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Stem education capacity development program for high school teachers in Tuyen Quang province, Vietnam Quang province, Vietnam

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Abstract
The success of the process of planning STEM education activities for students is largely dependent on the capability for STEM education. Difficulties and limitations in teachers' STEM education capacity have been identified through a survey and evaluation of the current state of STEM education capacity among 618 high school teachers in Tuyen Quang province, Vietnam. In order to provide information and professional skills in the area of planning and executing STEM education programs and cultivating a self-assured and optimistic mindset for students in the application, the research team has created a training program. During the present term, plan STEM-related instructional activities for pupils in accordance with Vietnam's 2018 general education program standards.

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1. Introduction

Implementing Directive No. 16/CT-TTg dated May 4, 2017 of the Prime Minister of Vietnam, since 2014, the Ministry of Education and Training has coordinated with the British Council to implement a STEM education pilot program. for some high schools in some provinces and cities.

In the 2014-2015 academic year, STEM education was also included in the Ministry of Education and Training's guidelines for the implementation of assignments in secondary education, and to this day, local governments across the country are encouraged to integrate STEM subjects

We are in the process of implementing our current high school program in related subjects

Additionally, STEM education is included in the academic year mandates of the Ministry of Education and Training nationwide

Tuyen Quang is a northern mountainous province of Vietnam. In this instance, STEM education has been carried out in accordance with the Ministry of Education and Training's goal. All preschools and high schools in the province now offer STEM instruction, following three years of trial implementation at all levels. The Tuyen Quang Department of Education and Training has mandated that schools integrate STEM education in the current time using adaptable instructional formats and activities that fit the needs of the school, like contests, extracurricular activities, and festivals like the Creative Experience Festival. Despite the organizing process, challenges and constraints persist: Teachers have difficulty building STEM topics in a way that both ensures the knowledge and skills requirements of the current curriculum framework, while also meeting the goals of developing learner qualities and capacities according to the new general education curriculum. Teachers have difficulty building STEM topics in a way that both ensures the knowledge and skills requirements of the current curriculum framework, while also meeting the goals of developing learner qualities and capacities according to the new general education curriculum. Teachers face difficulties in designing STEM topics in a way that secures the knowledge and skill requirements of the current curriculum framework and achieves the goal of developing learner qualities and skills in accordance with the new general education curriculum

The reason for the above difficulties is that the teacher's qualifications do not meet the requirements. According to some studies on the current state of integrated teaching capacity of middle school teachers in provinces and cities, up to 58.4% of teachers self-assess their integrated teaching capacity and interdisciplinary knowledge only in average level. The ineffective coordination between high schools and universities in the process of preparing and fostering professional capacity for teachers is another reason why STEM education is ineffective. This is especially true when it comes to research institutes, organizations, businesses, and high schools. To maintain consistency and continuity, cooperation from research institutes, academic and scientific associations, professional bodies, and corporations is also required. The truth reveals that a limited number of colleges and research centers have collaborated on teacher preparation programs; initially, businesses and private organizations worked together to support STEM education initiatives in schools. However, they are really a few outliers; a broad and long-lasting link has not yet developed. As of right now, Tuyen Quang lacks research on the topic of helping primary, secondary, and high school teachers become more adept at planning and executing STEM-related lesson plans in the context of putting the new general education program into practice.

Based on the aforementioned analysis, it is imperative to conduct research and create a training program with the aim of equipping high school teachers, particularly those in Tuyen Quang province, with the required skills to plan and implement STEM educational activities. Overcome teachers' lack of awareness and their incapacity to plan, coordinate, and create STEM activities in order to integrate STEM into the new general education curriculum in a methodical and scientific manner. In order to meet the criteria of the new general education program, we thus conducted a survey to assess the growth of competence to plan and coordinate STEM instructional activities for teachers in Tuyen Quang province. The findings of this issue's research are listed below.

2. Historical research

One of the teaching approaches that links knowledge to solving real-world problems is the STEM education model, which started to take shape in the 1990s. Based on this, the educational systems of many developed nations, including the US, UK, France, and others, have devoted a considerable amount of time to planning STEM-related learning activities across a range of topics. executed concurrently with the course of study. Yeping Li concluded that STEM education is a trend and would become more significant in the future after analyzing about 800 scientific papers published in 36 specialized journals between 2000 and 2018. the way that lessons are planned in high school, particularly when it comes to natural science courses. In their study, Shahali and colleagues (2016) assessed how engaging in the STEM education model may positively and effectively foster students' enthusiasm in learning and careers. A number of research have demonstrated that student abilities, activity organization strategies, and classroom teachers also have an impact on the quality of applying the STEM education paradigm to teaching, in addition to studies that highlight the benefits of doing so.

Because STEM education is interdisciplinary, activity designers need to have a deep understanding of all four STEM subjects (science, technology, engineering, and mathematics) in addition to having STEM teaching strategies for their students. The majority of high school teachers lack "broadness" in allied scientific subjects, particularly when it comes to integrated and interdisciplinary teaching, because they have only had extensive instruction in their specialties up to this point. Wilson (2011) contends that STEM educators must become proficient in the following four fundamental techniques: Creating big ideas; (2) Drawing on students' imaginations and ideas for modification and direction; (3) Assisting students in understanding the significance of events and occurrences; and (4) Encouraging students to provide explanations supported by arguments and evidence.

Additionally, Honey and colleagues (2014) proposed a 50-hour STEM teacher training program that covers the following topics in the classroom: how to apply information technology in STEM teaching; how to stimulate and create excitement for students; how to create a STEM learning environment; professional knowledge in each STEM field; integrated teaching methods; Lesson design methods that combine professional topics with STEM. Additionally, three practical teaching modules are provided to students in actual classroom settings.

In Finland, using knowledge and abilities from STEM subjects to tackle real-world problems is one way that STEM education aims to foster students' creativity and curiosity (problem-solving method). As a result, the STEM teacher training program stresses strategies to assist students in formulating ideas, organizing, and resolving scientific real-life problems in addition to assisting in the development of knowledge and research skills.

The Korean government promotes STEAM education, which is based on the STEM approach and adds arts as an additional field ("A"). Two teacher support programs are offered by the KOFAC (Korea Foundation for the Advancement of Science and Creativity) organization: the STEAM Research Group of Teachers and the Teacher Capacity Training Program (Professional Development Programs). There are three stages in the Teacher Competency Training Program: A basic course that combines in-person and online training (45 hours) offers professional knowledge and pedagogical skills to implement integrated teaching, develop teaching strategies, and more. An introductory level online course (15 hours) provides general knowledge about policies, goals, and approaches in STEAM teaching. Advanced course (52 hours) with the main goal of developing teachers' capacity in creating STEAM content for teaching (Kang, 2019).

In Singapore, the development of 21st-century teaching qualities includes critical thinking, creativity, communication, and problem-solving abilities, among other competencies linked to STEM education.As a result, in order to teach STEM, science instructors need to complete a training program that includes the following skills: engineering design, problem identification and solving, understanding the distinctions between STEM domains, task design, and implementing STEM in the classroom. Science instructors assigned to teach STEM in schools will thus be equipped with the skills and confidence necessary to participate in STEM instruction.

Numerous Asian nations, like Thailand, Taiwan, and Japan, also place a high priority on training STEM educators using the US model. These nations have started offering STEM teacher training programs; some have even taken inspiration from and advanced the field of teaching educators in natural science disciplines (also known as science education). Programs for the development and training of STEM teachers are widely available. Universities offer a wide range of informal, non-focused programs in addition to their official offerings, like online courses and online seminars (webinars). While there are various topics on which teachers are trained, the most widely used one is how to pique students' interest and enhance the content of lessons.

Research shows that there are many models of fostering STEM education capacity for teachers around the world,

This is a lesson learned for the research team when developing a training program to develop STEM educational capacity for teachers in Tuyen Quang province, Vietnam in the context of educational innovation.

3. Methods of research

A variety of expert, practical, and theoretical research methodologies are used in this article. The investigation and surveying of 618 instructors from 21 elementary, middle, and high schools in Tuyen Quang province produced the data used in the article. The selection of educators to partake in this survey guarantees the impartiality and dependability of the study findings. The province of Tuyen Quang is now assessing the STEM teaching competence of its instructors through the use of investigation and survey methodologies. In order to identify the flaws, restrictions, reasons, and systematize training programs, the study team also employed the technique of systematizing and summarizing research on STEM education in Vietnam. capabilities worldwide as a foundation for developing a teacher training program in the province of Tuyen Quang. The research team also conducted in-depth interviews with STEM teachers in order to examine the reasons behind the flaws and constraints in the growth of STEM education in classrooms. Several educators were consulted, and the process of conducting in-depth interviews with them was documented and examined.

4. Research results and discussion

4.1. Overview of the current status of STEM education capacity of teachers in Tuyen Quang province

We have created a survey with questions on evaluating 15 STEM education competency component competencies in order to shed light on the present state of high school teachers' ability to plan and coordinate STEM educational activities in Tuyen Quang province. The scale includes 5 levels: Good (5 points), Good (4 points), Average (3 points), Weak (2 points), Incompetent (1 point). The difference between each level is (5-1): 5 = 0.8 and the levels of the scale are: Level 1: Not capable (1.0 ≤ Average score < 1.8); Level 2: Has weak level of ability (1.8 ≤ Average score < 2.6); Level 3: Have average level of ability (2.6 ≤ Average score < 3.4); Level 4: Competent at a good level (3.4 ≤ Average score ≤ 4.2); Level 5: Has good level of ability (3.4 ≤ Average score ≤ 5.0). The survey subjects were teachers of 21 elementary schools, middle schools and high schools in Tuyen Quang province. The collected data are processed using SPSS software. The results obtained are shown in table 1.

Table 1: Current status of the capacity to design and organize STEM educational activities of high school teachers in Tuyen Quang province, Vietnam

Capacity	N	Minimum	Maximum	Sum	Mean	Std. Deviation
Approaching students	618	1.00	5.00	1855.00	3.0016	0.81018
Communicate and resolve situations in organizing STEM activities	618	1.00	5.00	2188.00	3.5405	0.67304
Encourage participation from other educational areas in STEM education activities.	618	1.00	5.00	2002.00	3.2395	0.65233
Capacity to design and manufacture STEM products	618	1.00	5.00	1711.00	2.7686	0.70183
Designing STEM educational activities	618	1.00	4.00	1809.00	2.9272	0.63107
Organize STEM teaching	618	1.00	5.00	1775.00	2.8722	0.71893
Develop supporting activities for STEM lesson plans	618	1.00	5.00	1799.00	2.9110	0.75543
Use IT and other STEM teaching aids	618	2.00	5.00	2036.00	3.2945	0.68368
Develop STEM teaching program	618	1.00	5.00	1831.00	2.9628	0.91285
Scientific research	618	1.00	5.00	1671.00	2.7039	0.88093
Use Test in student assessment	618	1.00	5.00	1938.00	3.1359	0.76659
Use other evaluation methods	618	1.00	5.00	1645.00	2.6618	0.69301
Use software	618	1.00	4.00	1640.00	2.6537	0.69950
Write a STEM teaching report	618	1.00	5.00	1539.00	2.4612	0.74838
Provide leaders at all levels with actionable advice on how to boost support for STEM education initiatives.	618	2.00	5.00	1668.00	2.6990	0.80519
Valid N (listwise)	618				2.9222	

The data table above illustrates the results, which indicate that the competencies are generally evaluated at a good and average level. The range of scores for the examined competencies is from an average of 2.4612 to a maximum of 3.5405. Higher ranked competencies include: problem-solving and communication in planning STEM activities (3.5405); Encourage participation from other educational areas in STEM education initiatives (3,2395); Utilizing IT and additional STEM educational resources (3.2945); Engaging students (3.0016); Assessing kids with tests (3.1359). The competencies in this group are regarded as good to near-average. To effectively carry out STEM educational activities, these competences are complementary to one another.

The ability to create STEM educational activities (2.9272), STEM teaching organizations (2,8722), scientific research (2,7039), creating activities to support STEM lesson plans (2.9110), and creating STEM products (2,686) are among the key competencies that managers and educators evaluate at a mediocre level. The information reveals that there is very little variation across managers and teachers who were polled, and the standard deviation is rather low. Our survey results are generally in line with the findings of author Nguyen Minh Anh Tuan (Education Magazine (2023), 23(12), pp. 53–58): with an average score of 2.72, a teacher's ability to effectively develop a STEM topic or lesson still has numerous limits. This demonstrates the necessity for education management organizations to come up with innovative ideas, such giving teachers more training but also giving them the chance to network and get professional experience in master design skills. STEM subjects or instruction with peers; In order to achieve the requirements of the 2018 Education and Training Program, teachers should have the opportunity to self-train in STEM education. This will increase their effectiveness and quality of instruction. Important competencies are typically evaluated on an average basis. Thus, more management solutions are needed to develop the capacity to design and organize STEM educational activities for high school teachers in Tuyen Quang province.

With average ratings ranging from 2.6 to 2.7, other competencies include using tests for student assessment, using alternative means of evaluation, using software, writing teaching reports, and making effective suggestions to leaders at all levels to boost support for STEM educational activities were scored lowest. Writing a STEM teaching report (2.4612) is the competency with the lowest rating, indicating that there is still room for improvement in the evaluation and report writing processes following STEM activity completion.

The biggest challenge is improving knowledge beyond each staff member's specific training, which is why the assessment of the aforementioned abilities is only at an average level. Today, STEM integrated education refers to the teaching and learning of several STEM topics, including science, technology, engineering, and mathematics, as well as the addition of additional courses like English, fine arts, literature, history, and geography.In contrast, teachers in pedagogical schools receive training that is primarily focused on a limited number of disciplines. When instructors are forced to "shift" from teaching a single subject to a new "subject" where major boundaries are blurred, they get confused about both professional knowledge and effective teaching strategies.

The research team discovered through direct teacher interviews, classroom observations, and observations that the ability to plan and coordinate STEM activities is superior than the ability to conduct STEM science research and plan STEM experiential learning opportunities. Few primary educators possess the skills necessary to plan and coordinate STEM instruction at a proficient level or above. Teachers report that when it comes to designing STEM classes, they frequently run into issues since it can be challenging to select courses that incorporate STEM education based on the current curriculum. (or no concepts for designs). After conducting in-depth interviews, teachers revealed that they find it difficult to design teaching activities for problems with practical applications because these problems require students and teachers to understand multidisciplinary elements of science, engineering, and technology; or the problem has practical applications but cannot result in a model product; or the problem is difficult to solve because of the amount of time required for these activities (because STEM lessons or educational activities often have to be organized in the form of projects, including a number of periods, and even several weeks for groups to carry out the project).

The facilities of the schools continue to be a barrier to the organization of STEM education by teachers; they must either prepare the ingredients themselves or assign students to do so. There are neither STEM classrooms nor funding in schools to support STEM education. Consequently, the majority of STEM goods focus on creating models out of repurposed materials and simulations so that students can see how the knowledge they have learned may be applied right away. There is no technical integration in the product.

From the limitations stemming from the above situation, management levels need to develop training programs and organize training to develop STEM education capacity for teachers.

4.2. Create initiatives and plan training sessions to help teachers in Vietnam's Tuyen Quang province become more proficient in STEM teaching.

4.2.1. Objective

Create initiatives and plan teacher preparation to ensure that educators are knowledgeable about STEM subjects and equipped to teach them. A key challenge for STEM programs in several nations has been identified as inadequate teacher instruction. Student learning is positively impacted by a teacher's level of subject-matter expertise, and a common shortcoming of STEM educators is their insufficient understanding to adequately explain concepts to their pupils. It is essential to provide teachers with the training and support they need to fully comprehend and excel in STEM teaching in high school.

To ensure that teachers are properly oriented toward STEM education, it is also imperative to assemble high-quality, reliable, and consistent materials. There are a lot of publications on STEM education available right now from numerous publishing houses, universities, and author collectives, but the strategies used are widely disparate and contradictory. As a result, selecting study materials causes confusion for high school teachers. Teachers must be aware of the fundamentals of STEM education, which include:

1. Integrated approach to content: science, technology, engineering, mathematics;
2. Emphasize the method of learning through practice, combining theoretical learning with the application of theories in complex practical situations;
3. Help students acquire the necessary skills and abilities to compete and develop.

However, the majority of instructors' ignorance of STEM teaching philosophy is the largest obstacle to the application of STEM. Therefore, in order to raise the credentials, experience, and professionalism of the personnel and teachers, schools must encourage self-study and self-improvement. It ought to be viewed as a necessary condition for the success of innovative teaching strategies and instructional approaches that satisfy contemporary educational standards.

In parallel with the issue of self-study and self-improvement, school leaders also need to proactively invite STEM education experts to provide systematic and practical training for the team to help deepen their understanding of the method, meaning, and benefits. teaching using STEM methods.

4.2.2. Materials and Application

The STEM Education Program's effectiveness is determined by the teaching staff. Enhancing their capability is therefore crucial. This task requires the attention of the Department of Education and Training, which will arrange teacher training and fostering in accordance with the following procedure:

(1) Determine the teaching staff's training needs

The Department of Education and Training must assess teachers' current circumstances in order to define their needs in terms of training. What level are they at? What is the teaching capacity of the program? What are their strengths and weaknesses? What must be fostered, what methods and forms of training should be provided? From there, we determine the training needs of the teaching staff. On that basis, build appropriate goals and training programs.

(2) Establish the objectives for teacher preparation

In order to support the successful implementation of the 2018 General Education Program, capacity building training for teachers aims to provide them with the tools, techniques, and updates they need to administer the STEM Education Program.

(3) Create instructional materials

Establish the objective

First of all, in our opinion, in order to meet the requirements of the 2018 General Education Program, we need to create a training program to enhance teachers' capacity. This program should focus on important issues to enhance teachers' basic knowledge and skills in STEM education, enhance teachers' capacity to develop programs, design STEM education topics, organize teaching activities, use teaching organization methods and forms, and assess students using the competency approach in STEM education.

Overarching goal: In order to meet the requirements of the 2018 general education program, one must possess the knowledge and professional skills necessary to plan and coordinate STEM educational activities as well as cultivate a positive and self-assured attitude in learners.

Specific objective: Accurately, completely, and correctly comprehend the Party's and the State's policies, rules, industry, and local legislation pertaining to STEM education; effectively carry out tasks in this area.

- Examine the fundamental ideas, objectives, and subject matter of STEM education in the 2018 General Education Program at the elementary, middle, and high school levels. - Examine the foundation for creating STEM learning activities. - Examine the formats and structures used to deliver STEM education.
- Complete the design and execution of several STEM learning activities with excellence in order to fulfill the requirements of the work unit's 2018 general education program.
- Assess your own and your colleagues' proficiency in creating and planning STEM-related learning activities. Create and apply student assessment instruments with skill in STEM education activities. When conducting STEM education or coordinating its implementation with other educators, adopt a serious demeanor.

Provide content for training programs

There are five modules in the program's content

Module 1 (10 lessons): Fundamental topics in STEM education and the abilities educators need to plan STEM-related activities. The information gives a broad overview of STEM education in Vietnam and globally, including definitions and theories of terminology, the idea and purpose of STEM education, Recognize and differentiate between STEM, STEMAM, and STEM; In order to facilitate learners' understanding of the organization of STEM educators' activities, the analysis highlights the abilities that educators must possess.

Module Two: Ten Lessons

The 2018 general education curriculum includes STEM education.

The information in Module 2 covers the objectives and subject matter of STEM education in the 2018 General Education Program for elementary, middle, and high school students as well as the framework for creating STEM learning activities. It also covers the structures and procedures for implementing STEM education in secondary education.

Module 3 (15 lessons): Create and plan STEM learning exercises for the 2018 general education curriculum. The material in Module 3 gives students a solid understanding of how to create STEM lessons, plan the STEM teaching process, and set up the STEM educational activities that will be incorporated into the 2018 general education curriculum.

Module 4 (5 periods): STEM education assessment.

Module 4's content presents a STEM competency framework for students to use as a foundation for deciding on assessment principles, putting assessment criteria into practice, picking material, forms, and assessment techniques, and assisting teachers in creating student assessment tools.

Module 5: (20 periods)

In the 2018 general education curriculum, practice developing and planning the implementation of several STEM education themes.

In addition to supporting schools in incorporating the content of professional team/group activities to continue editing and augmenting, the content presents several STEM lesson plans that serve as examples of the material covered in the aforementioned modules. Before implementing, add to and finish as necessary to ensure high-quality, successful implementation that is appropriate for the children and the actual school environment.

Pick and apply techniques for teacher preparation

Across the globe, the following approaches are frequently used in teacher preparation programs: expert-focused methodology.With this approach, teachers learn and implement what professionals know and have experienced. media-focused strategy. This approach uses information media to provide teachers with training materials. student-focused methodology. With the assistance of instructors, teachers independently complete the training curriculum using this way. Every one of the aforementioned training techniques has its benefits and drawbacks. Consequently, it is essential to incorporate all three approaches within teacher preparation. After that, by following a procedure that entails the following phases, teachers can be trained to instruct using the STEM education model:

Step 1: Provide teachers with training materials and a brief explanation of their contents by distributing them.

Step 2: Teachers conduct their own research on instructional materials;

Step 3: Arrange for teachers to swap training materials inside each school, among schools, or between school clusters;

Step 4: Using self-research, dialogue, and exchange of ideas, concentrate on the topics on which educators are unsure or disagree;

Step 5: Arrange training materials' solutions to instructors' ambiguous or conflicting content. About the type of instruction: Teachers must receive training in a wide range of varied and varied ways to fulfill the rising needs of contemporary education. These include: Personalized training, centralized training, remote training, training via the LMS system, online training where students receive learning materials, and training over the Internet…

Conditions of implementation

It is essential to reinvent the evaluation of teacher training outcomes in addition to the content, techniques, and formats of teacher preparation. Regarding the content of the review: We believe that two parts of evaluation are required: First, the competence of instructors to use the information and skills that are fostered in teaching, education, and practical STEM education; Second, the teachers' awareness of the issues being cultivated (in this case, STEM education); Third, provide educators the freedom to create STEM-related lesson plans. This is made tangible via STEM education-related items, instructor lessons, and lesson plans that are created by individual teachers and uploaded to the LMS system. Concerning the evaluation format: can make use of evaluation techniques like self-evaluation, professional team evaluations, student and parent evaluations, etc. The outcomes of evaluations are maintained in staff files and used as a foundation for planning, rotation schedules, plans for teacher training and development, staff arrangements, and the formation of a core group of STEM education educators.

Careful planning, program design, instructional materials, staff mobilization, facilities, equipment, and training instructors are all necessary for successful implementation.

5. Conclution

The research team suggested a training program to develop STEM education capacity for high school teachers in Tuyen Quang province, Vietnam, based on the current state of STEM education capacity of teachers in the province. We have analyzed and researched STEM education experiences in a number of countries around the world. In light of the new general education program's implementation, the training program has significance. The program's contents include recommendations to managers and educational policy makers on how to help instructors enhance their STEM education skills in order to raise the standard of general education. In 2023, the initiative will be piloted in Tuyen Quang province, Vietnam, with two training classes for around 600 high school teachers. The program's scientific merit and application are demonstrated by the early test results, which also indicate that teachers who took part in the training significantly improved their STEM education competencies. The outcomes of this pilot study will soon be reported in another study.

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