quality STEM instruction.

Current State of STEM Teaching

The survey responses provide insights into the current state of STEM teaching in high schools, specifically focusing on the frequency of STEM application in teaching practices. Table 5 presents the data related to four key questions assessing the extent to which teachers integrate STEM into their classrooms.

Question 5 (Q5) asked teachers about the frequency of incorporating STEM education into their teaching. The mean score was 3.74, with a standard deviation of 1.07, indicating that teachers often integrate STEM concepts into their lessons. However, the variability suggests that while some teachers frequently use STEM approaches, others do so less often, pointing to inconsistencies in STEM implementation.

Question 6 (Q6) examined the use of tools and materials supporting STEM education. The mean response was 3.60, with a standard deviation of 1.14, showing a moderate level of utilization of

STEM resources. This indicates that while many teachers are using various tools and materials, there is room for improvement in resource availability and usage.

Question 7 (Q7) focused on student participation in STEM projects and activities. The mean score was 4.24, with a standard deviation of 0.85, reflecting a high level of student engagement in STEM-related activities. This positive response suggests that when STEM projects are implemented, they effectively engage students and promote active learning.

Question 8 (Q8) assessed the effectiveness of students' participation in STEM activities. The mean response was 3.60, with a standard deviation of 1.23, indicating that teachers perceive student participation as moderately effective. The variability highlights the need for strategies to enhance the impact and outcomes of STEM activities.

In summary, the analysis of the current state of STEM teaching reveals that while there is a significant level of STEM integration and student engagement, there are disparities in frequency and resource usage. Addressing these inconsistencies through targeted support and resource provision can further enhance the effectiveness of STEM education in high schools.

Challenges in STEM Teaching

The survey responses reveal several significant challenges faced by teachers in the implementation of STEM education, as shown in Tables 5 and 6.

Question 9 (Q9) addressed the difficulty of finding support materials for STEM teaching. With a mean score of 3.88 and a standard deviation of 1.08, it is evident that many teachers struggle to access adequate resources. This challenge can hinder the effective delivery of STEM education, underscoring the need for improved resource availability.

Question 10 (Q10) evaluated the difficulty in assessing student performance in STEM activities. The mean response was 4.12, with a standard deviation of 0.92, indicating that evaluating student outcomes in STEM projects is a common challenge. This highlights the necessity for better assessment tools and methodologies tailored to STEM education.

Question 11 (Q11) focused on the time required to prepare for STEM teaching. The mean score was 4.12, with a standard deviation of 1.00, showing that many teachers find the preparation time for STEM lessons to be excessive compared to other teaching methods. This suggests a need for more streamlined preparation processes or additional planning time.

Question 12 (Q12) explored the need for more in-depth training in STEM education. The mean response was 4.28, with a standard deviation of 0.86, indicating a strong demand for professional development opportunities to enhance teachers' STEM teaching skills.

Question 13 (Q13) assessed the need for better infrastructure and support for STEM education. The mean score was 3.72, with a standard deviation of 1.18, reflecting a significant need for improved facilities and support systems.

Question 14 (Q14) examined the need for support from schools and colleagues. The mean response was 4.34, with a standard deviation of 0.75, showing that teachers feel a strong need for increased collaboration and support from their institutions.

In summary, the analysis highlights critical challenges in STEM teaching, including resource access, student assessment, preparation time, professional development, infrastructure, and institutional support. Addressing these issues is essential for enhancing the effectiveness of STEM education in high schools.

Discussion

The survey results indicate a generally positive perception of STEM education among high school teachers, with a strong consensus on its necessity and benefits for student development. However, significant challenges remain, particularly regarding resource availability, preparation time, and the need for professional development. Teachers also highlighted the difficulty in assessing student performance in STEM activities, which can hinder the effective implementation of STEM education. The variability in responses suggests that while many teachers are enthusiastic and capable of integrating STEM into their teaching, there are inconsistencies in practice and support across different schools.

The findings of this study align with previous research on the importance and challenges of STEM education. Do and Hong (2024) similarly found that STEM education enhances student engagement and learning outcomes, highlighting its critical role in modern education. However, they also noted the need for better resources and support, a challenge echoed in the current study. Le and Do (2023) emphasized the difficulties in resource availability and professional development, which are consistent with the challenges identified by the teachers in this survey.

Additionally, the study by Bùi et al. (2023) on STEM education in high schools in Ho Chi Minh City also reported similar issues, including the need for improved infrastructure and more effective assessment tools. The recurring theme of insufficient resources and support in multiple studies suggests a systemic issue that requires comprehensive policy and practical interventions.

Moreover, the study by Tran et al. (2024) on teacher evaluations of STEM effectiveness in the Mekong Delta region underscores the potential benefits of STEM education but also points to the necessity of ongoing training and institutional support to sustain its implementation. These findings are corroborated by the current study, which indicates a strong demand for professional development and better preparation resources among high school teachers.

The results of this study have significant implications for future STEM education practices. First, there is a clear need for increased investment in resources and infrastructure to support STEM teaching. Providing teachers with access to high-quality materials and tools is essential for the consistent and effective integration of STEM education (Do & Hong, 2024; Le & Do, 2023).

Second, professional development opportunities must be expanded to equip teachers with the necessary skills and confidence to implement STEM education effectively. Regular training sessions, workshops, and collaborative learning communities can help address the identified gaps in knowledge and practice (Nguyen et al., 2023).

Third, developing robust and practical assessment tools for STEM activities is crucial. Effective assessment methods will enable teachers to measure student performance accurately and provide meaningful feedback, thereby enhancing the overall quality of STEM education (Ha et al., 2023).

Finally, fostering a supportive school environment is vital. Encouraging collaboration among teachers, providing administrative support, and recognizing the importance of STEM education at the institutional level can create a conducive atmosphere for the successful implementation of STEM initiatives (Cao & Nguyen, 2023).

In conclusion, while the study highlights the positive perceptions of STEM education among high school teachers, it also underscores the need for targeted interventions to overcome the existing challenges. By addressing these issues, educational institutions can ensure that STEM education is effectively integrated into the curriculum, ultimately benefiting both teachers and students.

Conclusion

This study has provided a comprehensive evaluation of the current state of STEM education in high schools from the perspective of teachers. The key findings indicate that teachers generally have positive perceptions of STEM education, recognizing its importance and benefits for student development. However, significant challenges were identified, including difficulties in accessing adequate resources, the time-intensive nature of preparing STEM lessons, and the need for better assessment tools. Additionally, there is a strong demand for professional development opportunities and greater institutional support to enhance the implementation of STEM education.

To address the challenges identified in this study and improve STEM education in high schools, the following recommendations are proposed:

- Increase Resource Availability: Educational institutions should invest in providing high-quality STEM teaching materials and tools. This can include digital resources, laboratory equipment, and project-based learning kits to support effective STEM instruction (Do & Hong, 2024; Le & Do, 2023).
- Enhance Professional Development: Regular training programs and workshops should be organized to equip teachers with the necessary skills and confidence to implement STEM education effectively. These programs should focus on innovative teaching strategies, use of technology in STEM education, and assessment methodologies (Nguyen et al., 2023).
- Develop Robust Assessment Tools: Effective assessment methods tailored to STEM education should be developed and provided to teachers. These tools should enable accurate measurement of student performance and provide meaningful feedback to improve learning outcomes (Ha et al., 2023).
- Foster a Supportive Environment: Schools should create a collaborative and supportive environment for STEM teachers. This includes fostering teamwork among teachers, providing administrative support, and recognizing the importance of STEM education at the institutional level (Cao & Nguyen, 2023).
- Streamline Preparation Processes: To address the issue of time-consuming preparation for STEM lessons, schools should consider providing teachers with ready-to-use lesson plans, project templates, and other instructional resources that can save time and enhance efficiency.

Future research can build on the findings of this study by exploring the following areas: (1) Conducting longitudinal studies to track the impact of improved resources, professional development, and support on the effectiveness of STEM education over time; (2) Investigating students' perceptions and experiences with STEM education to provide a more holistic understanding of its impact and identify areas for improvement; (3) Comparing STEM education practices and outcomes across different regions or countries to identify best practices and successful implementation strategies that can be adapted to various contexts or (4) Examining the impact of educational policies on STEM education implementation and identifying policy changes that can support the widespread adoption of effective STEM practices.

In conclusion, while the study highlights positive perceptions and significant challenges in STEM education, it also provides actionable recommendations and identifies potential areas for future research. By addressing the identified challenges and implementing the proposed recommendations, educational institutions can enhance the quality and effectiveness of STEM education, ultimately benefiting both teachers and students.

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