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PRIMARY TEACHERS' READINESS OF TEACHING STEM - A STUDY AT THE NORTH MOUNTAINOUS IN VIETNAM

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ABSTRACT

STEM education is becoming more and more popular in the world. Vietnam has been performing STEM education in K-12 schools since 2014. However, many teachers have difficulty in teaching STEM, especially in the Northern mountainous area of Vietnam. This study aims to investigate the readiness of primary school teachers for STEM teaching. This research was conducted using a descriptive quantitative method. Data was collected through a survey of 380 primary school teachers in the Northern mountainous area of Vietnam. There are fifteen indicators to measure teacher readiness in teaching STEM. Respondents stated that they were less available to identify learning outcomes and were less prepared in designing learning content of STEM themes. They also have an insufficient understanding of STEM education and related disciplines, and they have additional challenges in deciding the process, planning instructional activities, creating educational facilities, and learning to evaluate student activities. In addition, they were having difficulty identifying STEM themes, designing learning activities, utilizing materials, communicating, and cooperating with students and other instructors. Despite their strong demands and conviction in students' abilities, they were hesitant to teach STEM. The findings suggested that these instructors were not entirely prepared to teach STEM. It is beneficial for elementary school administrators who are adopting STEM in Vietnam.

KEYWORDS: teaching STEM, teachers' readiness, the Northern mountainous of Vietnam, Primary school teachers

INTRODUCTION

We are living in the era of technology. The 4.0 revolution has had a strong impact on all areas of social life. STEM education is an important direction – which will affect the development of a country in this context (Kartimi, Ari Syahidul Shidiq, 2021). The relationship between knowledge and skills of subjects is becoming a new driving force in construct creative value. To meet that trend, many educational communities have focused on STEM education (Kartimi & Ari Syahidul Shidiq, 2021; Kurup et al., 2017). STEM education has brought about drastic changes in recent decades in the world.

In Vietnam, the Ministry of Education and Training has had many projects to bring STEM education to K-12 schools since 2006s, 2007s through some activities: STEM education festival. According to T. Thanh (2019), the contest in science and technology creation for high school students..., and is implemented mainly at high schools. However, teaching STEM in primary schools has not been paid enough attention. Besides, STEM education has been mainly implemented in cities, not in mountainous and rural areas (N. C. Thanh & Son, 2019). The newest Vietnam General Education Curriculum also identifies this educational model as one of the goals of Vietnam education after 2018. It is considered as an important and effective solution to basically and comprehensive innovation Vietnam education (Ministry of Education & Training, 2018; Nguyen Si Nam & Dao Ngoc Chinh, 2018).

2. LITERATURE REVIEW

STEM Education

STEM is an acronym for Science, Technology, Engineering and Mathematics. STEM education is a curriculum that aims to educate students in the four areas of Science, Technology, Engineering and Mathematics. Instead of teaching the four subjects as separate and discrete subjects, STEM integrates them into a cohesive learning model.

STEM was developed in the 1990s by the US National Science Foundation (Thingwiangthong et al., 2021). In the United States, STEM education has become an integrated discipline that has removed the traditional barriers between various scientific disciplines. Instead, it utilizes modern tools and technologies to solve complex problems (Kelley & Knowles, 2016). Since then, several nations have incorporated and promoted STEM education, including China, Japan, Korea, Thailand, the United Kingdom, and Australia…. (Bozkurt Altan & Ercan, 2016; M. Song, 2020; Shernoff et al., 2017; Thingwiangthong et al., 2021;). STEM education in general is aimed at persuading learners to apply topic knowledge to address real challenges in all countries. STEM education has been implemented in Vietnam since 2005 through a variety of activities in high schools. Pilot programs have had a beneficial, ubiquitous, and revolutionary impact on high school teaching and learning (H. T. T. Huong, 2019; Nam et al., 2018; N. C. Thanh & Son, 2019).

In recent years, the education of ethnic minorities and mountainous areas in Vietnam has always received profound and comprehensive attention from the whole society. The quality of education in mountainous areas has steadily improved due to reasonable policies and investment (Anh, 2021; Department of Ethnic Education, 2019). Every year, the Ministry of Education and Training of Vietnam issues papers advising and supporting the formation of extracurricular clubs, including Science clubs, however they are simply workshop materials, guidelines, and recommendations (N. C. Thanh & Son, 2019). In 2018, Ha Giang executed a pilot project to educate children in rural and ethnic minority communities via educational activities called "STEM on the Move: Supporting Rural and Minority Children Advancing Through Meaningful Education Programs.". According to the project,

teachers have been identified as a key player in promoting students' engagement in science, encouraging them to ask probing questions, establishing real-life connections, and encouraging students' creative thinking (N. H. Q. Huong, 2018). Many northern mountainous provinces have continued to offer STEM education recently, but primarily at the middle school and high school levels (Linh, 2020).

Competency framework of primary school teachers

Teacher competency is a critical aspect in successfully implementing STEM education (Song, 2020). In many countries, standards of professional practice for teachers have been developed as a basis for evaluating and nurturing teachers' development. Teachers' professional standards in the United Kingdom are established by three criteria: Teaching, Personal and professional conduct (The Secretary of State for Education, 2021). In Australia, standards for teachers are divided into three areas of instruction: Professional Knowledge, Professional Practice and Professional Engagement (Australian Institute for Teaching and School Leadership, 2011). In Vietnam, in 2018, the Ministry of Education & Training (2018) issued regulations on general professional standards for high school teachers (from primary to high school) including 5 standards with 15 criterias (Ministry of Education & Training, 2018). Song (2020) presents three components of teacher competency in his research, including: cognitive characteristics (CC), instructional skills (IS) and affective characteristics (AC). Song (2020) further demonstrates that these three competences are associated to the successful implementation of STEM education. This implies that, in addition to knowledge and skills, the capacity of teachers is also governed by other factors such as trust, feeling, communication, research, lifelong learning, socio-cultural, ICT and the capacity to create a positive learning environment (GSTEP, 2005; Kunter & Baumert, 2013; M. Song, 2020; Selvi, 2010).

At the primary level, the building of a competency framework for primary school teachers has also been studied. Compared with teachers at other educational levels, primary school teachers have the advantage of teaching many subjects, so they themselves have integrated teaching capacity. Alnoor & Hongyu (2011) determined that the competencies of primary school teachers are divided into four groups: Knowledge, Teaching skills, Assessment and evaluation, Professional value and behavior. Julia et al. (2020) recognized knowledge, skill, and attitude as three critical variables for successful instructors in their study on the preparedness and teaching competence of new teachers in primary schools. (L. T. T. Huong, 2017) also presented a framework for primary school teachers in Vietnam that included ten component competences, including: Political Qualities, Ethics, Lifestyles; Communication; Teaching; Social Activities; Professional Development; Mathematical Education; Literary Education; Social Science and Natural Science Education; Life Skills Education; Art Education. Several competency frameworks exist for primary school teachers that address competencies such as knowledge, skills, and attitudes (Alnoor & Hongyu, 2011; L. T. T. Huong, 2017; Julia et al., 2020); a variety of additional competences are also highlighted, including professional competence, the ability to assess and evaluate, and the ability to teach certain subjects. (Alnoor & Hongyu, 2011; L. T. T. Huong, 2017).

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The capacity of primary school teachers to teach STEM subjects

Several authors from around the world have focused their research on STEM/STEAM education on the competencies of STEM teachers. (Kim & Kim, 2016) presented teaching ability measures for STEAM Education in seven areas: Understanding STEM subjects; Teaching methodologies; Actively active student learning activities; Learner understanding; Creating an effective learning environment; Teacher Evaluation and Qualifications. (Kartimi & Ari Syahidul Shidiq, 2021) propose that the teacher's STEM teaching competence in the context of the twenty-first century include two component competencies: Implementing learning management; Contextualized Integrated Learning. According to Bozkurt Altan & Ercan (2016), science teachers must have the following two competences in order to effectively integrate STEM education: STEM education planning and STEM awareness; Nadelson et al. (2013) recommended six components, specifically for primary school teachers: Professional understanding in STEM education; Confidence; Attitude; Implement successful STEM teaching Create a favorable learning atmosphere for pupils; STEM curriculum development. Kurup et al. (2019) also emphasize that primary school teachers' capacity to teach STEM is founded on three factors: beliefs, understanding, and attitudes. As a result, while analyzing the teacher's STEM competence framework, the majority of the scholars identified three key factors: (1) STEM awareness; (2) STEM teaching principles; and (3) STEM teaching capacity (Bozkurt Altan & Ercan, 2016; Kartimi & Ari Syahidul Shidiq, 2021; Kim & Kim, 2016; Kurup et al., 2019; Nadelson et al., 2013). In addition to the three fundamental criteria, extra abilities are highlighted, such as: confidence; attitude; creating a welcoming learning environment; and developing STEM curriculum (Kim & Kim, 2016; Nadelson et al., 2013).

Previous studies have identified the key factors of teachers' competencies in teaching STEM (the author has identified the component competencies (Bozkurt Altan & Ercan, 2016; Kim & Kim, 2016; Kurup et al., 2019; Song, 2020); described the indicators (Kim & Kim, 2016; Nadelson et al., 2013; Rukoyah et al., 2020; Song, 2020).

Based on the previous description, this research aims to analyze the readiness of primary school teachers to implement STEM education in the Northern mountainous area of Vietnam. However, the success of implementing STEM teaching depends entirely on the teacher. Teachers in the northern mountainous region of Vietnam need intensive training with regards to their STEM teaching readiness, since their expertise, skills and knowledge will be a key part of the primary education reform.

3. METHODOLOGY

Research Goal

In this study, the researcher implemented descriptive quantitative method. The descriptive quantitative is chosen to measure the readiness of primary school teachers in the North mountainous of Viet Nam that implement STEM teaching. The descriptive quantitative research design purpose is to describe and interpret, the current status of an individual, setting, condition, or event (Mertler, 2017). With

descriptive quantitative research methods, this study aims to examine and define the existing situation (Andarwulan et al., 2021). By establishing this method, the researcher analyzed the average score of each variable and described the teacher's readiness of teaching STEM.

Sample and Data Collection

Population is a generating area that consists of objects that have certain qualities and characteristics determined by researchers to be studied and the conclusions to be drawn (Andarwulan et al., 2021). The population of this research is primary teachers that spread in various provinces in Viet Nam, such as Cao Bang, Lang Son, Thai Nguyen, Bac Kan, Son La, Lao Cai, Dien Bien, Lai Chau. The technique used in this study is random sampling. 380 teachers were selected from primary level as the study sample (19 teachers have 0-5 years' experience, 53 teachers have 6-10 years' experience, 94 teachers have 11-20 year' experience, 214 teachers have above 20 years' experience). Most participants are entitled to a bachelor's degree in education (287 teachers), while 2 of them have postgraduate degrees (2 teachers), and the rest is undergraduate degrees.

Table 1. Demographic background of participants

No	Demographic Background	Teachers	
		Total	%
	Gender		
1.	Male	61	16.1
	Female	319	83.9
	Education		
2.	Undergraduate	378	99.5
	Post-Graduate	2	9.5
	Teaching Experience		
	0-5 Years	19	5.0
3.	6-10 Years	53	13.9
	11-20 Years	94	24.7
	Above 20 years	214	56.4

The data was collected with online questionnaires. Moreover, the online questionnaire was also easy to be administered and accessed using various devices (Fraenkel et al., 2011). The majority of participants were contacted via messages and social media channels, while some of the participants being approached through direct letter to personal email. The link of the questionnaires is hosted by Google Forms. The questionnaire was open for a week.

Data Analysis

A 5-point scale is used to measure the teachers' readiness. The research questions were analyzed with descriptive statistical analysis. In descriptive analysis, the mean and standard deviations of responses for all readiness items were computed and reported in tables.

The research data collection technique was conducted using a questionnaire to measure teachers' readiness for the implementation of teaching STEM. Primary teachers' readiness toward the implementation of teaching STEM is measured by ten indicators (Kurup et al., 2019; Song, 2020), such as (1) Having sufficient knowledge on other STEM subjects, (2) Communication and cooperation with teachers and students, (3) Belief and patience with students' achievement. Likert scale is developed by (Highhouse et al., 2003).

4. FINDINGS

Primary teachers' readiness toward the implementation of teaching STEM is measured by 10 indicators. The measurement results of each indicator are described below.

Knowledge on STEM education

Based on the results of measurements on 380 primary teachers who are working in the North of mountainous of Vietnam, 7.1% respondents stated that their knowledge on STEM education was not available, 38.9% respondents stated that learning content was insufficiently available, 46.1% respondents stated that learning content was sufficiently available, 7.1% respondent stated learning content was available, and 0.8% respondents stated that content learning was highly available. The data shows that the majority of primary school teachers' awareness of STEM education is still lacking. Table 3 presents the calculation of cognitive on STEM education of primary school teachers in the northern mountainous area of Vietnam.

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Table 3. Primary Teachers' knowledge on other STEM subjects

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not available	27	7.1	7.1	7.1
Less available	148	38.9	38.9	46.0
Sufficiently available	175	46.1	46.1	92.1
Available	27	7.1	7.1	99.2
Highly available	3	0.8	0.8	100.0
Total	380	100.0	100.0	

Having sufficient knowledge on other STEM subjects

Based on the results of measurements on 380 primary school teachers, 7.6% respondents stated that their knowledge on other STEM subjects is not available, 50% respondents stated that it is sufficiently available, and 10.5% respondents stated that their knowledge on other STEM subjects was available. Meanwhile, only 2.9% teachers' self - assess that they have certain knowledge on other STEM subjects. The results showed that more than half of primary school teachers said that they had sufficient knowledge of subjects in STEM subjects, only 36.5% lacked confidence in the basic knowledge of STEM education. Table 4 shows the calculation of teacher readiness for knowledge of other STEM subjects.

Table 4. Primary Teachers' sufficient knowledge on other STEM subjects

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not available	29	7.6	7.6	7.6
Less available	110	29	29.0	36.6
Sufficiently available	190	50.0	50.0	86.6
Available	40	10.5	10.5	97.1
Highly available	11	2.9	2.9	100.0
Total	380	100.0	100.0	

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Available of identify STEM themes in curriculum

Based on the results of measurements on 380 primary school teachers, 21.3% respondents stated that their capacity in identify STEM themes in curriculum were less available, 41.8% respondents stated that their capacity was sufficiently available, and 30.8% respondents stated they was available in identify STEM themes in curriculum. The findings suggest that the majority of primary school teacher stated that availability of identify STEM themes in curriculum. Table 5 displays the calculation of the availability of identify STEM themes in curriculum.

Table 5. Primary Teachers' available of identify STEM themes in curriculum

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not available	12	3.2	3.2	3.2
Less available	69	18.2	18.2	21.4
Sufficiently available	159	41.8	41.8	63.2
Available	117	30.8	30.8	94.0
Highly available	23	6.0	6.0	100.0
Total	380	100.0	100.0	

Available of identify the process of teaching stem in primary school

Based on measurement results of 380 primary school teachers, 29.5% respondents stated that they were less identify the process of teaching STEM, 38.9% were quite adept at identify the process of teaching STEM, and 31.6% were adept at identify the process of teaching STEM. According to these statistics, the majority of primary school teachers are less capable of identifying the process of teaching STEM. Table 6 describes the calculation of data regarding the ability of elementary teachers in identify the process of teaching STEM.

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Table 6. Primary Teachers' **available of identify the process of teaching stem in primary school**

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not available	17	4.5	4.5	4.5
Less available	95	25.0	25.0	29.5
Sufficiently available	148	38.9	38.9	68.4
Available	114	30.0	30.0	98.4
Highly available	6	1.6	1.6	100.0
Total	380	100.0	100.0	

Available of identify STEM learning outcomes

Based on measurement results of 380 primary school teachers, 60% (13.4% not available and 46.6% less available) respondents stated that they have a tough time defining STEM teaching goals; 33.9% can identify but are unsure, and 6% are able and highly likely to establish STEM teaching goals. As a result, determining the goal of STEM instruction is a huge challenge for primary school teachers in Vietnam's northern mountainous regions. This has a significant impact on their capacity to teach STEM subjects. Table 7 describes the calculation of data regarding the ability of primary teachers in identify the learning outcomes.

Table 7. Primary Teachers' available on identify STEM learning outcomes

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not available	51	13.4	13.4	13.4
Less available	177	46.6	46.6	60.0
Sufficiently available	129	34.0	34.0	94.0
Available	18	4.7	4.7	98.7
Highly available	5	1.3	1.3	100.0
Total	380	100.0	100.0	

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Available of design learning content of STEM themes

Based on the measurement results on 380 primary school teachers, 53.4% of teachers were not able or less able to design STEM learning content and 45.2% of teachers were sufficiently available or available. Only 1.3% of surveyed teachers confirmed that they are highly available in developing learning content of STEM topics. The data signifies that the majority of primary school teachers are quite capable to design STEM learning content. Table 8 describes the calculation of data on the ability of primary school teachers to design STEM learning content.

Table 8. Capability of Design STEM learning content

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not available	18	4.7	4.7	4.7
Less available	185	48.7	48.7	53.4
Sufficiently available	157	41.3	41.3	94.7
Available	15	4.0	4.0	98.7
Highly available	5	1.3	1.3	100.0
Total	380	100.0	100.0	

Available of design and organize STEM learning activities

Based on the measurement results on 380 primary school teachers, 1.8% of teachers did not design STEM learning activities for their primary students, 68.1% stated that they found it quite hard to design STEM learning activities. The remainder indicate it is possible or very possible in designing STEM learning activities. This suggests that most primary school teachers are quite easy to design STEM learning activities. Table 9 describes the calculation of data on the availability of design STEM learning activities.

Although 30% of questioned instructors believe they have the capacity to plan and construct STEM education activities successfully, just 7.1% are entirely confident in their abilities to arrange these activities. When it comes to planning STEM education activities, the remainder find it difficult (50%) or lack confidence.

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Table 9. Availability of design and organize STEM learning activities

Valid	Frequency		Percent		Valid Percent		Cumulative Percent	
	Design	Organize	Design	Organize	Design	Organize	Design	Organize
Not available	7	19	1.8	5.0	1.8	5.0	1.8	5.0
Less available	91	171	24.0	45.0	24.0	45.0	25.8	50.0
Sufficiently available	168	163	44.2	42.9	44.2	42.9	70.0	92.9
Available	91	21	24.0	5.5	24.0	5.5	94.0	98.4
Highly available	23	6	6.0	1.6	6.0	1.6	100.0	100.0
Total	380	380	100.0	100.0	100.0	100.0		

Ability of designing and using STEM teaching and learning materials

Based on the results of measurements on 380 primary school teachers, 50% respondents stated that they were not available or less available of design STEM teaching and learning materials, 45% respondents stated that it is sufficiently available, and 3.2% respondents stated that their capacity in design STEM teaching and learning materials was available. Meanwhile, only 1.8% teachers' self - assess that they have certain design STEM teaching and learning materials. The results showed that half of primary school teachers said that they had sufficient available in design STEM teaching and learning materials. Table 10 shows the calculation of teacher capacity in design STEM teaching and learning materials.

Although primary school teachers in the Northern mountainous area's capacity to develop STEM teaching materials is still restricted, survey findings demonstrate that their ability to use available STEM educational materials is improving. Only 10% of instructors are unsure how to utilize it or are reluctant to do so. Approximately 90% of teachers can utilize or master STEM educational resources.

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Table 10. Availability of designing and using STEM teaching and learning materials

Valid	Frequency		Percent		Valid Percent		Cumulative Percent	
	Design	Use	Design	Use	Design	Use	Design	Use
Not available	15	4	3.9	1.1	3.9	1.1	3.9	1.1
Less available	175	34	46.1	8.9	46.1	8.9	50.0	10.0
Sufficiently available	171	159	45.0	41.8	45.0	41.8	95.0	51.8
Available	12	161	3.2	42.4	3.2	42.4	98.2	94.2
Highly available	7	22	1.8	5.8	1.8	5.8	100.0	100.0
Total	380	380	100.0	100.0	100.0	100.0		

Available of assess students' STEM activities

Based on measurement results of 380 primary school teachers, 34% respondents stated that they were not available or less available in assessing students' STEM activities, 34.7% were quite adept at assessing students' STEM activities, and 31.3% were adept at assessing students' STEM activities. Because the procedure of analyzing and assessing students' progress has been authorized by the Vietnamese Ministry of Education and Training, many instructors are confident in their abilities to assess students' learning outcomes in STEM education. Since the 2014 school year, all elementary schools have been subjected to this policy. Since then, municipalities and schools have arranged several training programs for teachers to improve their abilities in evaluating students' learning outcomes. Students are provided with a multitude of updated content that meets the criteria of the 2018 general education program.

Table 11. Primary Teachers' available of assess students' STEM activities

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not available	21	5.5	5.5	5.5
Less available	108	28.5	28.5	34.0
Sufficiently available	132	34.7	34.7	68.7
Available	109	28.7	28.7	97.4
Highly available	10	2.6	2.6	100.0

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Total	380	100.0	100.0	

Available of communicate and cooperative with students and other teachers

Based on measurement results of 380 primary school teachers, 8.2% respondents stated that they were less confident in communicate and cooperative with students and other teachers. Meanwhile most of respondent (91.8%) stated that they can communicate and cooperative with students and other teachers. Table 12 describes the calculation of data regarding the ability of communicate and cooperative with students and other teachers

Table 12. Primary Teachers' available of communicate and cooperative with students and other teachers

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Not available	3	.8	.8	.8
Less available	28	7.4	7.4	8.2
Sufficiently available	138	36.3	36.3	44.5
Available	169	44.5	44.5	89.0
Highly available	42	11.0	11.0	100.0
Total	380	100.0	100.0	

Needs and the confidence of teaching STEM

In below table with results of measurements on 380 primary school teachers, most teachers (91.4%) want to do STEM teaching in their schools because they understand how important STEM education is for the development of primary students' traits and skills. However, teachers' trust in their own competence to arrange STEM instruction is incompatible with the requirements. Only 11% are certain of their competence to teach STEM. These comments likewise concentrated predominantly on STEM-trained teachers.

Table 13. Needs and the confidence of teaching STEM

Valid	Frequency		Percent		Valid Percent		Cumulative Percent	
	Needs	Confidence	Needs	Confidence	Needs	Confidence	Needs	Confidence
Negative	33	173	8.6	45.6	8.6	45.6	8.6	45.6

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Neutral	149	165	39.2	43.4	39.2	43.4	47.8	89.0
Positive	198	42	52.2	11.0	52.2	11.0	100.0	100.0
Total	380	380	100.0	100.0	100.0	100.0		

Belief in students' capacity to learn STEM

Based on measurement results of 380 primary school teachers, only 10% of teachers feel their students are not capable of participating in STEM education activities. The majority of the remaining teachers (90%) feel that their students are capable of participating in STEM educational activities. Even still, up to 51.3 percent of teachers feel their students can engage completely. This is a promising indicator for the viability of integrating STEM education in primary schools in Vietnam's northern mountainous regions. Teachers' confidence in their students' capabilities is a key factor and motivator for teachers to make an effort to incorporate STEM education in their classrooms.

Table 14. Belief in students' capacity to learn STEM

Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Less capable	38	10.0	10.0	10.0
Quite capable	147	38.7	38.7	48.7
Capable	195	51.3	51.3	100
Total	380	100.0	100.0	

DISCUSSION

This research aims to measure the readiness of primary school teachers on teaching STEM in the North mountainous of Viet Nam. There are fifteen indicators to measure the readiness of primary school teachers towards the implementation of STEM learning and teaching, such as (1) Knowledge on STEM education; (2) Sufficient knowledge on other STEM subjects; (3) Available of identify STEM themes in curriculum; (4) Available of identify the process of teaching stem in primary school; (5) Available of identify STEM learning outcomes; (6) Available of design learning content of STEM themes; (7) Available of design STEM learning activities; (8) Ability of designing STEM teaching and learning materials; (9) Ability of using STEM teaching and learning materials; (10) Available of assess students' STEM activities; (11) Available of organize STEM learning activities (12) Available of communicate and cooperative with students and other teachers; (13) Needs of teaching STEM; (14) Confidence of teaching STEM; (15) Belief in students' capacity to learn STEM.

Understanding of STEM education and STEM Learning Content

To effectively implement STEM education, especially in the Northern mountainous areas of Vietnam, the decisive factor is the readiness of teachers (Nadelson et al., 2013). It is possible that primary school teachers in the northern mountainous areas of Vietnam have initially had approached STEM education, but they have not been equipped with the necessary skills to perform this activity well (H. T. T. Huong, 2019). School managers need to design training courses on STEM education and organize it effectively. For primary school teachers seeking to implement STEM education in their classrooms, the first step is to understand what STEM education is and what role it plays in the comprehensive development of students (Song, 2020). Teachers needed to have a clear understanding of STEM education and the objectives of the STEM pedagogical approach that they have to adopt. Support given by the education district officers and teacher training departments would have an impact on how teachers embrace STEM pedagogical approach (Rauf et al., 2019). Understanding STEM education can assist teachers in designing and organizing STEM activities in their classrooms with confidence. Teachers must, however, have a firm foundation of knowledge in the following topics in order to construct STEM teaching activities: science, technology, engineering, and math, as STEM combines four disciplines. In order to feel capable of teaching STEM, teachers need not only knowledge of STEM content, but comfort with that content, knowledge of pedagogies for teaching STEM, and practice using these pedagogies (Engels et al., 2017).

Identify STEM-integrated topics in the program

Teachers must find opportunities to integrate the Program's contents in the domains of science, technology, engineering, and math from the start of the school year in order to construct STEM teaching activities. Not every educational topic can be integrated together, but they must have a logical link and be completed at the same time. To do so, teachers must completely comprehend the primary school curriculum and select relevant information for subject design. It is then integrated into and included in the teacher's school year teaching plan.

According to the study's findings, 78.6 percent of the questioned teachers believe that the program's capacity to identify STEM-related subjects is properly presented. One advantage of Vietnamese primary education is that they are immensely complicated business people who teach all subjects Science, technology, engineering and math (L. T. T. Huong, 2017). According to the findings, teachers are capable of identifying STEM topics. However, the shift in the order of content knowledge in the Vietnamese general education program beginning in 2018 would be an impediment for primary school teachers, who will have to devote a significant amount of time to studying the program. As a result, the identification of STEM-integrated themes in the curriculum should be arranged in groups of teachers of the same grade level in order to activate teachers' ideas. Following the identification of the STEM integration subject, the teacher will pick the relevant instructional content for the topic.

Available of identify STEM learning outcomes and assess students' STEM activities

Learning outcomes serve as the foundation for selecting STEM teaching techniques and organizational forms, as well as constructing a sequence of learning activities for students. Learning outcomes serve

as the foundation for evaluating student learning outcomes. STEM teaching objectives must be specified in at least two of the four areas: science, technology, engineering, and math. Teachers must base their learning outcomes on the objectives to attain established in the Vietnamese general education program in order to identify the right learning outcomes. According to the findings of the study, only 40% of instructors can and are highly likely to identify STEM teaching goals.

Available of design and organize STEM learning activities

These are crucial skills for teachers to have while implementing STEM education. The activities are planned to be congruent with the program's aims and content; to guarantee practicality; and to focus on developing students' quality and capability.

STEM teaching must be organized in an adaptable and creative manner. STEM activities must be carried out in a variety of ways, including individual, group, whole-class, in-class, and out-of-class activities. Teachers must employ a variety of teaching approaches and methodologies when shifting tasks to students. Furthermore, teachers' classroom management abilities while planning STEM teaching activities are regarded a "art" and should be appropriate for students, particularly in primary school classrooms in mountainous areas of Vietnam's North, where the difference is extremely visible (Ha, 2005).

Ability of designing and using STEM teaching and learning materials

STEM education is a purposeful educational activity, so designing and using STEM teaching and learning materials also needs to be associated with specific pedagogical ideas and understood as a price for knowledge. Through manipulations and actions students can achieve their STEM learning goals. STEM education helps learners to apply knowledge to solve practical problems, so it is possible to imagine learners' knowledge as input signals. Practical problems to be solved are output signals, and learning materials are tools to help students solve problems (L. X. Quang et al., 2019). If possible, provide opportunities for students to be involved in the design and use process of STEM teaching and learning materials. At the same time, teachers should make the most of the available facilities of the school or local.

Available of communicate and cooperative with students and other teachers

Teaching is the process of communication between teachers and students, as well as between students and teachers. As a result, one of the necessary competencies for teachers to effectively apply STEM instruction is the capacity to communicate and collaborate with students and other teachers. Each STEM education offering mobilizes knowledge and abilities from a variety of sectors. Primary school students in Vietnam's northern mountainous areas, in particular, have very low communication skills, making it difficult for them to recognize problems and articulate their thoughts to others (P. H. Quang, 2016). As a result, teachers' problem-solving, task assignment, and problem-solving procedures should be clear and easy for students to understand and apply. Creating groups of teachers interested in this educational model to collaborate and share ideas, teaching experience, and combine to create shared

learning resources and equipment is an effective way to synchronously implement STEM education in primary schools in Vietnam's northern mountainous region.

This, however, is not a barrier for teachers in this area. According to the findings of the preceding study, 91.8% of teachers feel confident in their abilities to interact with students and colleagues.

Needs and the confidence of teaching STEM

Teachers' requirements and confidence in teaching STEM are not directly proportionate to one another. Although teachers in Vietnam's northern mountainous areas have a strong desire to teach STEM subjects, they lack the confidence to pursue this goal. This is comprehensible because most teachers desire to teach STEM in their classrooms because they realize the significance and importance of STEM education in Vietnam's and the world's growth. On the contrary, they remain concerned since there are few possibilities to access this educational paradigm, which is still new to schools in Vietnam's northern mountainous areas (Nam et al., 2018). This may be remedied by enacting policies and actions that support and inspire teachers, as well as providing chances for them to engage in training courses and put what they learn into practice. To overcome reluctance to change, teachers must have a positive attitude toward change and feel that such changes will benefit them, their students, and the school (Rauf et al., 2019)

Belief in students' capacity to learn STEM

Implementing STEM requires students to have faith in their talents. As a result, the basic competencies center on the teacher's intercultural competence and capacity to model intercultural competences for their students. This category covers attitudes, knowledge/awareness, and skills (Van Werven et al., 2021). A favorable survey finding is that 90% of students believe in their capacity to participate in STEM learning activities.

Students will engage more actively and confidently if educational activities are structured in accordance with their skills and effectively use their knowledge and life experiences (Song, 2020). Students need an environment that provides them with opportunities to engage in the practice of science, technology, engineering, and mathematics through real-world problems (Rauf et al., 2019).

5. CONCLUSION

This research focuses on the North mountainous of Viet Nam primary teachers' readiness toward on teaching STEM. Teacher readiness can be measured by 15 indicators, such as: Knowledge on STEM education; Sufficient knowledge on other STEM subjects; Available of identify STEM themes in curriculum; Available of identify the process of teaching stem in primary school; Available of identify STEM learning outcomes; Available of design learning content of STEM themes; Available of design STEM learning activities; Ability of designing STEM teaching and learning materials; Ability of using STEM teaching and learning materials; Available of assess students' STEM activities; Available of organize STEM learning activities; Available of communicate and cooperative with students and other

teachers; Needs of teaching STEM; Confidence of teaching STEM; Belief in students' capacity to learn STEM. It concludes that the majority of primary school teachers in eight provinces of on the North mountainous of Viet Nam who are not really ready for the implementation of teaching STEM. Based on the results of the teacher readiness assessment, education officials must devote immediate attention to investing in facilities and strengthening STEM teaching capacity for primary school teachers. Furthermore, teachers should organize themselves to learn about STEM education and actively arrange STEM activities that they believe would be most beneficial. The systems that have been put in place will undoubtedly aid continuous educational missions and training in times of difficulty, such as COVID at the present. The current outcomes of STEM teaching in elementary schools will lay the groundwork and establish ideal conditions for the growth of STEM education in Vietnam's northern mountainous area.

6. RECOMMENDATIONS

The reason of this research is to provide an overview of the readiness of primary school teachers in Vietnam for the implementation of teaching STEM. The results of the research will serve as recommendations to school management, the education department, and policy makers in general to develop STEM education in the North mountainous of Viet Nam primary teachers, especially at the primary school level. The results of this study motivated a series of new researches. Other researchers, for example, can conduct studies on the proposed and evaluated factors influencing the development of STEM teaching competence in primary school teachers. Alternatively, they might suggest and assess the efficiency of initiatives that influence the development of primary school teachers' STEM teaching competence. The research's sample can also be expanded or adjusted to include additional areas or levels of study.

7. LIMITATIONS

There are several limitations that need to be considered in this study. The study was conducted in 8 mountainous provinces in the North mountainous of Vietnam. This adaptive study is limited to primary school teachers. Therefore, the validity-reliability status of the scale for teachers of other levels has not been taken into account. Furthermore, the number of teachers was limited; one group includes teachers teaching different grades.

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