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CURRENT SITUATION OF PRIMARY SCHOOL TEACHERS' INTEGRATED STEM TEACHING COMPETENCE: AN EXPLORATORY STUDY IN THE NORTHERN MOUNTAINOUS PROVINCES OF VIETNAM

N. P. Thao[1,2], L. T. T. Huong[3], N. V. Dinh[4,5], N. T. T. Hang[6], C. V. Quyen[7], L. M. Cuong*[8], T. T. P. Thao[3]

[1]An Giang University, An Giang, Vietnam
[2]Vietnam National University Ho Chi Minh City, Vietnam
[3]Thai Nguyen University of Education, Thai Nguyen, Vietnam
[4]Culture School - Training Department, Ministry of Public Security, Thai Nguyen, Vietnam
[5]VNU University of Education, Vietnam National University, Hanoi, Vietnam
[6]Thai Nguyen University of Agriculture and Forestry, Thai Nguyen University, Thai Nguyen, Vietnam
[7]Hanoi Pedagogical University 2, Vinh Phuc, Vietnam
[8]Dong Thap University, Dong Thap, Vietnam

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ABSTRACT

STEM educational orientation originating in the United States nearly two decades ago has been researched by many educators in many different aspects, including the requirements of teachers' competence to teach STEM. However, STEM education has only been officially implemented on a large scale in high schools since 2019 in Vietnam. Therefore, research on STEM education and STEM teaching competence, in general, is currently a research direction of interest. This research aims to determine the current situation of integrated STEM teaching competence and participation in training for integrated STEM teaching of primary school teachers in the northern mountainous region of Vietnam. This research used a quantitative approach with an online survey of 2,416 primary school teachers in the Northern mountainous region of Vietnam, then eliminated invalid survey questionnaires and 2,305 questionnaires included in the analysis. The results of the data analysis show that teachers participate in training courses on STEM education. However, the implementation of STEM education in the Northern mountainous region of Vietnam still has many limitations, with the clear differences in affective characteristics and instructional skills between men and women; in which teachers with less than five years of experience have better integrated STEM teaching competence, which gradually decreases for older teachers; integrated STEM teaching competence also has clear differences between working areas. Based on these results, the authors propose several training and support strategies for teachers to implement STEM in teaching in the Northern mountainous region of Vietnam.

Keywords: integrated STEM competence; primary school teachers; STEM; Vietnam

INTRODUCTION

Originating in the United States nearly two decades ago, STEM educational orientation is considered a breakthrough educational reform in the United States to firmly establish the position of the world's leading nation in economy, science, and technology with quality labor resources in the fields of STEM (Friedman, 2005; Brown, 2012; Mizell & Brown, 2016; Committee on STEM Education, 2018; Yang & Ball, 2022). Subsequently, research on STEM education has attracted the attention of many educators (Ha

***Correspondence Address**
E-mail: lmcuong@dthu.edu.vn

et al., 2020; Huong et al., 2021; Aldeia & Nisa, 2023; Ali & Tse, 2023; Phuong et al., 2023).

In Vietnam, STEM education has been included in the written instructions for implementing secondary education tasks by the Vietnam Ministry of Education and Training (MoET) since the 2015 school year. Since then, it has continued to direct localities in the country to integrate STEM into the educational programs at schools (Vietnam Ministry of Education and Training, 2014). An official document providing guidelines for establishing and supervising STEM education programs in secondary education was released by MoET in 2019 (Vietnam Ministry of Education and Training, 2020a). The forms of STEM education organization proposed in this official correspondence include (1) teaching STEM-based science subjects, (2) organizing experiential STEM activities, and (3) organizing scientific and technological research activities. Implementing these forms will help students access and apply scientific knowledge into practice, improving their ability to approach Industry 4.0 and contributing to the country's development. However, many Vietnamese teachers still have difficulty organizing content and topics in a way that meets the requirements of the curriculum framework and promotes students' creativity. Currently, there are still no specific instructions on STEM topics in subjects/fields of study to facilitate teachers in organizing their teaching in the student curriculum in Vietnam (To Khuyen et al., 2020; Le et al., 2021; Nguyen & Bui, 2023).

The teaching staff is essential in determining the quality of teaching in general and integrated STEM teaching in primary schools (So et al., 2019; Martínez-Borreguero et al., 2022; Uștu, 2022). The role and awareness of teachers in successfully implementing STEM educational activities have been confirmed explicitly through many studies (Bell, 2016; Al Salami et al., 2017; Margot & Kettler, 2019). Previous research has also confirmed the relationship between teacher preparation to teach STEM and student achievement in STEM fields (Nadelson et al., 2013). Therefore, teachers' STEM-integrated teaching competency, as well as the factors affecting this capacity, have received attention from many studies (Kurup et al., 2019; Song, 2020; Thuy et al., 2020; Cheng & Yeh, 2022; Romero-Rodríguez et al., 2023). Nevertheless, prior studies have demonstrated that STEM education research in Asia is still in its infancy (Lee et al., 2019), and there is less research on the availability of Asian teachers' readiness to implement STEM. In Asia, there has not been much research on the readiness to teach STEM integration of teachers in mountainous areas, where economic and social conditions are still challenging.

In Vietnam, several studies have also explored issues related to STEM education in general and teachers' STEM-integrated teaching competency in particular. These studies mainly discuss the teaching competency framework in general and integrated STEM teaching in particular (Thuy et al., 2020; Trang et al., 2020; An et al., 2021), difficulties, obstacles, perceptions of teachers in implementing STEM education (Phan et al., 2023; Duy et al., 2023), developing STEM teaching competence for teachers (Thuy et al., 2020; Em, 2021; Nguyen & Bui, 2023), and awareness and confidence of Vietnamese primary school teachers towards STEM integrated teaching approach Phan et al., 2023). There have also been studies on the teaching skills of primary school teachers, but these studies were implemented in large cities with developed socio-economic conditions Le & Bui, (2021).). Retraining activities to improve teaching competence for primary school teachers are also implemented in Vietnam in various forms (Duc et al., 2022).

However, more research is required on the current situation of integrated STEM teaching competence of primary school teachers to have appropriate suggestions and recommendations for developing integrated STEM teaching competence for primary school teachers, which contributes to the development of STEM education in Vietnam in particular. There are no studies on teachers' readiness to implement STEM education in mountainous provinces, where education still faces difficulties due to complex natural conditions, remote lands, sparse population chopping boards, and diverse ethnic cultures. Information investigating differences in teachers' STEM-integrated teaching competencies based on factors such as gender, teaching experience, and workplace can play an essential role in developing and implementing teacher training strategies. Based on information about differences in teaching competencies, teacher training and development programs can be customized to meet the specific needs of each group of teachers. For example, training courses may help new teachers gain more experience grasping effective STEM teaching methods. In contrast, other training courses may focus on developing advanced skills for teachers with extensive experience.

This research aims to conduct initial surveys to see the relationship between the integrated STEM teaching experience and participation in the training on integrated STEM teaching of pri-

mary school teachers in the Northern mountainous region of Vietnam. This also intends to answer the following questions: What is the level of STEM-integrated teaching competency of primary school teachers in the northern mountainous region of Vietnam? Are they ready to implement STEM teaching in schools? Is there any difference in integrated STEM teaching competence between male and female teachers? Is there any difference in integrated STEM teaching competence between teachers in urban, rural, or mountainous regions? Is there any difference in integrated STEM teaching competence between teachers of different seniorities? From there, some recommendations and suggestions are made for developing integrated STEM teaching competence for primary school teachers in the Northern mountainous region of Vietnam.

There are many different concepts about integrated STEM teaching. Sanders (2009) defines integrated STEM education as 'approaches that explore teaching and learning between/among any two or more STEM subject areas, and between a STEM subject and one or more other school subjects'. Moore et al. (2014) characterize integrated STEM education as 'an effort to combine some or all of the four disciplines of science, technology, engineering, and mathematics into one class, unit, or lesson based on connections between the subjects and real-world problems'. Although contexts may originate from different STEM subjects, integrated STEM curriculum models can feature STEM content learning objectives focusing mainly on one subject (Moore et al., 2014; Ling et al., 2019). According to Kelley and Knowles (2016), integrated STEM education refers to the approach to teaching STEM content of two or more STEM domains while enforcing STEM practices in a real-world setting to enhance student learning. It can be understood that STEM interactive teaching is an approach to interactive teaching between two or four fields, including Science, Technology, Engineering, and Mathematics, with an active and experiential learning orientation to practice and develop STEM skills and core skills for learners.

Teachers are considered a crucial factor influencing the success of many educational reforms such as integrated STEM education (Keiler, 2018; Stohlmann et al., 2012). STEM teachers must not only grasp the topic they teach but also be able to communicate concepts and processes to create effective STEM teaching. Furthermore, teachers must become proficient with technology to show how fascinating integrated STEM education is (Khairani, 2016; Spyropoulou & Kameas, 2020; Lo, 2021). Especially for young learners, STEM learning is only truly effective if teachers adapt their pedagogical strategies appropriately (Nadelson et al., 2013; Leung, 2023).

However, the authors acknowledge that integrated STEM education teaching approaches still have limits. The proposed STEM teaching approach may not be possible in all circumstances and may limit the content covered. Some of the required knowledge in science and mathematics that is theoretically focused may not provide authentic engineering design applications, and standard STEM practices are limited by current technology (Kelley & Knowles, 2016).

Song (2017) synthesizes the literature and uses behavioural event interviewing techniques and qualitative data collected from 11 superior and average teachers. The study shows that the critical items of the three teacher competence areas are as follows: 1) teachers' knowledge of other STEM subjects and ability to make connections between other subjects; 2) student-centred activities and project-based curriculum; 3) communication and collaboration among teachers and willingness and enthusiasm for the integrated STEM domain. Based on these findings, Song (2017, 2020) builds an integrated STEM teaching competence structure that includes three component competencies: cognitive characteristics, instructional skills, and affective characteristics. At the same time, 21 elements of 3 component competencies were identified (see Figure 1).

In Vietnam, there have also been several authors interested in and mentioned teaching competence, integrated teaching competence in general, and integrated STEM teaching competence. Hung (2016) proposes that teaching competence in vocational education includes four components: teaching design competence, teaching implementation competence, teaching assessment competence, and instructional management competence, and identifies 15 elements of 4 component competencies. The elements in the competence of the instructional management component overlap and have the functions of the remaining three component competencies (Thuy et al., 2020). Cao & Đinh (2019). suggest an integrated teaching competency structure for Chemistry students, including three component competencies: general cognitive competence for integrated teaching, competence for designing and organizing integrated teaching activities, and competence for testing and evaluating integrated teaching and identify 9 criteria of 3 component competencies; but some criteria are not specific and do not fully address integrated teaching com-

petence. Trang et al. (2020), using the literature review and expert methods, demonstrate an integrated STEM teaching competence framework for Chemistry pedagogy students consisting of four component competencies and eight indicative behaviours. In particular, the component competencies include (1) general cognitive competence in integrated STEM teaching, (2) competence in designing STEM education topics in teaching Chemistry, (3) competence in conducting STEM education teaching, and (4) competency-based test and evaluation in teaching integrated STEM topics. Thuy et al. (2020), based on the synthesis of studies of Cao & Đinh (2019), Hung (2016), and Song (2017), offer an integrated STEM teaching competency framework including 4 components: cognitive competence of STEM education, competence to design STEM teaching plans, competence to implement STEM teaching plans, and competence to evaluate and adjust STEM teaching plans (Thuy et al., 2020).

In this study, we used Song's (2017, 2020) research results to analyze the current state of teacher competency for integrated STEM in primary school teachers in Northern Vietnam.

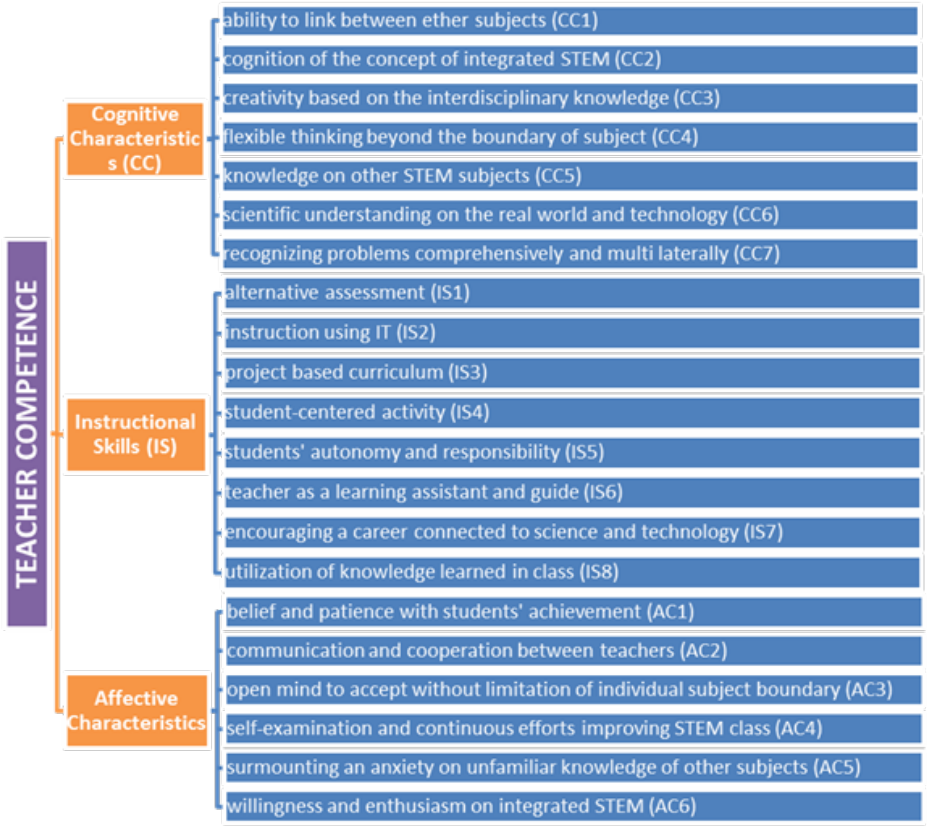

Figure 1. Structure of Teacher Competence for Integrated STEM (Song, 2017, 2020)

METHODS

To find out the current situation of teachers' integrated STEM teaching in Vietnamese primary schools, in this study, the authors designed and used a survey tool with 02 main content parts: Part 1 includes 8 questions about some general information about the subjects, including gender, seniority, qualification, working area, type of school, subjects of teaching, participation in STEM training activities, STEM teaching experience; Part 2 includes 21 questions using a 5-point Likert scale (from 1 - incomplete to 5 – successfully complete) to evaluate teachers' implementation of integrated STEM teaching through groups of cognitive expression, instructional skill expression, and affective expression of integrated STEM teaching competence. These questions were developed based on teacher competency for integrated STEM, as proposed by Song (2017, 2020). The component competencies were translated from English into Vietnamese, and the back translation method was used to ensure the equivalence of the meanings of items. Before conducting the official survey, pilot interviews were conducted with 20 primary school teachers in Thai Nguyen, Vietnam, to test the meaning and understandability of the questionnaire. After receiving comments

from the pilot test, we reviewed and adjusted to obtain a final questionnaire.

The survey subjects were teachers at primary schools in the Northern mountainous region of Vietnam. To ensure that the survey had wide coverage but was still representative, the study selected subjects according to the stratified method, according to clusters, specifically (1) selected according to the area where teachers work (including the mountainous region, rural area, urban area); (2) chose by type of school (including public schools and private schools); (3) geographical location (the Northern mountainous region of Vietnam). After determining the survey subjects, the questionnaire online using Google Forms was sent. The survey implementation time was three weeks (from August 22, 2023 to September 11, 2023).

The study received 2,416 responses. After cleaning and removing forms filled in with missing information or incorrect options not included in the survey form, the study received 2,305 qualified responses for data analysis. Data were coded and entered into Excel and SPSS 26 software to analyze the results. Data analysis techniques mainly used descriptive statistics. In addition, to test the difference in integrated STEM teaching competence by gender and working areas, we used the T-Test and the One-way ANOVA technique (Mishra et al., 2019).

RESULTS AND DISCUSSION

According to the results shown in Figure 2, the number of teachers surveyed is unequal in gender. Specifically, of a total of 2,305 survey forms, only 10.2% of the forms were answered by male teachers, and the remaining 89.8% were answered by female teachers. This is one of the basic characteristics of pedagogical profession selection in Vietnam, in which women always make up the majority of human resources in the pedagogical field, especially primary school pedagogy (Vietnam Ministry of Education and Training, 2020b).

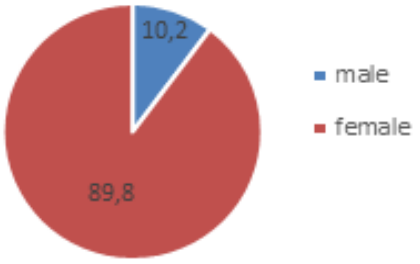

Figure 2. Statistics on the Number of Teachers by Gender (Percentage)

Regarding seniority, Figure 3 shows that the number of teachers with over 20 years of experience accounts for the majority (54.1%); The number of teachers with less than 5 years of experience is only about 15.8%.

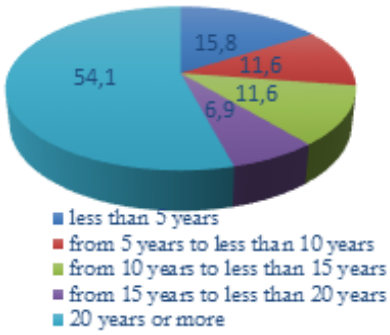

Figure 3. Statistics on the Number of Teachers by Seniority (Percentage)

Table 1 shows information about the research subjects, including the number of teachers according to the work areas and the type of school where the teachers work. The number of public schools is 89.9%, consistent with school models in Vietnam. Because the study focuses on the Northern mountainous region of Vietnam, the number of schools surveyed in the mountainous region is relatively high, namely 61.6%.

Table 1. General Information about the Research Subjects

General information		Number	Percentage
Type of school where teachers are working in	Regular public school	2,072	89.9
	Public school for ethnic students	208	9
	Domestic private school	24	1
	Private schools with foreign elements	1	0
Working place/ area	Urban area	255	11.1
	Rural area	630	27.3
	Mountainous region	1,420	61.6

To collect more information about teachers' STEM teaching experiences and participation in STEM training courses in primary schools, the study used two survey questionnaires on times of teaching STEM and participation in STEM training courses. The results obtained can be seen in Table 2.

Table 2. Teachers' STEM Teaching Experience and Participation in STEM Training

STEM teaching experience	Participation in STEM training						Total	
	Never		Participation in training session(s)/ course(s) (theory only)		Participation in training sessions/ courses (including theory and practice)			
	Number	%	Number	%	Number	%	Number	%
Never directly taught before	269	25.0	381	35.4	425	39.5	1,075	100
Have taught 1-2 times	46	5.4	224	26.4	578	68.2	848	100
Have taught 2-4 times	5	2.3	36	16.2	181	81.5	222	100
Have taught 5 times or more	4	2.5	17	10.6	139	86.9	160	100
Total	324	14.1	658	28.5	1,323	57.4	2,305	100

The number of teachers participating in STEM training (only theory or including both theory and practice) is 1,981 teachers (accounting for 85.9% of the number of teachers surveyed). This accurately reflects the current situation of organizing training and improving qualifications in integrated STEM teaching for primary school teachers in Vietnam in recent years. Starting from 2019, training programs have been organized in many different plans, leading to many teachers being trained to innovate and update the curriculum, which increases gradually every year.

However, among the 1,981 teachers trained to teach STEM, up to 40.6% of teachers have never directly taught STEM, and only 156 teachers (accounting for 7.9%) have taught 5 times or more. Additionally, among the 1,075 teachers who have never directly taught STEM, up to 74.9% of the teachers have participated in training (or only theory 35.4%, or both theory and practice 39.5%). This means they have participated in training courses, though most teachers have not applied it or applied it very limitedly in an offline classroom.

Concerning this information on the experience of STEM teaching and participation in STEM training according to the seniority of teachers, Table 3 shows specific results as follows: Among the total number of teachers surveyed, teachers with seniority with 20 years or more have participated in training the most (accounting for 48.7% of the total number of teachers surveyed; 90% of the teachers with 20 years or more of experience have participated in STEM training). However, the participation of this group in implementing STEM education in schools is still limited, in which 514 teachers (approximately 41.2%) have never directly taught STEM, 494 teachers (accounting for 39.6%) have only just taught STEM 1 to 2 times, the number who taught 5 or more only accounted for 8.4% (105 of 1,248 teachers). With 364 young teachers with less than 5 years of experience, 237 teachers who have never directly taught STEM are quite large, accounting for 65.1%. However, it can also be explained by the fact that among the 364 teachers, the number who have not been trained to teach STEM accounts for 29.4% (107 of 364 teachers), while the number of untrained teachers with more than 5 years of experience is only 11.2%.

Looking at the information about the STEM teaching experience and participation in STEM training by the teachers' working place/ area, from Table 3 we can see that the percentage of teachers who have participated in training STEM teaching in the three areas is nearly equal (86.7% in urban areas, 86.2% in the rural areas, 85.7% in the mountainous region). This explains and confirms that efforts to implement training and increase teacher qualifications for STEM education in Vietnam are being accomplished synchronously across areas. However, the number of teachers who have never directly taught STEM is quite large, 1,075 out of 2,305 teachers (accounting for 46.6% of the total number of teachers surveyed), in order from the mountainous region (accounting for 56%), the rural areas (accounting for 35.4%), and the urban areas (accounting for 8.6%). In case of the proportion of teachers in each region considered, the mountainous region has 602 out of 1,420 teachers (accounting for 42.4% of the total teachers in the mountainous region), the rural area has 381 out of 630 teachers (accounting for 60.5% of the total

teachers in the rural areas), 92 out of 255 teachers are in the urban areas (accounting for 36.1% of the total teachers in the urban areas). Therefore, regarding the proportion of teachers who have not directly taught STEM, teachers in urban areas have the lowest number/proportion. This result can be explained by the greater convenience of facilities, interest of students and parents, and other factors in STEM education in urban areas than in rural areas and mountainous regions. This is also a prerequisite for teachers to better implement STEM educational activities. This is also similar to studies in Malaysia conducted by Abdullah et al. (2015) and Khairani (2016).

Table 3. Number of Teachers with STEM Teaching Experience and Participating in STEM Training by Seniority and Working Area

		By seniority						By working area			
		Less than 5 years	**From 5 to less than 10 years**	**From 10 to less than 15 years**	**From 15 to less than 20 years**	**From 20 years or more**	**Total**	**Urban area**	**Rural area**	**Mountainous region**	**Total**
Participation in STEM training	Never	107	34	27	31	125	324	34	87	203	324
	Participate in training session(s)/ course(s)	257	233	240	128	1,123	1,981	221	543	1,217	1,981
	Total	364	267	267	159	1,248	2,305	255	630	1,420	2,305
STEM teaching experience	Never taught directly	237	130	125	69	514	1,075	92	381	602	1,075
	Have taught	127	137	142	90	734	1230	163	249	818	1,230
	Total	364	267	267	159	1,248	2,305	255	630	1,420	2,305

Integrated STEM teaching competence is demonstrated through 3 characteristics, including cognitive characteristics (CC), instructional skills (IS), and affective characteristics (AC). Each characteristic is analyzed based on 6 to 8 items. The three characteristics of integrated STEM teaching competence, as described in Figure 4, are all evaluated by teachers as fully implemented, and the differences in the characteristics are not too large. However, it is implemented best and most effectively for teachers with less than 5 years of experience, and such exemplary implementation and effectiveness are gradually reduced for teachers with greater seniority. This result is consistent with the context in which STEM teaching has been officially implemented in Vietnam since 2019. Since then, teacher training schools have added subjects, topics, and extracurricular activities for teachers so that they can understand and implement integrated STEM teaching. Therefore, young teachers (with less than 5 years of experience) are more professionally trained, leading to their integrated STEM teaching competence, which may be better than other subjects. Integrated STEM teaching requires teachers to change teaching methods and techniques, elaborate lesson content preparation, and so on. Therefore, young teachers also have the advantage of changing themselves compared to older teachers.

Affective characteristics (AC) perform most effectively at all ages, followed by instructional skills characteristics (IS) and finally cognitive characteristics (CC). This result is also similar to the previous research on instructional skills, student-centred and project-based instructional methods in general: Affective characteristics, communication, cooperation between teachers, and teachers' enthusiasm and willingness in convergence education are considered the most critical factors (Song, 2017).

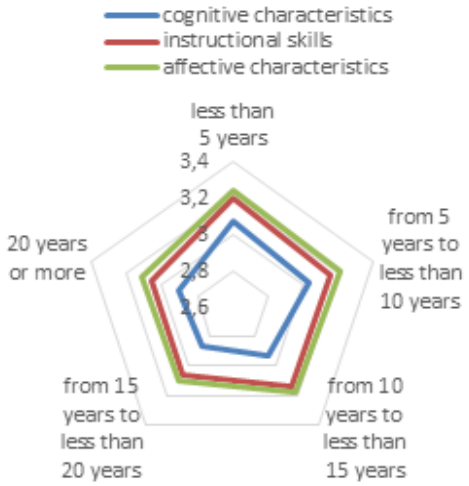

Figure 4. Integrated STEM Teaching Competence by Teachers' Seniority

Is there any difference in integrated STEM teaching competence between male and female teachers? Are there any differences between teachers in urban, rural, or mountainous areas? Are there any differences between teachers with different seniority or not? To answer those questions, the results of the T-Test and the One-way ANOVA difference test of items by gender, seniority, and working place of teachers are shown in Table 5.

Table 5. T-Test and One way ANOVA Test Results of Items by Gender, Seniority, and Working Place of Teachers

Items	T-test by gender	ANOVA test by seniority	ANOVA test by working place
	Sig. T-test	sig.ANOVA/Welch	sig.ANOVA/Welch
CC1	0.006	0.000	0.000
CC2	0.000	0.001	0.000
CC3	0.025	0.000	0.000
CC4	0.421	0.000	0.000
CC5	0.103	0.000	0.000
CC6	0.098	0.001	0.000
CC7	0.145	0.001	0.000
IS1	0.001	0.000	0.000
IS2	0.250	0.000	0.000
IS3	0.013	0.000	0.000
IS4	0.000	0.022	0.000
IS5	0.000	0.023	0.000
IS6	0.002	0.218	0.000
IS7	0.012	0.000	0.000
IS8	0.001	0.096	0.000
AC1	0.001	0.009	0.001
AC2	0.002	0.000	0.000
AC3	0.012	0.849	0.000
AC4	0.003	0.003	0.000
AC5	0.001	0.002	0.000
AC6	0.000	0.005	0.000

By gender, all items of affective characteristics (AC) show clear differences (sig values are all less than 0.05). Regarding cognitive characteristics (CC), items including CC1, CC2, CC3, and CC5 have gender differences; the remaining CC4 (Flexible thinking beyond the boundary of the subject), CC6 (Scientific understanding of the real world and technology), and CC7 (Recognizing problems comprehensively and multi laterally) have no differences between male and female teachers (sig values are all greater than 0.05). Regarding instructional skills (IS), all items show gender differences except for item IS2 (Teachers can instruct using IT) (sig value greater than 0.05). In addition, based on the mean value between men and women, it shows that women teachers have better integrated STEM teaching competence than men.

By seniority, all cognitive characteristics have sig values less than 0.05, so there are clear differences between ages and seniority. Regarding instructional skills and affective characteristics, there are also differences, except item IS6 (Teachers act as a learning assistant and guide), IS8 (Utilization of knowledge learned in class), and AC3 (Open mind to accept without limitation of individual subject boundary) have sig values greater than 0.05, showing no difference between ages and seniority.

According to the working place/area, all items of 03 characteristics of integrated STEM teaching competence have sig values of less than 0.05, showing a clear difference between the three working areas, in which the urban areas are better than the rural and mountainous areas.

CONCLUSION

In Vietnam, STEM education was officially implemented in schools in 2019. Like other developing countries, Vietnam inherits STEM teaching models that are implemented effectively in developed countries. The effectiveness of bringing STEM education into schools is highly dependent on the competence of STEM teachers. However, due to the novelty of STEM education in primary schools in Vietnam, teachers with non-STEM-related backgrounds are sometimes asked to teach STEM in primary schools. Therefore, teacher training activities to improve integrated STEM teaching competence have been implemented in different forms in Vietnam for many years.

This study conducted initial surveys to see the relationship between the experience of integrated STEM teaching and primary school teachers' participation in training on integrated STEM teaching in the Northern mountainous region of Vietnam. Research results show that participation in STEM education training programs is relatively high. However, the implementation of STEM education in primary schools in the Northern mountainous region of Vietnam still has a low proportion. Research results also show apparent differences in affective characteristics and instructional skills between men and women, and such characteristics and skills of female teachers are better than those of male teachers. The age difference is also shown in the research results. Teachers with less than five years of experience also have better integrated STEM teaching competency, which gradually decreases with older teachers. Besides, teachers' integrated STEM teaching competence in urban areas is better than in rural and mountainous areas. These results are informative and can guide future strategies to support teachers' implementation of STEM education. The article presents research results, practical strategies, and recommendations to support teachers in improving their integrated STEM teaching competency. This application-focused approach helps bridge the gap between research and practice.

Through some initial results, we have some recommendations for developing STEM teacher competence in Vietnam in particular, as well as developing countries with similar educational backgrounds to Vietnam: (1) Strengthen STEM training for teachers: Provide training and coaching programs related to STEM education for teachers of all ages and working areas. This can help improve STEM teaching competence and help teachers become more confident in applying STEM in teaching. The most effective form of training (to help teachers confidently carry out STEM activities at school) includes theory and practice; (2) Support for young teachers: Special support for new teachers or teachers with less than five years of experience to help them develop their STEM teaching competence. This can include creating mentorship programs or workshops so that they can share their experiences with more experienced teachers; (3) Customized training based on region/area: Consider specific training and support for teachers based on their work area (urban area, rural area, mountainous region) to ensure that teachers understand how to apply STEM in their specific contexts.

These results may help improve STEM education in the Northern mountainous region of Vietnam and create appropriate training and support strategies for teachers applying STEM in

teaching. This initial research result can suggest many directions for further research in the STEM education domain in the Northern mountainous region of Vietnam, such as more research to gain a deeper understanding of the causes and specific factors that affect the implementation of STEM in schools in the Northern mountainous region of Vietnam to make more specific recommendations to improve the STEM's teaching and learning situation.

This study has the following limitations: Conducting the online survey may limit participation by teachers with limited internet access or technology proficiency, potentially introducing bias in the sample. Additionally, research that relies on self-reported data through surveys may be susceptible to response biases, such as social desirability bias or recall problems memory (memory recall issues). The study primarily focuses on quantifying the current situation without delving into qualitative aspects or providing detailed explanations of observed differences in capabilities based on demographics.

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