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Awareness and Confidence of Vietnamese Primary School Teachers towards STEM-Integrated Teaching Approach

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Abstract. Science, Technology, Engineering, and Mathematics (STEM) education has been piloted by the Vietnamese Ministry of Education and Training for primary school teachers since 2022. This research aims to evaluate awareness, confidence and the correlation between those variables with the demographic factors of Vietnamese elementary school teachers after nearly a year of implementing integrated STEM teaching. This study used a questionnaire survey method consisting of 30 items on a 5-point Likert scale for 148 elementary school teachers in the Central and Central Highlands of Vietnam. Data was analysed using SPSS software. Descriptive statistics results showed that Vietnamese elementary school teachers have good awareness but lack confidence in STEM-integrated teaching. Correlation analysis showed a positive correlation between teachers' awareness, confidence, and some demographic factors (educational level, work area). The outcomes of the one-way ANOVA analysis revealed a positive correlation: increased levels of teachers' education corresponded to heightened awareness and confidence in STEM-integrated teaching. Additionally, teachers located in urban areas demonstrated greater awareness and confidence compared to their counterparts in rural countryside and highland areas.. Some recommendations to increase awareness and improve confidence in teaching STEM integration for Vietnamese elementary school teachers are presented at discuss session.

Keywords: awareness; confidence; primary school teacher; STEM-integrated teaching

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1. Introduction

STEM (Science, Technology, Engineering, and Mathematics) integrated teaching has become an integral part of the elementary school curriculum (Dan & Wong, 2018) because implementing STEM education in the early school years not only positively impacts learning attitudes (Toma & Greca, 2018), increases students' learning motivation (Dönmez et al., 2022), it also ensures that instruction is focused on the needs of the students and enhances critical thinking, reasoning, creativity and problem-solving abilities (Bell, 2016; Stohlmann et al., 2012). Beyond that, it focuses on forming key knowledge and skills for 21st-century citizens (Fajrina et al., 2020; National Reearch Council, 2012). Therefore, there have been many studies aimed at promoting students' understanding of STEM and positive attitudes toward STEM (Knipprath et al., 2018; Utami et al., 2020).

Although Vietnam's new general education programme, which was just reformed in 2018, does not have a separate STEM subject, it recognises the benefits of STEM education which has been integrated into the curriculum of some other subjects such as Math, Science, Technology, and Informatics right from elementary school (Ministry of Education and Training, 2018). According to the 2018 Vietnam general education programme, STEM education is an educational model based on an interdisciplinary approach, helping students apply science, technology, engineering and mathematics knowledge to solve real-life problems in a specific context (Ministry of Education and Training, 2018). Through STEM education, learners are encouraged to mobilise knowledge and skills in the STEM fields to create a tangible STEM product. This means enhancing the role and contribution of technology and engineering to students' learning products, thereby overcoming the limitation of Vietnamese students who only learn science and math knowledge well but lack the ability to apply this in practice (Ministry of Education and Training, 2018).

Until 2020, Vietnam's Ministry of Education and Training issued an official dispatch guiding and requiring teachers to deploy STEM in secondary education (grades 6-12) (Ministry of Education and Training, 2020). However, compared to secondary education, primary schools have not received much attention in teaching STEM (Lam, 2021). Nonetheless, the introduction STEM education into primary schools is a necessity (Keane, 2022) because children at this age are naturally curious, creative and cooperative, which are essential elements for integrated learning (Banko, 2013; Fridberg, 2022; Nikolopoulou & Tsimperidis, 2023). It was not until 2022 that the Ministry of Education and Training of Vietnam issued an official document implementing pilot STEM education at the elementary level and it is expected that by 2024 there will be a new official document directing implementation for primary school level nationwide (Ministry of Education and Training, 2022). In addition to achieving many positive results after one year of implementation, the representative of the Ministry of Education also frankly admitted that the development of STEM lesson plans for teachers is not highly effective (Ministry of Education and Training, 2023). The reason might be that elementary teachers are not familiar with planning STEM-integrated activities or do not know how to apply STEM knowledge into teaching practice (Ministry of Education and Training, 2023).

STEM education requires teachers to prepare knowledge in many different subjects while primary school subjects are still taught separately and most primary school teachers often are only required to complete instruction in science and mathematics (Ministry of Education and Training, 2018). It is a fact that teachers rarely have access to technical knowledge through their previous training. Therefore, teachers face many challenges when implementing STEM education (Brophy et al., 2008) because their comprehension of the connection between STEM subjects and engineering domains is restricted (Nadelson et al., 2009). In addition, teachers may not be excited about the prospect of teaching STEM topics because they may believe that STEM-related subject areas are hard to teach or too esoteric for young students (Skamp & Mueller, 2001; Yates & Chandler, 2000). Thus, it can be seen that the effectiveness of implementing integrated STEM teaching depends greatly on teachers' awareness and their level of comfort when teaching (Thibaut et al., 2018; Wan, 2023). Therefore, it is necessary to continuously develop the subject, requiring teachers to regularly update STEM knowledge and integrated teaching skills (Du et al., 2019; Gardner et al., 2019; Guskey, 2002).

Besides awareness, teachers' confidence in STEM teaching is also an important factor in predicting the ability and effectiveness of integrated STEM teaching (Lam, 2021; Nikolopoulou & Tsimperidis, 2023). Teachers' confidence affects their behaviour, and confidence and behaviours will shape attitudes and impact the teacher's teaching effectiveness (Voet & De Wever, 2016). Low teacher confidence can negatively affect student learning, and confidence is positively correlated with knowledge (Shahzad & Naureen, 2017). Although they have a strong belief in the role of applying STEM in teaching, elementary school teachers are still not confident in teaching STEM because they do not have enough knowledge in this field (Hsu et al., 2011). Numerous studies claimed that in addition to emphasising pertinent skills, professional development for teachers should also address their attitudes and confidence in interdisciplinary teaching (English, 2016; Marginson et al., 2013). To achieve effectiveness in STEM education requires improving teachers' awareness and confidence in STEM teaching (Daugherty et al., 2014; Guzey et al., 2014; Wyss et al., 2012).

The above reports have shown that, right from the elementary level, Vietnam has had an interest and orientation in integrating STEM, but the effectiveness in the first year of pilot implementation is not high. This may partly be due to the influence of Vietnamese primary school teachers' awareness and confidence about integrated STEM teaching. This research aims to clarify Vietnamese primary school teachers' awareness and confidence in STEM-integrated teaching and explore the relationship between them and demographic issues. From there, the study offers some recommendations that contribute to raising the awareness and confidence of Vietnamese primary school teachers about STEM teaching. Research questions include:

1) What is the level of Vietnamese primary school teachers' awareness and confidence in STEM-integrated teaching approaches?

2) Is there any correlation between awareness, confidence, and demographic factors (gender, working region, education level, seniority of teachers) of primary school teachers related to STEM-integrated teaching?

3) Is there any difference between demographic factors and primary school teachers' awareness and confidence about STEM-integrated teaching approaches?

2. Methodology

2.1 Data Collection Instrument

The research used the survey method with a questionnaire tool. The content of the questionnaire was about teachers' awareness and confidence about teaching STEM at elementary schools. The survey tool was improved from the study of Yasar et al. (2006), including K-12 Teachers' Introduction to Design, Engineering and Technology (DET). Yasar's tool consisted of 41 items that are categorised into four parts: the Significance of DET, Familiarity with DET, Stereotypical traits of Engineers and Engineering Characteristics. This instrument's overall internal consistency was satisfactory (Cronbach's alpha = 0.88). Internal reliability for the four factors in the tool was acceptable, with Cronbach's alpha coefficients for each of the above factors being 0.91, 0.83, 0.76 and 0.66 respectively (Yasar et al., 2006).

The nature of DET and STEM in teaching is interdisciplinary integration, and they both contain T and E elements. They differ only partially in the fields of participation such as S and M. However, Yasar's instrument only refers to interdisciplinary learning in DET fields, and the items in factors Stereotypical Characteristics of Engineers, and Characteristics of Engineering in Yasar's instrument cannot be applied to the Vietnamese context. Therefore, to meet the research objective, this study only used items that focused on awareness and confidence in DET teaching. The DET items have been revised to reflect a more general focus on STEM. For instance, "I am interested in learning more about DET through in-service" was rephrased to "I am interested in learning more about STEM through in-service". In addition, some survey items on Yasar's teacher confidence in the form of questions were revised into affirmative sentences to help teachers choose answers on the Likert scale more easily. For example, "How familiar are you with DET?" was rephrased to "I am familiar with STEM"; and "How confident do you feel about integrating more DET into your curriculum?" was rephrased to "I feel confident about more STEM integration into the curriculum". The survey's 30 items were translated into Vietnamese on a five-point Likert scale ranging from 1 strongly disagree to 5 strongly agree to evaluate teachers' opinions more accurately. In the survey, 18 items focused on teachers' awareness of STEM-integrated teaching and 12 items focused on teacher confidence when teaching STEM-integrated.

The survey questionnaire comprised three parts in which part 1 described the purpose of the survey, briefly introduced the reasons and benefits of STEM in the primary curriculum and the role of teachers in implementing STEM-integrated teaching; Part 2 presented primary school teachers' self-report data on demographic information (gender, seniority of teachers, education level, and geographic location of the primary school where they were teaching); and part 3 consisted of 30 items for teachers to self-assess their awareness and confidence about STEM-integrated teaching in primary schools. The first practical survey was

conducted with 55 primary school teachers to check the reliability of the instrument, and showed that the reliability of the scale was good with Cronbach's alpha for 30 items of the scale being 0.89. The reliability for teacher's awareness and confidence in STEM-integrated teaching had Cronbach's alpha coefficients of 0.87 and 0.85 respectively. This result showed that the scale of awareness and confidence of primary school teachers about STEM-integrated teaching after we improved Yasar's scale, could be used for the survey in this study.

2.2 Participants

The survey was conducted anonymously with teachers of 15 primary schools in the Central and Central Highlands of Vietnam. Using stratified random sampling, three schools in the highland region, six schools in the countryside, and six schools in the urban area were obtained, with the survey period from February to March 2023. Of the 175 hard copies that were given out, 169 were returned, of which 148 copies (85%) were filled out with complete information. Out of 148 teachers, 24.3% were male and 75.7% female; 83.1% of teachers were currently teaching in the countryside and urban areas; 81% of teachers had a university degree or higher; 52.1% of teachers had more than 10 years' teaching experience. Table 1 displays the participants' detailed demographic information.

Table 1: Demographic of participants

	Percent
Gender	
Male	24.3
Female	75.7
Working region	
Highland	16.9
Countryside	44.6
Urban area	38.5
Education level	
Associate bachelor	18.9
Undergraduate	64.2
Postgraduate	16.9
Seniority of teachers	
year 0-5	14.2
year 5-10	33.8
year 10-15	26.4
year 15-20	16.2
year over 20	9.5

2.3 Data Analysis

The survey data was processed and analysed using SPSS software and was analysed according to two components, namely awareness and confidence of primary school teachers on STEM-integrated teaching. First, the reliability of the survey tool was reaffirmed by calculating descriptive statistics including the average score, maximum value, minimum value and standard deviation of teachers on each element. Next, the study analysed the correlation between awareness, beliefs and demographic factors of elementary school teachers related to STEM-integrated teaching. Finally, a One-way ANOVA analysis of variance (Allen & Bennett, 2008) aimed to examine the differences between elementary teachers' demographic factors and their cognitive components and beliefs about STEM-integrated teaching.

3. Findings

3.1 Primary school teachers' awareness and confidence in STEM-integrated teaching

The mean value and standard deviation of each variable, all 18 variables in the awareness factor, and 12 variables in the factor of primary school teachers' confidence in STEM teaching were calculated to answer the first research question. The results are presented in detail in Appendix 1 and Appendix 2.

Appendix 1 shows that most of the survey variables on Vietnamese primary school teachers' awareness of teaching STEM learning are generally quite good (M=3.27 and SD=0.33). The average score of 18 survey variables in the element of elementary school teachers' awareness of STEM-integrated teaching is from 2.29 to 3.66. The standard deviation value is from 0.47 to 0.72. Specifically, teachers were well aware of the importance of STEM in teaching such as *STEM should be integrated into the curriculum* (M=3.66, SD=0.70), *educating for pre-service teachers about STEM-integrated teaching is important* (M=3.58, SD=0.65), *Using engineering to develop new technologies in the science curriculum is important* (M=3.50, SD=0.68). Teachers' motivation for teaching STEM was quite clear as *promoting learning excitement for learners* (M=3.29, SD=0.60), *promoting an understanding of how STEM affects society* (M=3.33, SD=0.61), *developing learners' understanding of the technical world* (M=3.18, SD=0.60). Teachers were quite interested in developing their ability to teach integrated STEM such as *interested in learning more about STEM through workshops* (M=3.64, SD=0.67), *interested in learning more about STEM through peer training* (M=3.57, SD=0.66), *interested in learning more about STEM through training courses* (M=3.51, SD=0.61), *interested in learning more about STEM through college training courses* (M=3.44, SD=0.59). However, the variables related to the teacher's awareness of engineering in particular, and the science underlying STEM, in general, had low mean scores, namely *teaching my students to understand the design process* (M=2.29, SD=0.47), *teaching my students to understand the process of communicating technical information* (M=2.69, SD=0.59), *teaching my students to understand the role and impact of STEM* (M=3.02, SD=0.60), *teaching my students to understand* the science underlying STEM (M=2.50, SD=0.62), *teaching my students to understand the types of problems to which STEM can be applied* (M=2.68, SD=0.62).

The confidence of primary school teachers in STEM-integrated teaching was not high (M=2.53, SD=0.50), as shown in Appendix 2. The mean score and standard deviation in 12 survey variables were quite low, the mean score ranges from 2.38

to 2.70 and the standard deviation ranges from 0.74 to 0.86. Specifically, teachers believed that there were many barriers for teachers to successfully organise STEM-integrated teaching such as *teachers' lack STEM-integrated knowledge* (M=2.60, SD=0.78), the p*revious curriculum had little support for STEM-integrated teaching at the start of a career* (M=2.56, SD=0.75), *lack of STEM-integrated training* (M=2.24, SD=0.77), *lack of time for teachers to approach about STEM integration* (M = 2.37, SD=0.77), *lack of support from management* (M=2.52, SD=0.82). *It is these barriers that are the main reason why teachers are less familiar with STEM* (M=2.70 and SD=0.76), *less use of STEM in classroom activities* (M=2.38, SD=0.76), and *lack of confidence when integrating more STEM into the curriculum* (M=2.50, SD=0.83).

Thus, our findings on STEM-integrated teaching for primary school teachers in Vietnam showed that although teachers had a good awareness of STEM-integrated teaching, they lacked confidence in their ability to teach STEM in their classroom environment. Our findings were consistent with previous studies on teachers' awareness and confidence when implementing an integrated curriculum (Nadelson et al., 2013; Nadelson et al., 2009; Tao, 2019; Yasar et al., 2006).

3.2 Correlation between primary school teacher's awareness and confidence of STEM-integrated teaching with demographic factors

To answer the second research question**,** the correlation between the awareness and confidence of primary school teachers about STEM-integrated teaching with demographic factors was analysed. The results are presented in Table 2.

Through correlation analysis, it found that the confidence factor on STEM-integrated teaching had a high correlation (r=0.63, p<0.01), and a positive correlation with the awareness factor. Regarding the correlation with demographic factors, the confidence factor had a positive correlation with Working region (r=0.23, p<0.01), and had a high positive correlation with Education level (r=0.46, p<0.01). Similar to the confidence factor, the awareness factor also had a very strong positive correlation with the working region (r=0.42, p<0.01) and education level (r=0.74, p<0.01). This study shows that the more qualified teachers are, the greater their awareness and confidence in STEM-integrated teaching. The common point for awareness and confidence of STEM-integrated teachers was that there was no relation to their gender or seniority. This result was consistent with a previous study by Nadelson and Hasan Bakırcı (Bakırcı & Karışan, 2017; Nadelson et al., 2013), which pointed out that in the face of new changes, for example, a STEM-integrated teaching approach, whether primary school teachers were qualified or had a lot of experience in teaching, they also showed a lack of confidence in meeting new challenges.

Table 2: Correlation between awareness and demographic factors of primary school teachers about STEM-integrated teaching (n=148)

		Confidence	Awareness	Gender	Seniority of teachers	Education level	Working region
Confidence	Pearson Correlation	1	0.63**	0.11	0.03	0.46**	0.23**
	Sig. (2-tailed)		0.00	0.17	0.06	0.00	0.00
Awareness	Pearson Correlation		1	0.07	0.04	0.74**	0.42**
	Sig. (2-tailed)			0.37	0.59	0.00	0.00
Gender	Pearson Correlation			1	0.04	0.08	-0.04
	Sig. (2-tailed)				0.59	0.29	0.55
Seniority of teachers	Pearson Correlation				1	-0.06	-0.02
	Sig. (2-tailed)					0.49	0.74
Education level	Pearson Correlation					1	0.09
	Sig. (2-tailed)						0.06
Working region	Pearson Correlation						1
	Sig. (2-tailed)						

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

3.3 Differences in teacher's awareness and confidence about STEM-integrated teaching related to demographic factors

One-way ANOVA was analysed to answer the third research question. Since teachers' awareness and confidence about STEM-integrated teaching were not related to gender and seniority of teachers as presented above, we only examined differences in primary school teachers' awareness and confidence in STEM-integrated teaching with their demographics including working region and education level. The results are detailed in Table 3.

Table 3: Correlation between education level, working region and awareness, confidence about STEM-integrated teaching of primary school teachers

		N	Mean	Std. Deviation	Region	N	Mean	Std. Deviation
Awareness	Associate bachelor	28	3.01	0.17	Highland	25	3.04	0.30
	Undergraduate	95	3.19	0.19	Countryside	66	3.22	0.33
	Postgraduate	25	3.87	0.18	Urban area	57	3.43	0.27
	Total	148	3.27	0.33	Total	148	3.27	0.33

		N	Mean	Std. Deviation	Region	N	Mean	Std. Deviation
Confidence	Associate bachelor	28	2.37	0.23	Highland	25	2.33	0.44
	Undergraduate	95	2.42	0.45	Countryside	66	2.49	0.50
	Postgraduate	25	3.24	0.27	Urban area	57	2.66	0.51
	Total	148	2.53	0.50	Total	148	2.53	0.50

The one-way ANOVA analysis results indicated that there was a statistically significant difference between education level and awareness (p=0.00) and between education level and confidence (p=0.00) of primary school teachers in STEM-integrated teaching. Table 3 provides specifics regarding this difference's mean score. This table shows the positive correlation between teachers' awareness of STEM-integrated teaching and their educational attainment. Specifically, teachers with postgraduate qualifications had significantly higher awareness than teachers with lower qualifications (M=3.87). However, the teacher's awareness with an undergraduate degree (M=3.19) was higher but not much than that of teachers with an associate bachelor's degree (M=3.01). This result was also true for the correlation between confidence and education level of primary school teachers. Specifically, the higher education level teachers had, the more confidence they had in STEM-integrated teaching, in which, teachers with postgraduate qualifications had much higher confidence than teachers with lower qualifications (M=3.24), however, teachers with undergraduate degrees (M=2.42) had higher confidence than teachers with associate bachelor degree (M=2.37) but not significantly.

Statistically significant differences were also found through one-way ANOVA analysis between working regions and awareness (p=0.00), working regions, and confidence (p=0.01) of primary school teachers about STEM-integrated teaching. Table 3 shows that teachers in the countryside areas had higher awareness and confidence about STEM-integrated teaching but not significantly for teachers in the highland areas. Teachers in the urban areas had better awareness and higher confidence about STEM-integrated teaching compared to the other two regions.

4. Discussion

4.1 Increase teachers' awareness related to technical factors

It can be seen that although STEM education has only been officially piloted by the Ministry of Education and Training for less than a year, surprisingly, Vietnamese primary school teachers' awareness of integrated STEM teaching is generally quite good. Our analysis results have found that Vietnamese elementary school teachers are aware of the importance of STEM in teaching. Teachers' motivation for teaching STEM is quite clear, and they are also quite interested in developing integrated STEM teaching capabilities. While many studies suggest that a focus on engineering design is considered the best way to implement an integrated STEM curriculum (Moore et al., 2013; Householder & Hailey, 2012), Vietnamese teachers' awareness of factors related to engineering is still low. This is also the reason why engineering is said to be the least integrated subject among the four STEM fields (Sun et al., 2023). The technical element requires the integration of relevant scientific knowledge,

mathematical analysis and technological applications to carry out processes from design ideas to actual product output (Fan et al., 2021). This provides students with opportunities and experiences in applying interdisciplinary knowledge through a variety of instructional models, such as project-based and contextual learning (Han et al., 2015; Sevian et al., 2018), thereby creating opportunities for students to form key knowledge and skills for 21st-century citizens (Fajrina et al., 2020). Therefore, Vietnam's STEM education policies need to pay more attention to developing primary school teachers' cognitive capacity related to engineering elements through establishing learning activities and encouraging their participation.

4.2 Increase Vietnamese primary teachers' confidence in implementing integrated STEM teaching

This study also shows that Vietnamese primary school teachers' confidence level in implementing STEM teaching in the classroom is low. The reason may be because: 1) Vietnamese teachers face many challenges in interdisciplinary knowledge, encountering conflicts between the limitations of the practical teaching context and the expectations of effective STEM implementation (Lam, 2021); 2) Vietnam's educational programme does not have STEM subjects and lacks flexibility, so teachers who want to teach STEM need to adjust the educational programme and time to implement appropriate STEM content (Bien et al., 2019); 3) Math, Science and Technology subjects in the Vietnamese primary school curriculum are not integrated but are taught separately. Teaching STEM is not mandatory but teachers are encouraged to integrate this into experiential activities or in some of the above subjects. Teachers, thus, tend to avoid teaching STEM, leading to a lack of confidence (Ministry of Education and Training, 2018). According to Bencze (2010), elementary teachers with little or no professional development in STEM education will lead to a lack of knowledge about STEM content. A lack of training in organising STEM-integrated teaching also leads to teachers' low confidence in STEM-integrated teaching (Czajka & McConnell, 2016); therefore, teachers appear reluctant to implement integrated STEM education (Toma & Greca, 2018). This finding reaffirms previous research on a significant and favourable relationship between teachers' confidence in teaching STEM subjects and their understanding of the subject matter (Docherty-Skippen et al., 2020; Nadelson et al., 2013; Skamp & Mueller, 2001; Yasar et al., 2006). According to Nadelson et al. (2009), elementary school teachers are limited in their knowledge, effectiveness, and confidence when teaching STEM content because they are only required to complete minimal individual science and math courses. Meanwhile, teachers' confidence is an important factor determining the effectiveness of integrated STEM teaching (Nikolopoulou & Tsimperidis, 2023). Focusing on and enhancing professional development through training sessions (English, 2016; Marginson et al., 2013) can fully equip teachers with knowledge and skills in organising STEM teaching and assessment (Guzey et al., 2014). This contributes to the success of implementing this type of integrated curriculum in the classroom (Laboy, 2011) and increases teachers' confidence in teaching STEM.

4.3 The differences in educational level and working regions of Vietnamese primary school teachers regarding STEM teaching

This study shows that the more qualified elementary school teachers are, the greater their awareness and confidence in STEM teaching. This result confirmed research by Khuyen et al. (2020) that there is a statistical difference in STEM teaching awareness of teachers in different educational level groups. This is reasonable, because the more highly qualified a teacher is, the more specialised their professional knowledge and pedagogical skills related to teaching organisation are. This good preparation leads to an increase in their confidence compared to teachers with fewer qualifications. Some teachers realise they can gain abilities they did not think they had before they obtained their master's degree (Wang et al., 2011).

Primary school teachers' awareness and confidence in STEM teaching also gradually increase according to their working area, from the highlands to rural and urban areas, respectively. This may be because Vietnam's educational universities, which regularly organise conferences and seminars related to educational solutions and innovations, are concentrated in urban areas. Because elementary teachers in urban schools have more opportunities to access and develop expertise related to STEM teaching, urban teachers have higher awareness and confidence than other regions. On the contrary, rural areas and the highlands do not offer the same convenience as urban areas, and transport is even more inconvenient. Therefore, teachers in these regions do not have regular access or have slower access to educational innovation issues. As a result, their awareness and confidence are lower than urban teachers. Tao's research also confirms that differences in teachers' teaching areas affect their confidence in implementing STEM education. This is also because urban areas have richer educational and academic resources, a developed economy and more convenient transportation than other areas. Therefore, the educational improvements were often first implemented in urban schools (Tao, 2019).

The results of this study show that Vietnam needs to have specific STEM policies, focus more on developing STEM capacity for primary school teachers, especially teachers in rural and highland areas, and equitably ensure the quality of STEM teaching by teachers in different regions.

5. Limitations

The survey was conducted among 148 teachers, a notably small fraction compared to the extensive population of approximately 400,000 primary school teachers. Moreover, the sample predominantly focused on the Central Highlands of Vietnam, lacking representation from both North and South Vietnam, which limits the generalisability of the findings. Although the study attempted to include teachers with diverse qualifications, teaching experience, and regional backgrounds, the limited sample size remains a significant constraint. Future studies should consider widening the survey's scope by including more varied geographical regions, demographics, and a larger number of primary school teacher participants to enhance the comprehensiveness and reliability of the results

The scale surveying elementary school teachers' awareness and confidence in STEM-integrated teaching has adequate reliability and validity, but this scale restricts the teachers' answer information. However, this study has provided a preliminary view of the current state of awareness and confidence of Vietnamese primary school teachers towards STEM-integrated teaching, providing useful information for the country and researchers in finding ways to develop STEM-integrated teaching competencies for primary school teachers.

6. Conclusions and Implications

Research showed that Vietnamese primary school teachers had a relatively good awareness of STEM-integrated teaching, but their confidence in the implementation of STEM-integrated teaching was low. The more qualified teachers, working in urban areas, were, the higher their awareness and confidence about STEM-integrated teaching compared to teachers with lower-level qualifications working in other regions. Meanwhile, the gender and seniority factors of teachers did not affect their awareness and confidence about STEM-integrated teaching in primary schools.

Our findings provide a rationale for continuing research to improve the awareness, confidence and effectiveness of primary school teachers in implementing STEM-integrated teaching. To overcome the challenge related to low confidence, as well as continue to raise the awareness of teachers about the implementation of STEM-integrated teaching in a period when Vietnam is implementing a new general educational curriculum, first of all, Vietnam needs to research and complete STEM teaching materials, effectively organise training programmes, and conduct multi-stage training to develop STEM-integrated teaching capacity for teachers in all localities. In addition, STEM learning modules need to be included in the bachelor's degree in pedagogy, to develop students' capacity for STEM-integrated teaching after graduation.

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Appendix 1: Mean score of primary school teacher's awareness about STEM-integrated teaching

	N	Minimum	Maximum	Mean	Std. Deviation
I would like to be able to teach my students to understand the role and impact of STEM	148	2.00	4.00	3.02	0.60
I would like to be able to teach my students to understand the science underlying STEM	148	2.00	4.00	2.50	0.62
I would like to be able to teach my students to understand the design process	148	2.00	4.00	2.29	0.47
I would like to be able to teach my students to understand the types of problems to which STEM can be applied	148	2.00	4.00	2.68	0.62
My motivation for teaching science is to promote an understanding of how STEM affects society	148	2.00	5.00	3.33	0.61
I am interested in learning more about STEM through training courses	148	2.00	5.00	3.51	0.61
I would like to be able to teach my students to understand the process of communicating technical information	148	2.00	4.00	2.69	0.59
My motivation for teaching science is to prepare learners for the world of work	148	2.00	5.00	3.52	0.67
My motivation for teaching science is to motivate learners to learn	148	3.00	5.00	3.29	0.60
I believe that STEM should be integrated into the curriculum	148	2.00	5.00	3.66	0.70
I am interested in learning more about STEM through workshops	148	3.00	5.00	3.64	0.67
I am interested in learning more about STEM through college training courses	148	3.00	5.00	3.44	0.59
Using engineering to develop new technologies in the science curriculum is important	148	2.00	5.00	3.50	0.68
I am interested in learning more about STEM through peer training	148	2.00	5.00	3.57	0.66
My motivation for teaching science is to develop learners' understanding of the technical world	148	2.00	4.00	3.18	0.60
My motivation for teaching science is to educate scientists, engineers and technologists for industry	148	2.00	5.00	3.28	0.69
Planning the implementation of the project in teaching science is important	148	2.00	5.00	3.56	0.72
Educating for pre-service teachers about STEM-integrated teaching is important	148	2.00	5.00	3.58	0.65
Awareness	148	2.72	4.22	3.23	0.33
Valid N (listwise)	148				

Appendix 2. Mean score of primary school teachers' confidence about STEM-integrated teaching

	N	Minimum	Maximum	Mean	Std. Deviation
I am familiar with STEM	148	1.00	4.00	2.70	0.76
I regularly attended a separate STEM course outside of the programme of the programme before teaching	148	1.00	5.00	2.59	0.86
I feel confident about more STEM integration into the curriculum	148	1.00	5.00	2.50	0.83
Teachers' lack of knowledge is a barrier to integrating STEM into the curriculum	148	1.00	5.00	2.60	0.78
My previous curriculum effectively supported my ability to teach STEM-integrated learning at the start of the career	148	1.00	5.00	2.56	0.75
My previous curriculum demonstrated STEM integration	148	1.00	5.00	2.50	0.75
Lack of training is a barrier to STEM integration	148	1.00	5.00	2.57	0.77
I use STEM in classroom activities	148	1.00	4.00	2.38	0.76
Lack of time for teachers to learn about STEM integration is a barrier in STEM teaching	148	1.00	5.00	2.37	0.77
I find the standards of traditional science relevant to STEM	148	1.00	5.00	2.52	0.75
Lack of support from management is a barrier to STEM integration	148	1.00	5.00	2.52	0.82
My school supports STEM integration	148	1.00	4.00	2.53	0.74
Confidence	148	1.17	3.67	2.53	0.50
Valid N (listwise)	148				