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CURRENT SITUATION AND SOLUTIONS TO IMPROVE THE QUALITY OF TEACHING IN STEM EDUCATION IN GENERAL SCHOOLS: A CASE STUDY IN SOME NORTHERN PROVINCES OF VIETNAM

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Abstract:
The paper delves into the state and challenges of STEM (Science, Technology, Engineering, and Mathematics) education in schools. By conducting an intensive survey, it offers insights into the current status of STEM education and highlights the perceptions and difficulties faced by educators in adopting STEM methodologies. The study reveals that while there's an increasing recognition of the importance of STEM in the natural sciences curriculum, several obstacles impede its full implementation. A significant challenge is the difficulty in correlating real-world issues with natural science subjects, making it tough for educators to make lessons engaging and relevant. Furthermore, the lack of appropriate educational tools and materials, combined with inadequate infrastructural facilities in schools, further hampers the quality of teaching. Moreover, the research identifies a gap in the training of educators. Many teachers are unfamiliar with STEM, lacking both understanding and confidence in the approach. This is exacerbated by time constraints in the classroom and insufficient support from parents. Additionally, the paper points out that only a limited number of natural science topics can be aptly integrated into STEM projects, creating a narrower scope for educators. To address these challenges, the paper suggests the need for better training for teachers specifically tailored to STEM requirements, more substantial institutional support, and

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fostering a closer relationship between STEM education and the broader natural sciences curriculum.

Keywords: current situation, solutions, STEM education, Vietnam, teacher training

1. Introduction

In today's rapidly evolving global landscape, there is a compelling need for individuals equipped with 21st-century skills, encompassing critical thinking, entrepreneurship, communication, collaboration, decision-making, leadership, problem-solving, accountability, and creativity. One of the educational approaches that has been spotlighted in cultivating these skills is STEM education (Ministry of Education and Training, 2018). The genesis of STEM education globally was witnessed when the United States recognized an imminent requirement for change to maintain its dominant stature. Further, technological advancements have considerably influenced this educational approach (Anne Jolly, 2017). The U.S., renowned for its excellence in STEM education, has received unwavering support from its Congress, President, Department of Labor, and citizens. Its inception was primarily to address the anticipated quality of its future workforce (Hung & Nhu, 2022).

Similarly, countries like Australia have made significant strides in this domain. In 2009, the Invigorating STEM initiative was introduced, enriching knowledge for high school students in Sydney. This program engages students and their families in STEM activities, demonstrating the national-level emphasis on this paradigm (Victoria Government). The allure of STEM is not limited to developed nations like the U.S., Australia, or Canada. Many Asian countries, recognizing its importance, have embraced STEM education, witnessing it as a pivotal approach in the contemporary competitive economic climate among nations (English & King, 2018; Goktepe & Ozdemir, 2018).

In Vietnam, the STEM education trend echoes its international counterparts, with a flurry of events and activities being organized to foster greater national engagement (Hoang et al., 2020). Introduced around 2010 via various tech and education entities, both domestic and international, the reach of STEM has been growing steadily. Activities and campaigns have been initiated to expose students to experiential learning and scientific exploration. However, according to Ngo Van Hung and colleagues (2021), these endeavors often remain isolated, lacking in connectivity and coherence. Presently, research into STEM education in Vietnam is still in its infancy, with most literature offering informational and opinion-based insights rather than deep-rooted theoretical foundations or applications in Natural Science education.

Central to the successful adaptation and integration of innovations like STEM into the educational framework is the role of teachers. Their understanding and readiness for STEM education is crucial for the effective implementation of new curricula and for addressing associated challenges. As identified by Ngo Van Hung & Pham Van Hoan

(2019), the perception and preparedness of Natural Science teachers in Vietnam significantly impact the success of the 2018 general education curriculum.

This study embarks on a journey to understand the current scenario of STEM education in northern provinces of Vietnam and aims to propose strategies to enhance its quality and effectiveness.

2. Literature Review

STEM education, an interdisciplinary approach integrating science, technology, engineering, and mathematics, has increasingly been recognized as pivotal for addressing the demands of the 21st-century global economy. The following literature review delves into the existing body of research on STEM education, its global evolution, its significance in different regions, and its current standing in Vietnam.

2.1 Global Emergence and Importance of STEM Education

The early roots of STEM education can be traced back to the United States' drive to maintain its competitive edge in the global arena (Jolly, 2017). The emphasis on STEM emerged from concerns about future workforce quality, economic vitality, and national security (Langdon, et al., 2011). This interdisciplinary approach was seen as a means to cultivate innovative thinkers and problem solvers essential for the new age. Countries like Australia followed suit, recognizing the crucial role of STEM in preparing students for a future where technological advancements would shape professional and everyday lives (Victoria, 2019). The Australian government's national STEM strategy emphasizes partnerships, innovation, and the development of students' STEM skills from an early age (Office of the Chief Scientist, 2016). The research underscores the critical relationship between STEM education and economic growth. Countries with strong STEM education systems tend to display higher levels of innovation, which in turn, leads to increased economic productivity (Freeman et al., 2015; Marx, 2017).

2.2 STEM in Asia

Many Asian countries, realizing the importance of STEM in today's digital age, have implemented policies to integrate STEM education into their curricula. Singapore, for instance, has been at the forefront of STEM excellence, with a curriculum that emphasizes inquiry-based learning, critical thinking, and problem-solving (Nguyen, 2017; Ngo & Do, 2020)). Japan and South Korea, too, have invested significantly in STEM education, given their technological industries' growth (Kim et al, 2018). Such countries recognize that to remain globally competitive, a workforce skilled in STEM is essential. STEM education, thus, is not merely a trend but an educational imperative for these nations (English & King, 2018).

2.3 STEM in Vietnam

Vietnam, though late to the global STEM movement, has shown considerable interest in the last decade (Le Huy Hoang et al., 2020). The introduction of STEM in Vietnam can be associated with collaborations between tech and educational entities, which emphasized experiential learning and scientific exploration (Hung et al., 2021). Despite these advancements, research highlights the fragmented nature of STEM initiatives in Vietnam. Most activities remain isolated, with a noticeable lack of connectivity and coherence. Additionally, most existing Vietnamese literature on STEM remains informational rather than deeply analytical or theoretical (Hung & Nhu, 2022). The role of educators in the successful integration of STEM cannot be overstated. A study by Ngo Van Hung & Pham Van Hoan (2019) highlighted the influence of teachers' perceptions and preparedness in shaping the success of STEM initiatives. Effective STEM education in Vietnam, as the study notes, requires teachers who are not only familiar with the curriculum but also confident and skilled in its delivery.

2.4 Challenges in Implementing STEM

Implementing STEM is not without challenges. Across the globe, educators face issues related to curricular integration, resources, teacher training, and assessment (English & King, 2018; Siti et al., 2019). A study by Anthony Edward Kelly & Richard A. Lesh (2000) underscores the importance of professional development in ensuring teachers are well-equipped to facilitate interdisciplinary STEM learning. Another challenge is the need for relevant and culturally appropriate pedagogies (Sherry, 2017). In conclusion, the literature presents a clear picture of the global significance of STEM education and its evolving narrative in various regions, including Vietnam. This study aims to further contribute to this discourse by exploring the current state of STEM in northern provinces of Vietnam and proposing strategies for enhancement.

3. Material and Methods

3.1 Study Design

This study adopted a cross-sectional research design aimed at assessing the current state of STEM education in select provinces in Northern Vietnam. Through a two-phase methodology, this study not only gauged the existing STEM education practices but also evaluated the feasibility of proposed strategies to elevate teaching quality.

3.2 Sample Selection

For the purpose of this study, 15 schools from three provinces in Northern Vietnam were purposively selected. These schools were chosen based on their distinct educational settings, representing both urban and rural backgrounds. In total, 160 STEM teachers from these schools participated in this study.

3.3 Instruments

STEM Education Questionnaire (SEQ): Designed for educators, the SEQ consisted of both open and closed-ended questions. The questions sought to extract insights about the challenges faced by educators, existing curriculum standards, available resources, and pedagogical methods in place.

Solution Feasibility Questionnaire (SFQ): Post identification of challenges and potential solutions, this questionnaire was administered to gauge teachers' perspectives on the feasibility and anticipated impact of the proposed strategies.

3.4 Data Collection

Both SEQ and SFQ were pilot-tested with a small group of STEM teachers outside the study's sample to ensure clarity, validity, and reliability. Once refined, the SEQ was administered to the selected sample of educators, which was later followed by the SFQ after a gap of three weeks. The questionnaires were distributed both in printed form and electronically, depending on the preference of the participants.

3.5 Data Analysis

The collected data was initially subjected to descriptive statistics, presenting frequency distributions, means, and standard deviations of the respondents' answers. Open-ended responses from SEQ were subjected to thematic analysis to identify common patterns, challenges, and areas of improvement in the existing STEM education practices. The feedback from SFQ was evaluated to determine the viability of the proposed strategies. The proposed strategies were ranked based on the percentage of teachers who deemed them "feasible" and "very feasible."

3.6 Ethical Considerations

Prior to data collection, informed consent was obtained from all participants. The study's purpose, methods, and intended use of results were explained transparently. Participants were ensured of the confidentiality of their responses, with the option to withdraw at any stage without repercussions.

4. Results and Discussion

The integration of STEM (Science, Technology, Engineering, and Mathematics) education in teaching Natural Science for Grade 6 has become a topic of focus in the pedagogical arena (Lê et al., 2020). Based on our survey results depicted in Table 1, it is evident that teachers' perceptions of STEM education significantly influence their approach to designing STEM lessons and their teaching methodologies.

One of the most pivotal factors in the successful implementation of the STEM curriculum appears to be a teacher's proactive attitude and positive disposition towards STEM. Such educators are firm believers in the potential of STEM integration to enhance student outcomes. Among the most pressing challenges faced by teachers is the

preparation of materials and instruments for teaching. This is further compounded by the lack of necessary infrastructure in schools. Notably, teachers in Thanh Hóa seem to encounter more difficulties in identifying real-life problems associated with Natural Science topics. All three teacher groups—those from Hà Nội, Hà Nam, and Thanh Hóa—express concerns about the insufficient time allocated to teaching Natural Science.

Table 1: Survey results on the current status of teaching based on STEM education.

No	Identify	Agree			Disagree			Uncertain		
		Ha Noi	Ha Nam	Thanh Hoa	Ha Noi	Ha Nam	Thanh Hoa	Ha Noi	Ha Nam	Thanh Hoa
1	It's challenging to identify real-world problems related to the Natural Science subject.	31.0%	43.2%	41.2%	58.6%	49.5%	50.3%	10.3%	7.3%	8.5%
2	Preparing teaching tools and study materials is quite difficult, as school facilities lack essential educational equipment.	72.4%	82.5%	88.3%	20.7%	13.2%	6.1%	6.9%	4.3%	5.6%
3	The allocated time for teaching Natural Science in class is still not appropriate.	51.7%	54.3%	63.4%	31.0%	33.3%	22.1%	17.2%	12.4%	14.5%
4	Teachers do not fully understand STEM; they lack the competency to implement STEM.	34.5%	50.3%	55.4%	44.8%	31.0%	30.3%	20.7%	18.7%	14.3%
5	Only a few Natural Science topics can be applied in STEM projects.	31.0%	35.6%	44.3%	51.7%	49.0%	39.2%	17.2%	15.4%	16.5%
6	There's limited support from students' parents.	62.1%	66.4%	63.2%	27.6%	23.8%	29.0%	10.3%	9.8%	7.8%
7	Teachers are not accustomed to preparing STEM lesson plans.	72.4%	76.3%	78.9%	20.7%	19.2%	14.9%	6.9%	4.5%	6.2%
8	Teacher training is very generic and does not meet requirements.	72.4%	73.2%	72.9%	27.6%	24.7%	24.8%	0.0%	2.1%	2.3%
9	Teachers lack confidence that STEM is a suitable approach for teaching natural science.	20.7%	23.6%	19.3%	73.7%	71.9%	75.6%	5.6%	4.5%	5.1%

Furthermore, the data illustrates that an alarming 72.8% of teachers believe that the training they receive is too generic and does not meet the demands of teaching STEM effectively. A staggering 75.9% of the surveyed teachers also admitted their unfamiliarity with formulating STEM lesson plans.

The Ministry of Education and Training (2020, 2018) provides several recommended formats for organizing STEM education, contingent upon the nature of each subject and the available infrastructure:

- **STEM Lesson-based Teaching:** This is the predominant approach in secondary schools. Teachers design STEM lessons to be implemented in their regular curriculum either through integrated intradisciplinary or interdisciplinary approaches. Students, in this format, are more engaged in exploring textbooks and other materials to gain and apply knowledge.
- **STEM Experiential Activities:** These can be executed in the form of clubs or real-life experiential tasks. They are conducted based on students' interests and choices. Schools can set up STEM corners within the campus or introduce digital libraries, virtual experiments, simulations, and educational software for students to explore and experience real-life applications of science and technology.
- **Research in Science and Technology:** Aimed at students who are passionate about exploratory activities, schools can periodically host STEM festivals or science and technology competitions.

For effective STEM lesson planning, a structured 8-step engineering design process should be followed. Schools and teachers should maximize the use of readily available technology and equipment, keeping costs minimal and leveraging minimum required teaching equipment.

Table 2: Survey results of teachers on solutions to improve teacher quality in STEM education-based teaching

No	Identify	Agree	Disagree	Uncertain
1	Raise teachers' awareness of the importance of STEM in teaching the Natural Science subject.	48.60%	50.15%	1.25%
2	Essential resources must be provided when implementing STEM projects.	42.50%	51.25%	6.25%
3	Educational institutions need to train teachers with STEM teaching skills.	78.12%	20.63%	1.25%
4	There should be professional development for teachers on STEM in teaching Natural Science.	72.00%	28.00%	0.00%
5	Provide materials on STEM topics/lessons for teaching the Natural Science subject.	98.75%	0.62%	0.63%
6	Organize STEM forums for Natural Science for secondary school teachers and students.	90.63%	1.88%	7.50%

Table 2 sheds light on the enhancement of teacher training in STEM. An overwhelming 98.75% of teachers stress the need for dedicated STEM teaching materials for Natural Science. A significant 90.63% suggest organizing forums for teachers and middle school students focusing on Natural Science's STEM aspects.

Teachers' perceptions undeniably shape the trajectory of STEM education in schools. For STEM to flourish, a holistic ecosystem, supported by well-informed teachers, apt resources, and dedicated time, is imperative. The need for more context-relevant training, better resources, and infrastructural enhancements emerges distinctly from the data. Schools, education bodies, and policymakers must collaborate to streamline STEM education, ensuring it aligns with contemporary demands while capitalizing on available

resources. Future studies might delve deeper into devising strategies to overcome the highlighted challenges, ensuring the robust integration of STEM in Natural Science education.

5. Recommendations

Based on the presented results and the discussions that ensued, the following recommendations are proposed to effectively integrate STEM education within the realm of Natural Science in Vietnam:

- **Improved Teacher Training:** The findings highlight that a significant number of teachers feel inadequately trained in STEM. Hence, specialized and focused training programs need to be developed to equip teachers with the necessary skills and knowledge to efficiently deliver STEM lessons. These training programs should not only focus on the content but also emphasize the pedagogical strategies unique to STEM education.
- **Resource Allocation:** The survey points out the challenge of limited physical resources in schools. It is recommended that school administrators prioritize budget allocation for STEM education, ensuring that classrooms have the necessary tools and equipment. Partnerships with local businesses or grants can also be explored to fund the necessary resources.
- **Real-world Problem Integration**: Teachers in Thanh Hóa, in particular, find it challenging to relate STEM topics to real-world problems. Workshops or training sessions that help teachers identify and integrate real-world problems into their curriculum can be beneficial. This will not only make the lessons more relevant but will also boost student engagement.
- **Curriculum Development:** Given the belief of many teachers that only a few Natural Science topics can be integrated into STEM, there is a need for a comprehensive STEM-integrated Natural Science curriculum. This would guide teachers on how to incorporate STEM into various topics seamlessly.
- **Parental Involvement:** The data suggests that there is limited support from parents. Schools should thus organize STEM awareness sessions for parents, emphasizing the significance and benefits of STEM education for their children's future. Engaging parents can lead to more support at home, which can be crucial for successful STEM integration.
- **Flexible STEM Activities:** As proposed by the Ministry of Education and Training, schools should be encouraged to adopt a flexible approach in organizing STEM activities. This includes in-class STEM lessons, extracurricular STEM clubs, and practical experience activities. Schools should also consider organizing STEM festivals or competitions, fostering a love for science and technology among students.
- **Digital Resource Integration:** Given the high percentage of teachers who believe in the need for STEM-related materials, the integration of digital resources, such

as online libraries, virtual experiments, simulations, and educational software, should be emphasized. This can help overcome the limitation of physical resources and also cater to the tech-savvy nature of today's students.

- **STEM Forums:** To foster a community of practice and continuous learning, schools or education departments should consider organizing STEM forums. These forums can serve as platforms where teachers and students can share experiences, best practices, and challenges related to STEM.

In conclusion, the successful implementation of STEM in Natural Science lessons requires a multi-pronged approach. Through concerted efforts from all stakeholders, including teachers, parents, school administrators, and policymakers, STEM education can truly thrive and prepare students for the challenges of the 21st century.

6. Conclusion

The journey towards integrating STEM education within the Natural Science curriculum in Vietnam, as illuminated by our study, is both promising and fraught with challenges. The essence of STEM—its interdisciplinarity, its hands-on nature, and its focus on real-world problem-solving—aligns deeply with the competencies desired in today's global workforce. In equipping our students with these skills, Vietnam positions itself as a forward-thinking nation, poised to lead in an era driven by innovation.

Our study has underscored the necessity for a holistic approach towards STEM integration. While the enthusiasm and interest are palpable among educators and students alike, systemic challenges such as resource constraints, gaps in teacher training, and curriculum limitations persist. Overcoming these challenges necessitates a collaborative effort, transcending individual classrooms or schools, and involving policymakers, industry stakeholders, and the wider community. Importantly, as our findings from Thanh Hóa indicate, there's a profound need to localize the STEM integration process. One-size-fits-all solutions risk marginalizing certain communities or failing to address unique local challenges. A bottom-up approach, where educators are empowered to adapt and innovate, can ensure that STEM education is both globally competitive and locally relevant. Furthermore, the role of parents, often overlooked, emerged as crucial. In creating a STEM-supportive ecosystem, their involvement and understanding can serve as a catalyst, augmenting the efforts of educators and policymakers. The proverb, "*It takes a village to raise a child*," seems fitting here—it might very well take an entire community's concerted effort to raise a STEM-ready generation.

In sum, this exploration into the state of STEM in Vietnam's Natural Science lessons offers insights and lessons, not just for Vietnam, but for any nation striving to integrate STEM into its educational framework. It serves as a testament to the complexities involved, but more importantly, as a beacon of the incredible potential that awaits when these challenges are navigated with foresight, collaboration, and dedication. The future of STEM in Vietnam, while paved with challenges, shines brightly with promise.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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