Uncovering the Challenges and Requirements of Elementary School Teachers in Implementing STEM Educational Activities in Vietnam

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Abstract. Enhancing science, technology, engineering, and mathematics (STEM) education requires a comprehensive understanding of the practical challenges encountered by teachers during implementation. This research study aimed to uncover valuable insights into the integration of STEM education in Vietnam as perceived by primary school teachers. Employing a mixed method approach, the study engaged 454 teachers and administrators from primary schools across the northern, central, and southern regions of Vietnam. Data were collected through interviews and an online survey, focusing on the challenges and needs of teachers in organizing STEM educational activities. Findings reveal that elementary school teachers in STEM education face challenges such as professional competency, program methodologies, resource availability, time and space constraints, and the need for a comprehensive STEM ecosystem. The primary school teachers expressed a strong desire for professional development support, encompassing: (a) increased opportunities for experiential learning, collaboration, and knowledge-sharing among colleagues, supplemented by expert-led training sessions on STEM skills implementation; (b) a preference for practical training courses, sharing of real-world experiences, and a need for continuous and regular professional development activities, as opposed to sporadic training sessions; (c) provision of financial support and conducive conditions to facilitate ongoing professional growth; and (d) assistance in leveraging technology for effective STEM education. These research findings serve as a vital foundation for educational managers and teacher training institutions to formulate policies and implement support mechanisms that are essential for the success of STEM education.

Keywords: challenges in implementation; primary school teachers; professional development; STEM education; STEM integration in Vietnam

1. Introduction

The development of science, engineering, technology, and mathematics (STEM) education in the era of the Fourth Industrial Revolution is not only a prevailing trend but also a strategic imperative for many countries. It offers a competitive advantage in policy implementation, human resource development, and preparedness for the demands of this transformative era (Chuyen & Vinh, 2023; Kelley et al., 2020). The overarching objective of STEM education is to cultivate a profound comprehension of STEM disciplines and foster the requisite characteristics of 21st century citizens. This encompasses the development of human resources specialized in STEM fields. Simultaneously, STEM education endeavors to instill enthusiasm and active engagement among learners within these domains (Nguyen et al., 2022; Thu et al., 2024).

Vietnam – as a country undergoing a transitional phase of industrialization, modernization, and international integration – is not exempt from the global educational paradigm. To proactively seize opportunities and devise practical solutions that harness advantages, while mitigating the adverse repercussions of the Fourth Industrial Revolution, the Prime Minister issued a Directive No. 16/CT-TTg (issued on May 4, 2017) on strengthening capacity to access the 4th Industrial Revolution that outlines a comprehensive set of initiatives aimed at enhancing the country's preparedness to embrace this transformative era. One of the key measures highlighted is the imperative

> "*to effect substantial policy shifts and internal modifications in educational and vocational training systems, with a concerted emphasis on cultivating a workforce capable of adapting to emerging technological trends in production. This entails a particular focus on promoting science, technology, engineering, and mathematics (STEM) education, foreign language acquisition, and information technology integration within general education curricula.*" (Prime Minister, 2017, p. 3)

The education sector has been entrusted with a crucial mandate: "*Advancing the integration of science, technology, engineering, and mathematics (STEM) education within the general education framework*" (Prime Minister, 2017, p. 3). In line with this directive, Vietnam's new general education program explicitly emphasizes the significance of STEM education, encompassing both the cultivation of human capital and the embodiment of an integrated educational approach to foster learners' capacities and attributes. Consequently, this paradigm shift presents a multitude of novel challenges and requisites, particularly for primary school teachers operating within the Vietnamese educational context.

Scholarly discourse underscores the pivotal role of teachers in shaping the quality of education, a responsibility greatly influenced by the training they receive (Rodríguez et al., 2024). Education systems grapple with the formidable task of identifying optimal strategies to equip new teachers, while bolstering the competencies of their existing teaching cohort (Castro-Rodriguez & Montoro, 2021). Nevertheless, the implementation of STEM education in Vietnam presents an array of challenges, particularly concerning the integration of interdisciplinary science within STEM pedagogy, as well as practical contextual constraints and institutional management mechanisms. Identifying these pressing needs is of

utmost importance for teachers in their quest to reform and innovate their instructional approaches (Lin et al., 2023). Such evaluations can inform educational management and teacher training institutions in facilitating the provision of essential conditions for educators. Despite the increasing emphasis on STEM education in Vietnam (Hai et al., 2023; Phan et al., 2023), there exists a paucity of research that delves into the specific challenges and difficulties encountered by primary school teachers in this domain. This dearth of scholarly attention is particularly noteworthy considering Vietnam's position on the precipice of modernization and its concerted endeavors to enhance the quality of education and training. Consequently, this study aimed to address this research gap by investigating the following research questions:

1. What are the key obstacles and challenges encountered by elementary school teachers in the organization of STEM educational activities for students in Vietnam's primary schools?
2. What are the professional development needs of elementary school teachers to effectively address the demands of innovation in STEM education?
3. What actions should management agencies and teacher training institutions undertake to support teachers in enhancing their professional capacity and fostering conducive conditions for improving the effectiveness of organizing STEM educational activities?

Through the investigation of these research topics, this study aimed to expand knowledge regarding facets of STEM education implementation in Vietnam, such as the efficacy of various professional development strategies and the influence of contextual factors on STEM education delivery. The results of this study can assist management levels, teacher training programs, and educational officials in Vietnam in creating focused initiatives to support educators and improve STEM education.

2. Literature Review
2.1 Main Challenges Encountered by Elementary School Teachers
Existing research has shed light on the various challenges faced by elementary school teachers in implementing STEM education. A key challenge is the integration of interdisciplinary knowledge within STEM curricula (Kurup et al., 2019). Certain educators have expressed concerns regarding curriculum disruption when implementing integrated STEM education, due to the interconnected nature of the subjects (Bagiati & Evangelou, 2015; Lesseig et al., 2016). Teachers also encounter pedagogical shifts when delivering STEM instruction, transitioning from a directive role to a more facilitative one, where students are encouraged to navigate their own learning paths (Lesseig et al., 2016; Park et al., 2017). Furthermore, some teachers not only lack subject-specific knowledge but also exhibit limited awareness of effective teaching strategies for STEM education (Mustafa et al., 2016). Access to technology remains a significant challenge for teachers, particularly in elementary STEM settings. Insufficient resources and infrastructure impede students' ability to fully engage with technological tools and resources (Anh & Vinh, 2024; Triplett, 2023). Additionally, the implementation of STEM education faces various systemic challenges, such as

a lack of systematic approaches, limited support from schools, and issues related to time management and learner competencies (Kiazai et al., 2020). While students initially exhibit engagement in integrated STEM activities, it is challenging for teachers to sustain this motivation and interest over an extended period (Dare et al., 2018). Time management and overcrowded classes are commonly identified as barriers to effective STEM education implementation, as teachers struggle to balance and allocate sufficient time for STEM subjects (Dare et al., 2018). Furthermore, teachers face challenges related to the lack of quality assessment tools for STEM programs, with over 40% of teachers expressing concerns about the absence of effective evaluation measures (Dare et al., 2018). Additionally, the increasing workload associated with STEM programs, including the time required for planning, preparing materials, and accommodating diverse student needs, emerges as a significant concern for teachers (Bagiati & Evangelou, 2015).

2.2 Professional Development Needs
Integrating interdisciplinary knowledge within STEM education presents significant challenges for elementary school teachers. Kurup et al. (2019) highlighted these challenges, emphasizing the need for professional development courses to deepen teachers' pedagogical understanding and facilitate the real-life application of this interdisciplinary approach. Training interventions have proven effective in addressing the pressing need to bolster STEM knowledge among teachers (Gardner et al., 2019). This underscores the essential requirement for teachers to develop strong subject knowledge, pedagogical expertise, and innovative adaptability to effectively meet the demands of their future classrooms (Abell, 2013). The implementation of STEM education necessitates a pedagogical shift from a directive to a facilitative role, requiring teachers to navigate this transition and demonstrate flexibility in handling unexpected situations that may arise (Lesseig et al., 2016; Park et al., 2017). Furthermore, in practice, teachers often struggle to develop a comprehensive grasp of the inherent interconnectedness within the integration of STEM disciplines. Additionally, they require a deeper understanding of the pedagogical frameworks necessary to address these concepts within authentic contexts (Dare et al., 2018). Moreover, teachers have expressed a need for more formative assessments that enable them to gauge students' understanding of concepts across different STEM subjects. Lastly, it is essential for teachers to possess the necessary linguistic skills to support students in engaging in key STEM functions, such as hypothesizing, describing, justifying, and explaining.

2.3 Actions Needed to Support Teachers
In light of the challenges faced by elementary school teachers in implementing effective STEM education, as outlined in sections 2.1 and 2.2, a comprehensive and targeted approach is required to adequately support these educators.

Existing research has highlighted the difficulties associated with the integration of interdisciplinary knowledge within STEM curricula (Kurup et al., 2019), prompting the need for robust professional development courses. These courses should aim to deepen teachers' pedagogical understanding and facilitate the real-world application of interdisciplinary approaches, addressing the core concerns expressed by educators (Kurup et al., 2019). Furthermore, to effectively meet the

demands of STEM education, teachers must strengthen their subject-specific knowledge and pedagogical expertise (Abell, 2013). Training interventions that enhance these critical competencies, as noted by Gardner et al. (2019), are essential. Additionally, teachers require support in navigating the pedagogical shift from a directive to a more facilitative role, developing the flexibility to handle unexpected situations that may arise in the classroom (Lesseig et al., 2016; Park et al., 2017).

Given that teachers often struggle to develop a comprehensive understanding of the inherent interconnectedness within STEM disciplines, professional development should focus on enhancing their knowledge of the pedagogical frameworks necessary to address these concepts within authentic contexts (Dare et al., 2018). Furthermore, teachers have expressed a need for more effective formative assessment strategies to gauge students' understanding across different STEM subjects (Dare et al., 2018). This underscores the importance of addressing this requirement through targeted professional development and the provision of appropriate assessment tools. Lastly, to better support students in engaging with key STEM functions, such as hypothesizing, describing, justifying, and explaining, teachers must possess the necessary linguistic skills (Dare et al., 2018). Incorporating language-focused training within professional development programs can enhance teachers' ability to facilitate these critical STEM activities.

In the Vietnamese context, several studies have specifically examined the difficulties faced by high school teachers in organizing STEM educational activities (Duc et al., 2022; Duyen Em, 2021; Hai et al., 2023). Drawing upon these studies, we developed a survey instrument to assess the challenges experienced by elementary school teachers in Vietnam when organizing STEM activities. The survey aims to evaluate the current state of STEM educational practices among primary school teachers, taking into account the practical conditions and contextual factors unique to Vietnam. The findings of this survey will provide valuable insights to educational administrators, training institutions, and other stakeholders, enabling them to offer the necessary support for enhancing the effectiveness of STEM education in Vietnam.

3. Methodology
3.1 Research Setting and Participants
The study specifically targeted teachers involved in STEM instruction across the northern, central, and southern regions of Vietnam. We invited a total of 490 individuals, including primary school teachers, administrators, and individuals with experience in primary education, to participate in the research. Ultimately, 454 individuals agreed to take part in the study, forming the participant cohort (see Table 1).

Table 1: General information about the survey sample

Variable	Item	Frequency	Percent
Gender	Male	173	38.1
	Female	281	61.8
Educational level	Undergraduate	349	76.9

	Graduate	78	17.1
	Other	27	6.0
Years of experience	Less than 5 years	31	6.8
	5–10 years	203	44.7
	10–15 years	151	33.3
	More than 15 years	69	15.2
Occupation	Teacher	413	90.9
	Manager	41	9.1
Living area	City	149	32.8
	District	162	35.7
	Rural	143	31.5
Total		**454**	**100**

3.2 Research Instrument

The study employed Google Forms as a means of communication for gathering data. The survey instrument comprised two sections. The first section focuses on collecting participants' background information, such as gender, educational level, experience, occupation, and living area (Table 1). The second section consists of questions on STEM perspectives. Based on rigorous research methodologies, 29 questions were selected for inclusion in the study. The level of difficulty faced by primary school teachers in organizing STEM educational activities was assessed using a five-point Likert scale.

3.3 Data Collection Process

Purposive sampling was employed to collect data for this study. The data collection process consisted of three rounds. In the first round, invitations were sent out via email and social media platforms such as Facebook and Zalo. The second round involved selecting teachers as survey respondents, who then completed the survey using Google Forms. The third round included a screening assessment and in-depth exploration of respondents' opinions. Furthermore, to gain a deeper understanding of the challenges and aspirations of these teachers, in-depth interviews were conducted with a randomly selected sample of educators from various regions of Vietnam, including both mountainous and flat areas. These interviews provided rich qualitative data to supplement the survey findings. Each interview lasted approximately 30 to 40 minutes, and detailed notes were taken to ensure an accurate recording of the participants' responses.

3.4 Data Analysis

We utilized Microsoft Excel as a means for data summarization and visualization. The quantitative data analysis involved two steps. First, we calculated the descriptive statistics, such as frequencies and percentages, for the various background characteristics of the respondents (gender, educational level, years of experience, occupation, and living area), as presented in Table 1. These statistics provided a comprehensive overview of the sample demographics. Next, we conducted an item-level analysis to examine the interview participants' responses to the questions on the level of difficulty faced in organizing STEM educational activities. Results are reported in the form of visualization for interpretation.

4. Results and Discussion

4.1 Main Findings from the Survey

The survey results are discussed in relation to each respective research question.

4.1.1 *Research Question 1: What are the key obstacles and challenges encountered by elementary school teachers in the organization of STEM educational activities for students in Vietnam's primary schools?*

Challenges pertaining to the individual perspectives. To establish a foundation for subsequent surveys focusing on assessing the challenges faced by elementary school teachers in STEM education, respondents were initially queried regarding the frequency of implementing STEM lessons in their respective schools. Respondents were asked to indicate their level of implementation using a scale consisting of five response options (1 = *very often*, 2 = *frequently*, 3 = *occasionally*, 4 = *rarely*, 5 = *never)*. The results from this inquiry are presented in Figure 1.
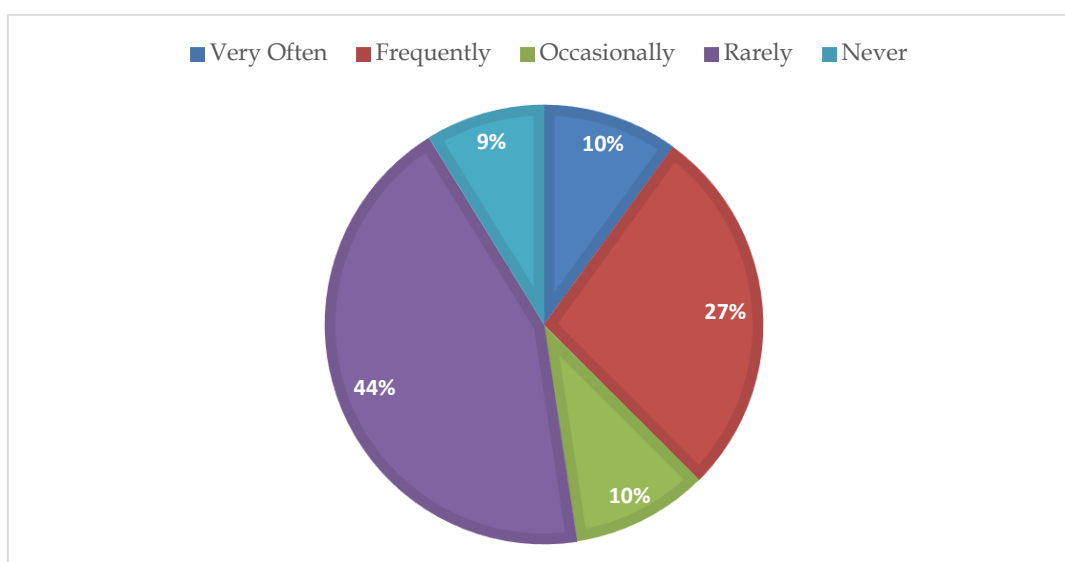

Figure 1: Level of implementation of STEM educational activities by respondents

The findings reveal that nearly half of the respondents (44%) rarely integrated STEM in educational activities, while 27% reported frequent implementation of STEM education lessons, predominantly observed in urban areas with favorable conditions. Conversely, approximately 9% of respondents indicated that they had never conducted STEM educational activities as part of their teaching practice, although they did participate in professional development activities related to STEM education organized by their schools.

The professional capacity of primary school teachers in Vietnam exhibits certain characteristics, including variations in qualifications and disparities in starting points in their professional development. Many teachers have graduated from secondary pedagogical training or pedagogical colleges and have subsequently undergone additional training to meet professional requirements. Consequently, the lack of formal and comprehensive training opportunities poses a challenge.

Error! Reference source not found. presents survey results regarding respondents' attitudes and perceptions toward STEM educational activities.
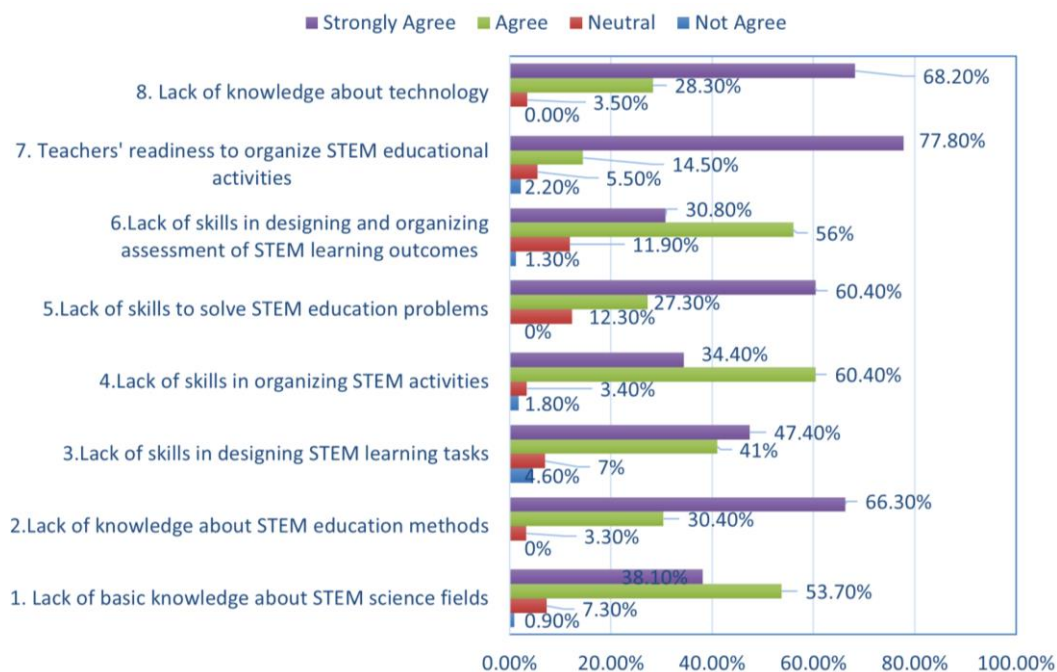

Figure 2: Challenges of respondents regarding STEM professional competencies

The findings reveal a high level of willingness among respondents to participate in STEM educational activities (no. 7), with 77.8% strongly agreeing. However, 66.3% of respondents expressed a perceived lack of knowledge regarding the organization of STEM activities (no. 2), encompassing aspects such as processes, learning strategies for students, and more. Several respondents also highlighted challenges related to technological proficiency, expressing concerns about becoming outdated regarding the integration of information technology in STEM instruction. This perception was particularly evident among those with over 10 years of teaching experience. The recent curriculum framework presents difficulties for teachers in organizing content and topics that fulfill the requirements of the curriculum while nurturing student creativity. Some teacher qualifications do not align with the demands of organizing STEM lessons. Furthermore, most teachers are trained to teach individual subjects, posing a challenge when implementing interdisciplinary teaching such as STEM education. In-depth subjects such as computer science, robotics, and programming necessitate larger budget investments (no. 8), a sentiment strongly agreed upon by 68.2% and agreed upon by 28.3% of respondents. Moreover, a significant proportion of respondents (93.4%) had not had access to professional training courses focused on the application of computer science, robotics, and programming in organizing elementary STEM activities in Vietnam. Several respondents reported minimal participation in technology support activities for organizing STEM educational activities (reported from 8 subjects by a total of 15 participants). Organizing STEM education demands innovative approaches to activity design for students (no. 4), a perspective supported by 60.4% of respondents and strongly agreed upon by 34.4%. Additionally, 47.4% of

respondents strongly agreed and 41% agreed that they faced challenges in designing tasks, managing learning groups, and ensuring fairness and student engagement (no. 3). A notable percentage of respondents (60.4% strongly agree, 27.3% agree) also expressed having difficulties in problem-solving when organizing STEM activities (no. 5).

Designing and implementing assessments to evaluate student learning outcomes presents another challenge in STEM education. A considerable percentage of respondents (30.8% strongly agree, 56% agree) expressed having difficulties in designing assessment criteria and appropriate tools to assess the capacities of individual students (no. 6). Respondents also expressed concerns regarding the varying levels of student participation, engagement, enthusiasm, and ability in STEM activities, and they struggled to quantify and measure these aspects accurately.

Challenges pertaining to the conditions, organizational methods, and support from government management levels in the context of implementing STEM educational activities. **Error! Reference source not found.** presents results for the challenges encountered by survey respondents regarding the support conditions for organizing STEM educational activities. The foremost obstacle identified was the issue of large class sizes (no. 1) (70.7% strongly agree, 23% agree), which significantly hampers activity organization. Insufficient teaching materials (no. 2) also impeded respondents' ability to innovate their teaching methods (54.8% strongly agree, 38.3% agree). The absence of dedicated STEM classrooms or practice rooms where students can engage in groupwork, research, and experimentation (no. 3) posed an additional challenge (46.4% strongly agree, 42% agree). Notably, in mountainous, rural, and some urban areas of Vietnam, teachers face challenges related to limited access to computers, Internet connectivity, and functional classrooms. Consequently, the majority of tools and supplies used for organizing STEM experiential activities are homemade, with teachers relying on available materials and the sporadic mobilization of support from parents and other resources. This scarcity of resources often engenders hesitation among teachers in preparing and implementing STEM lessons, especially in the absence of professional observation lessons.
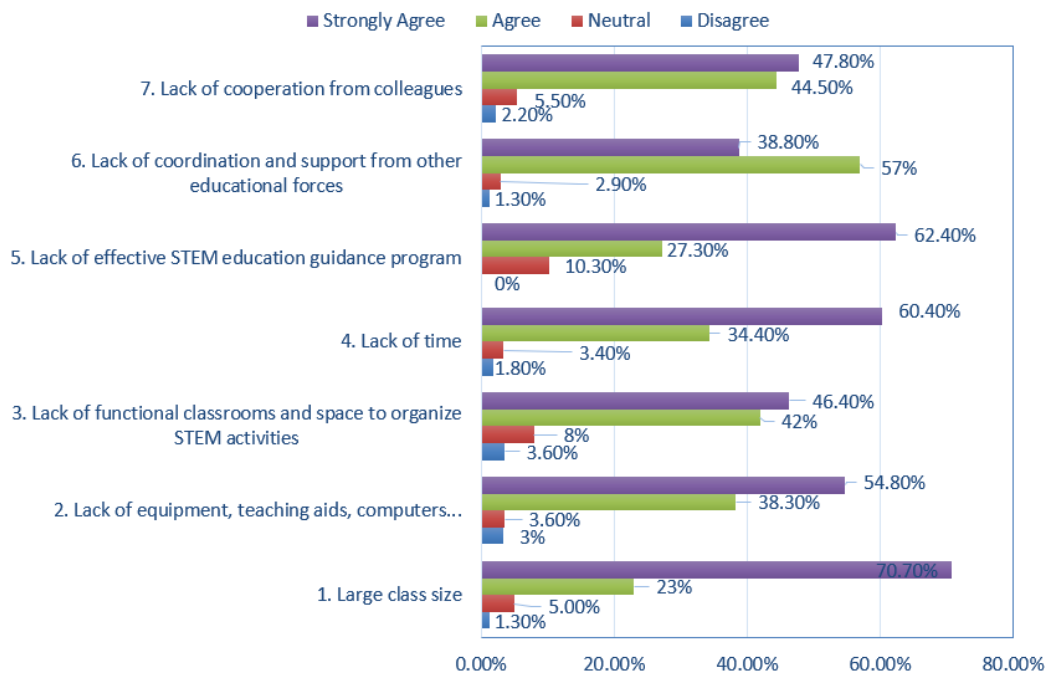
Figure 3: Challenges of respondents regarding conditions to support STEM education

In Vietnam, the absence of a standardized curriculum for STEM education presented a significant challenge for respondents in relation to organizing content and topics (62.4% strongly agree, 27.3% agree), as indicated in **Error! Reference source not found.** (no. 5). Teachers face difficulties in striking a balance between meeting the requirements of the general education curriculum and implementing STEM education effectively. The lack of a specific program and guidelines further compounds the challenges, as teachers struggle to organize content and topics in the most appropriate manner, while ensuring adherence to program requirements and time allocation within the students' overall teaching plan. Consequently, schools encounter numerous obstacles in this regard.

4.1.2 *Research Question 2: What are the professional development needs for elementary school teachers to effectively address the demands of innovation in STEM education?*

Table 2 presents the results on the pressing need for essential support to enhance the expertise of teachers in Vietnam. Specifically, there was a strong consensus among survey respondents on the significance of increasing practical experience (no 1) (71.0% strongly agree, 28.3% agree) and fostering students' engagement in professional activities through lesson research (no. 5) (68.3% strongly agree, 31.5% agree), rather than relying solely on training seminars. A small percentage of the respondents agreed with the benefits of the effectiveness of seminars and training sessions (no. 2) (15.6% strongly agree, 23.5% agree) in improving STEM education.

Furthermore, respondents highly valued the model of training experts in STEM education (no. 4) (63.4% strongly agree, 32.8% agree) and emphasized the importance of exchanging and sharing expertise between schools (no. 3) (45% strongly agree, 27.8% agree). In addition, a significant proportion of respondents

(37.4% strongly agree, 51.0% agree) believed that it is necessary to address teachers' beliefs and enhance their readiness for change (no. 7). More than 78% of respondents also advocated for increased collaboration and dedicated planning time among STEM teachers across different grade levels (no. 9). Respondents also offered a range of other suggestions, although not all of them can be addressed comprehensively. For instance, there was consensus (35.3% strongly agree, 45.0% agree) on the need to strengthen the professional assessment of STEM education (no. 6).

Table 2: Enhancing teacher expertise to address STEM education challenges

No	Item	Strongly agree	Agree
1	Increase attendance to experience	71.0%	28.3%
2	Training seminar	15.6%	23.5%
3	Exchange and share expertise between schools	45.0%	27.8%
4	Invite experts to provide in-depth training on skills	63.4%	32.8%
5	Professional activities based on lesson research	68.3%	31.5%
6	Strengthen professional assessment of STEM education	35.3%	45.0%
7	Changing beliefs for teachers	37.4%	51.0%
8	Enhance collaboration and promote the establishment of STEM professional groups	40.5%	34.0%
9	Increase teacher collaboration and planning time	41.5%	36.7%
10	Organize periodic seminars	28.0%	38.5%

4.1.3 *Research Question 3: What actions should management agencies and teacher training institutions undertake to support teachers in enhancing their professional capacity and fostering conducive conditions for improving the effectiveness of organizing STEM educational activities?*

Table 3 presents results on aspects related to several key actions that management agencies and teacher training institutions should undertake to support teachers in enhancing their professional capacity and fostering conducive conditions for improving the effectiveness of STEM educational activities.

First, increasing investment in facilities and equipment for organizing STEM educational activities (no. 1) received strong support (67.3% strongly agree, 27.4% agree). Respondents teaching in mountainous and disadvantaged areas particularly highlighted the challenges they faced in terms of classroom conditions and space for conducting STEM activities. Specifically, respondents emphasized the importance of technological support (no. 3) (38.9% strongly agree, 43.2% agree) and the availability of teaching aids (no. 2) (35.4% strongly agree, 36.5% agree) to facilitate the organization of STEM activities.

Second, there was consensus among respondents on the need to reduce the number of students in each class (no. 5) (58.2% strongly agree, 34.5% agree). Respondents recognized that students' level of awareness and proactive participation in STEM activities significantly impacts their learning effectiveness.

In areas facing difficulties, such as the central and southwestern regions of Vietnam, students often struggle with limited language abilities and face challenges in independently and autonomously engaging in STEM learning tasks.

Third, respondents strongly advocated for an increase in the variety of STEM experiential activities (no. 6) (57.0% strongly agree, 45.4% agree). Additionally, there was a high level of agreement (56.8%) regarding the importance of building an ecosystem in STEM education (no. 7). These aspects are seen as crucial for promoting active student engagement and effective learning.

Fourth, incentive mechanisms, motivation, and financial support were identified as important conditions for enhancing the effectiveness of STEM education in Vietnam. Respondents highlighted the relatively low living standards they face (no. 4), with 54.0% strongly agreeing and 37.0% agreeing that the current level is high.

Table 3: Level of actions needed to support STEM education

No	Item	Strongly agree	Agree
1	Invest in STEM education facilities and equipment	67.3%	27.4%
2	Support in making teaching materials	35.4%	36.5%
3	Support for technology applications	38.9%	43.2%
4	Encouragement mechanism and financial support for teachers	54.0%	37.0%
5	Reduce the class size	58.2 %	34.5%
6	Enhance different types of STEM experiences	57.0%	45.4%
7	Building a STEM education ecosystem	18.7%	56.8%

4.2 Main Findings from the In-Depth Interviews
During the in-depth interviews, participants emphasized that *a significant obstacle they face is the lack of time to invest in STEM activities* (participants 1, 2, 5, and 8). Currently, STEM education is limited to occasional observation activities and seminars within professional groups. Primary school teachers are *burdened with teaching multiple subjects and managing large numbers of students (with some classrooms exceeding 45 students per class)* (participants 1–10, 13). This places considerable pressure on them to attend to routine professional tasks. Consequently, they have limited time available to dedicate to intensive engagement with STEM activities.

The in-depth interviews shed light on participants' enthusiasm for developing specialized programs that cater to STEM education across all grade levels. Participants also expressed the need for support in terms of *facilities to facilitate the organization of STEM educational activities* (participants 3, 5, 6). However, certain regions in Vietnam, particularly mountainous and disadvantaged areas, face limitations in terms of classrooms, facilities, and conditions necessary for teaching STEM effectively. At present, teaching materials are primarily designed for individual subject areas, *focusing heavily on theory and lacking specific instructions for*

implementation (participants 1–13). The lack of consensus among participants on STEM educational models and methods contributes to a lack of coherence in professional understanding and direction, further complicating the implementation of STEM education.

In the interviews, participating educational managers reported a significant challenge in implementing STEM educational activities, namely the *misalignment between teacher qualifications and the requirements of STEM instruction* (participants 3, 14, 15). Teachers with pedagogical degrees have limited exposure to STEM education, primarily focusing on teaching subjects such as mathematics and the Vietnamese language. Furthermore, according to participants, teachers *exhibit apprehension towards learning and sharing with their colleagues, resulting in limited exchange and collaboration between teachers of different subjects* (participants 3, 14, 15) in terms of implementing STEM educational activities.

According to participants, teachers encounter difficulties in selecting appropriate STEM topics and integrating interdisciplinary content, as this disrupts the overall timetable plan of the school or grade. One notable finding from this study is the existence of a *crisis* (participants 1, 2, 7, 8) among elementary school teachers regarding their ability to *effectively teach mathematical concepts and subject knowledge to meet quality examination standards* (participants 7, 8), with a particular emphasis on mathematics, Vietnamese language, and science subjects. Balancing the demands of these core subjects with the time and capacity required to organize interdisciplinary STEM activities poses a significant challenge. In Vietnam, teachers' teaching effectiveness is predominantly evaluated based on students' academic achievements, assessed through subject-specific tests. As a result, teachers *prioritize test preparation sessions to ensure high student scores* (participants 1, 3, 7, 8, 14, 15), often relegating STEM activities to a lower priority despite the ongoing educational reforms in Vietnam aimed at developing students' capacities and qualities.

4.3 Discussion
In terms of obstacles and challenges faced by primary school teachers, our findings reveal several key insights. First, compared to prior research, our data show dissimilar findings regarding teachers' readiness to integrate STEM in education. While the vast majority of survey respondents in our study agreed that they were not yet ready to effectively implement STEM in their classroom, recent evidence in the literature (e.g., Kırkıç & Arıkan, 2023; Lamanauskas, 2022) has shown more positive perceptions among teachers. Part of the reason to explain this phenomenon is the regional and knowledge characteristics of the teacher population in our study. The lack of access to such training opportunities, especially in remote or underserved regions, may be a key factor. Furthermore, young primary school teachers may not have adequate knowledge in diverse fields, as they just graduated. In contrast, experienced elementary school teachers graduated mostly from vocational training, thus limiting knowledge in a particular topic.

Second, the rapid advancements in technology and the evolving nature of STEM fields can make it challenging for teachers, especially those with longer tenures,

to keep up with the latest developments and teaching methods (Vinh et al., 2024). This finding is consistent with prior research (Triplett, 2023). One plausible explanation for this challenge is the significant time lag between the introduction of new technologies and the corresponding professional development opportunities available to teachers (Pappa et al., 2024). Additionally, the lack of sustained and targeted training programs can further exacerbate the issue, as teachers may not have the necessary support to continuously update their knowledge and skills. Moreover, the disparities in access to resources and training, especially in remote or underserved regions, can contribute to the difficulties faced by experienced teachers in keeping pace with the latest STEM teaching methods. This finding aligns with the existing literature, which highlights the importance of equitable professional development opportunities to address the diverse needs of the teaching workforce (Mustafa et al., 2016).

In terms of the professional development needs for elementary school teachers, our research identified several key insights. First, the strong preference among teachers toward increasing opportunities to directly experience STEM activities and content aligns with the existing literature. Studies have consistently shown that hands-on, experiential learning opportunities are highly valued by teachers and can significantly improve their content knowledge and pedagogical skills in STEM subjects (Dan & Gary, 2018; Tiep, 2023). This preference may stem from the recognition that direct engagement with STEM concepts and practices can help teachers better understand and effectively convey this information to their students. In addition, the teachers' desire for in-depth training from STEM subject-matter experts is also consistent with previous research. Studies have found that access to high-quality professional development led by experienced practitioners can positively impact teachers' self-efficacy and confidence in teaching STEM subjects (Velychko et al., 2022). This finding may reflect the perceived gaps in teachers' own STEM content knowledge and the need for specialized support to address these gaps. However, our data also reveal a unique emphasis on the importance of professional activities focused on lesson research and development, which is not as prominently featured in the existing literature. This preference may be rooted in the teachers' recognition that collaboratively designing and refining STEM lesson plans and instructional approaches can lead to more effective and engaging student learning experiences (Tiep, 2023).

Concerning support and actions needed for primary school teachers, our study uncovered some main points. A significant majority of survey respondents strongly agreed that investing in STEM-focused facilities and equipment is a critical priority. This finding aligns with prior research indicating the importance of providing teachers and students with access to high-quality, well-resourced STEM learning environments (Diana, 2021). Inadequate or outdated facilities and equipment can act as a barrier to effective STEM instruction, and the survey data suggest that teachers recognize the need for targeted investments in this area. Second, according to the data, the teachers believed that support for technology applications and the development of teaching materials is essential in supporting STEM education. This finding is consistent with studies that have highlighted the importance of providing teachers with the necessary technological resources and

curriculum support to integrate STEM concepts and practices into their teaching (Anderson et al., 2022; Pappa et al., 2024).

4.4 Implications

The findings from this study have several key theoretical implications. The discrepancies observed between the teachers' readiness to integrate STEM and the more positive perceptions reported in recent literature point to the need to further explore the role of regional and knowledge characteristics in shaping teacher preparedness for STEM education. Additionally, the challenges teachers face in keeping pace with the rapid advancements in STEM fields and technologies highlight the importance of developing theoretical frameworks that account for the dynamic nature of STEM knowledge and the corresponding professional development needs of teachers. Moreover, the emphasis placed by the teachers on collaborative lesson research and development represents a unique theoretical insight, suggesting the potential to extend theories on effective STEM teacher professional development to include a stronger focus on collaborative curriculum design.

The findings from this study also have several key practical implications. Foremost, the need for tailored professional development programs that provide teachers with hands-on STEM experiences and subject-matter expert training to address the discrepancies in teacher readiness observed is evident. Additionally, ensuring equitable access to STEM-focused facilities, equipment, and technological resources, particularly in remote or underserved regions, is crucial. The emphasis on collaborative lesson research and development indicates the value of providing structured opportunities for teachers to work together in designing and refining STEM instructional approaches. For sustainable STEM education, it is vital to cultivate a STEM education ecosystem that involves the active participation of organizations, corporations, universities, and research institutes directly with high schools. Presently, the establishment and maintenance of such an ecosystem has not received adequate attention. There is a lack of engagement from business organizations, teacher training institutions, research institutes, and general education establishments in establishing STEM research groups and similar initiatives.

4.5 Limitations and Future Research Directions

While the study provides valuable insights into teachers' perspectives on STEM education in Vietnam, there are several limitations to consider for future research. First, the reliance on self-reported data through a survey instrument, although supplemented by data from in-depth interviews, could be subject to potential biases or inaccuracies in respondent responses. Future research could explore alternative data collection methods, such as classroom observations or student performance assessments, to corroborate and enrich the understanding of teachers' practices and their impact on student outcomes. Second, the cross-sectional nature of the data collection limits the ability to examine longitudinal trends or causal relationships between the factors explored. Longitudinal studies that track changes in teachers' STEM-related beliefs, knowledge, and instructional approaches over time could provide deeper insights into the developmental nature of STEM education and the long-term effects of professional development

initiatives. Finally, the study was conducted within the specific context of Vietnam, and the findings may not be directly generalizable to other educational systems or settings without further investigation. Cross-cultural comparisons of STEM educational practices and teacher development in diverse international contexts could shed light on the role of contextual factors, such as educational policies, cultural norms, and resource availability, in shaping effective STEM teaching and learning.

5. Conclusion
The findings from this study highlight the multifaceted challenges Vietnamese primary school teachers face in effectively implementing STEM education. While teachers recognize the value of STEM education for students' future prospects, they often struggle to balance short-term academic goals with the practical realities of designing and delivering integrated STEM content. The study insights align with the broader literature on the critical role of teacher professional development in promoting reform-oriented practices in STEM education, particularly in the context of developing countries. The results underscore the urgent need for policymakers and teacher training institutions to address teachers' practical concerns and develop tailored professional development programs. These programs should emphasize hands-on STEM experiences, opportunities for collaborative lesson planning and knowledge-sharing, and dedicated time for training activities. Supplementing this with increased investment in STEM-focused facilities and infrastructure, as well as strengthened partnerships with higher-education, vocational, and research institutions, could help leverage the necessary resources and expertise to support effective STEM education in Vietnamese primary schools. Ultimately, this study provides valuable evidence to guide the development of a comprehensive, unified, and integrated approach to STEM education in Vietnam. By addressing the various systemic and practical challenges identified, education stakeholders can work toward ensuring that primary school teachers are equipped and empowered to deliver high-quality STEM learning experiences that prepare students for the demands of the 21st-century workforce and beyond.

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