



**CURRENT STATUS OF DEVELOPING CAPACITY IN DESIGNING
AND ORGANIZING STEM EDUCATION ACTIVITIES
FOR TEACHERS TUYEN QUANG PROVINCE'S**

Doan Thi Cuc, Trinh Thi Thu Huong

Tan Trao University, Viet Nam

Center for continuing education - vocational education Son Tay, Viet Nam

Email address: dtcuc@tqu.edu.vn; trinhhuong9@gmail.com

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Abstract:

Previous studies have published research on solutions to develop the capacity to design and organize STEM educational activities based on the inheritance of research on theory and current organizational situation, the current state of capacity to design and organize STEM educational activities of teachers in Tuyen Quang province. Within the scope of this paper, we present eight ideas to help teachers in Tuyen Quang province, in particular, and STEM teachers in general, develop the competence to plan and organize STEM teaching activities. The solutions interact in a dialectical way. Effective implementation necessitates a policy system, human resources, and proper facilities.



GIẢI PHÁP PHÁT TRIỂN NĂNG LỰC THIẾT KẾ VÀ TỔ CHỨC CÁC HOẠT ĐỘNG GIÁO DỤC STEM CHO GIÁO VIÊN TỈNH TUYÊN QUANG ĐÁP ỨNG CHƯƠNG TRÌNH GIÁO DỤC PHỔ THÔNG 2018

Đoàn Thị Cúc, Trần Thị Thu Hương

Trên giảng đường Đại học Tân Trào, Việt Nam

Trung tâm GDTX-GDNN Sơn Tây, Việt Nam

Địa chỉ Email: dtcuc@tqu.edu.vn; trinhhuong9@gmail.com

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*Giải pháp phát triển năng lực,
giáo dục STEM, giáo viên,
Tuyên Quang*

Tóm tắt

Nghiên cứu về các giải pháp phát triển năng lực thiết kế và tổ chức hoạt động giáo dục STEM dựa trên việc kế thừa các nghiên cứu về lý luận và thực trạng tổ chức, thực trạng năng lực thiết kế và tổ chức hoạt động giáo dục STEM của giáo viên tỉnh Tuyên Quang đã công bố tại các nghiên cứu trước đó. Trong phạm vi bài báo chúng tôi đề xuất 8 giải pháp phát triển năng lực thiết kế và tổ chức hoạt động giáo dục STEM cho giáo viên tỉnh Tuyên Quang nói riêng và giáo viên giảng dạy STEM nói chung. Các giải pháp có mối quan hệ biện chứng tác động lẫn nhau, để thực hiện có hiệu quả đòi hỏi cần có một cơ chế chính sách, nguồn lực con người, cơ sở vật chất phù hợp.

1. Introduction

Taking on the successes of STEM education research, as well as the information given and assessed in studies published in 2022 on the current state of STEM education capacity of teachers in some primary, middle, and high schools in Tuyen province We organized and suggested eight solutions: (1) Raise awareness of STEM education and educational capacity development STEM for teachers among management of Departments/Offices of Education and Training, schools, and teachers. (2) Create a process for designing STEM instructional activities that are appropriate for local practical conditions. (3) Create programs and

organize teacher training so that instructors understand STEM education and are able to implement it. (4) Create and sustain STEM groups in high schools. (5) establish school education programs and professional team plans that focus on STEM education and establish the circumstances for its implementation. (6) Encourage collaboration among teachers within and outside of the school to form a STEM education community of high school instructors. (7) Create a set of criteria for assessing the quality of STEM education. (8) Improving pedagogical students' ability to develop and organize STEM educational programs.

The simultaneous implementation of the above solutions will contribute to advancing STEM education in high schools, which is a critical and urgent task in the current context because STEM may be done using a variety of pedagogical methodologies according to local conditions. The amount given to local educational programs accounts for approximately 20% of the time in the 2018 general education curriculum. As a result, if STEM education research is utilized and incorporated into the development of local educational programs, it will improve the effectiveness and scientific research potential of high school students and teachers by connecting education education and local practices, thereby contributing to the improvement of human resource quality [1], [2], [3].

2. Methods

The goal of this research is to propose solutions to develop the capacity to design and organize educational activities for teachers in Tuyen Quang province to meet the requirements of the 2018 general education program using a combination of methods of analysis, synthesis, generalization, research on the results of STEM education activities and the current status of STEM education capacity of high school teachers in Tuyen Quang province, method of asking for opinions experts...

3. Research results

3.1. Principles of proposed solutions

Principles ensure the objectiveness of the educational process

The primary purpose of the new education is to educate the full person, with a focus on character education. Educational activities in various conditions of general schools are focused toward the educational process's aims. As a result, establishing STEM education ability for high school instructors must be founded on the personality development of learners' educational goals.

Ensure educational principles

First and foremost, initiatives to improve STEM educational competence for high school teachers must adhere to general educational principles. That is the meaning of "learning combined with practice, education combined with productive labor, school associated with society." Simultaneously, ensuring

the fundamental principles of teaching theory and educational theory. Human education principles are built on the fundamental foundation of learning human ethics - the highest goal of education - and on the fundamental content of humanistic philosophy: all for people, all for people.

Ensuring practicality and efficiency

This principle ensures that solutions to enhance STEM education capacity for high school teachers are based on the limitations and obstacles that occur in practice, as discussed in detail in chapter 2. The solution must be determined in terms of suitable costs, minimal time consumption, and human resource savings, but the outcomes must be high. The issue of efficiency, practicability, and cost-effectiveness is critical to achieving the objective of creating STEM teaching capacity in high school instructors.

3.2. Solutions to build teachers' competence to plan and organize stem education activities in Tuyen Quang province in order to meet the new general education program

3.2.1. Raising STEM education awareness among management of Departments/Offices of Education and Training, schools, and teachers, as well as developing STEM education competence among teachers

Aim: Raise STEM education awareness among the Department of Education and Training, schools, administrators, and teachers, and develop STEM education capability among instructors. Teachers will have a sense of learning, studying, and building STEM education capacity as a result of managers' proper and comprehensive awareness, consequently boosting the efficacy of the quality of organizing STEM education activities in schools.

Content and implementation:

Strengthen propaganda to raise awareness of the meaning and importance of STEM education among educational management agencies at all levels, general education institutions, parents, students, and the community, and to develop STEM education capacity for teachers for comprehensive fundamental innovation in education and training in general, and general education innovation in particular.

To ensure high consistency in implementing tasks and solutions, thoroughly understand the guiding

documents of educational management levels on educational activities related to STEM education.

Strengthen coordination in organizing STEM education propaganda activities for high school students such as: STEM Festival; Exchange activities of students, teachers, educational administrators with universities, businesses, scientists, managers, businessmen...

Supplement and finish directive and advice materials; Create guide documents for STEM education implementation.

Enhance the organization of training and development for managers and instructors in the management and implementation of STEM education activities. Increase the effectiveness and quality of STEM instructional programs.

Strengthen facilities and teaching equipment for STEM education.

Collaborate with higher education institutions, research institutes, businesses and other educational institutions and strengthen management of STEM education.

Conditions for implementation: materials and guidance materials from all levels of educational management and policymakers are required. Conditions in terms of human resources and guaranteed facilities are required.

3.2.2. *Create a process for designing STEM instructional activities that are appropriate for local practical conditions.*

Aim

Preparing an effective lesson plan is critical in student-centered STEM teaching approaches. A teacher will have to produce multiple STEM lesson plans for lessons during the school year, thus there must be a design and execution process that takes into account the school's practical conditions as well as the learners' skills. [10], [11], [12], [15], [16]... We propose in this study a process for planning STEM lessons/topics, a method for designing STEM experience activities, and a process for guiding students to explore science and technology, all of which include brief, scientific, and technological processes. Tuyen Quang province's reality is consistent.

Content and implementation

a. STEM lesson/topic design process (STEAM)

- *Step 1. Identify the STEM topic and STEM knowledge that needs to be addressed*

- *Step 2. Identify STEM topic goals*

- *Step 3. Develop product criteria/problem solving solutions and a set of guiding questions*

- *Step 4. Design the process of organizing teaching activities*

- *Step 5. Design an evaluation, adjustment and development plan*

Differences of the above process compared to other processes:

- The design process steps ensure that the elements in the closed structure of the teaching process (goals, content, methods, organizational form, and evaluation of teaching results) are in place.

- Step 5 broadens the element of adapting and expanding the teacher's design through talks with colleagues and educational experts about the design's benefits and limitations, from which instructors practice. Develop the capacity to design, change, assess, and create STEM teaching strategies that are appropriate for the situation.

The process of organizing teaching of STEM topics

Based on the guidance of the Ministry of Education and Training (2022), we propose to organize STEM education teaching including 5 activities:

Step 1. Identify design and manufacturing problems

Step 2: Research background knowledge and propose design solutions

Step 3. Choose a design solution

Step 4. Prototype fabrication, testing and evaluation

Step 5. Share, discuss, adjust

b. STEM experience activity design process

STEM experiential activities are a type of STEAM education in which educators design activities associated with practice, integrating content from fields (Science, Mathematics, Arts, Technology, Technique), with the goal of directing students to actively and proactively participate in learning and know how to apply newly learned knowledge to solve problems,

thereby contributing to the development of students' qualities and abilities.

We suggest a process for building STEM/STEAM experience activities that includes the following fundamental steps [5], [2] by analyzing Official Dispatch No. 3089/BGDDT-GDTTrH (2020); Overall education program 2018, Subject program, and researching the theoretical overview of STEM and practical survey.

Step 1. Find out students' needs, understanding and cognitive abilities

Step 2. Select the content and name the activity topic

Step 3. Determine operational goals

Step 4. Design the process of organizing STEM experience activities

The process of organizing STEAM experience activities is based on active teaching methods and strategies, with the five categories of learning activities listed below:

- Activity 1: Define the problem (design and production specifications).

- Activity 2: Conduct background research and propose design options.

- Activity 3: Present and discuss design possibilities, using background knowledge to explain, justify, and select the best solution (if multiple solutions are available).

- Activity 4: Produce products/equipment... in accordance with the design plan (updated in response to comments); test and evaluate.

- Activity 5: Display and discuss made objects; make changes to the original concept.

Step 5: Assess and create STEAM experience activity themes.

Assess pupils' work using specific criteria. The criteria must also assure the direction of the learning process and the application of students' prior knowledge. Teachers suggest strategies to develop activity subjects at a higher level based on students' knowledge and skills.

The method of directing pupils via scientific and technological research.

The greatest level of STEM education is organizing scientific and technical research activities, in which STEM themes can be integrated through scientific research activities and scientific and technology contests. This activity is not open to all pupils, but rather to those who have the capacity, interest, and enthusiasm for scientific investigation, discovery, and practical problem-solving approaches.

For students, there are two forms of research in scientific and technical research: engineering projects and science projects. These projects are determined by the cognitive capacity of students at each level. Based on research and theoretical references from published works, we offer the following eight phases to aid students in scientific and technical research:

Step 1. Choose a research topic/topic

Step 2. Research overview and build a theoretical framework

Step 3. Develop an outline/explanation of the topic/project

Step 4. Organize research

Step 5. Publish a scientific article about the research results of the topic/project (if possible)

Step 6. Write a report summarizing the topic/project

Step 7. Presentation introducing the topic/project

Step 8. Evaluate, accept and adjust

Implementation conditions

There is a need for assistance in training instructors on generating STEM educational content, exploiting STEM topics in present curricula, and STEM teaching methodologies. Methods for stimulating pupils' interest in science and creative discovery.

Furthermore, increased cooperation and support from leaders at all levels, universities, research institutes, STEM education centers... are required. Improve school physical facilities.

3.2.3. Create training programs and organize teacher training so that instructors understand STEM education and can execute it.

Aim

Create programs and organize teacher training so that instructors understand STEM education and are able to execute it.

Content and implementation

The teaching staff determines the successful implementation of the STEM Education Program. Therefore, enhancing their capacity is extremely important.

The Department of Education and Training and the Office of Education and Training need to pay attention to this work and organize training for teachers on the following contents and steps:

- (1) Identify the training needs of the teaching staff
- (2) Determine the goals of training teachers

The amount of knowledge includes 5 modules. Training time: 60 hours. Total time is 45 hours of theory, discussion, and practical instruction; 15 hours of self-study and self-study.

Table 1. Structure of training program

No	Content	Số tiết				
		Total	Theory	Discussion	Practice introduction	Self-study
	Disseminate training programs and rules (Students research and learn at the beginning of the course)					
1	Module 1: Basic issues about STEM education and the competencies teachers need to organize STEM education activities	10	3	4		3
2	Module 2: STEM education is included in the 2018 general education curriculum.	10	3	4		3
3	Module 3: Capability to plan and implement STEM instructional activities in the 2018 general education curriculum.	15	5	5	3	2
4	Module 4: STEM education assessment capabilities	5	1	1	1	2
5	Module 5: Develop your ability to plan and coordinate STEM instructional programs for instructors.	20			15	5
	Evaluate training results					
	Total	60	12	14	19	15

- 4) Develop a teacher training plan
- 5) Innovate the organization of teacher training
- 6) Teacher training methods
- 7) Innovate assessment of training results

Implementation conditions

Planning, structuring training programs, teaching materials, motivating workers to participate, facilities,

(3) Developing the content of the training program

First of all, based on the requirements for implementing the 2018 General Education Program, the requirements for implementing the STEM Education Program and some research on the STEM education competency framework for teachers[2], [2], [8], [9], [11] [13], [16], [17], [18]... we develop a training program to improve the capacity of teachers, focusing on the issues mainly later

3.2.4. Develop strategies and maintain STEM clubs in high schools

Aim

Building STEM clubs in high schools helps students refine their learning skills while also creating a learning environment that allows students to apply what they've learned to real-life circumstances. STEM clubs play a critical part in achieving this goal in today's STEM education environment.

Content and implementation

Below are 8 basic steps to building a STEM club.

- Step 1. Build vision and commitments
- Step 2. Build an organizational structure
- Step 3. Prepare logistics
- Step 4. Attract students to participate
- Step 5. Organize activities in each session
- Step 6. Invite parents to participate
- Step 7. Invite experts to participate.
- Step 8. Store information and build images of the club's activities

Implementation conditions

Teachers must implement effective strategies to engage and entice students to participate in and sustain Club activities. Plans and monthly performance reports are required. Furthermore, a team of club administrators who are motivated and responsible young students and teachers is required.

3.2.5. *Create school education programs and professional team strategies that focus on STEM education and create the circumstances for its implementation.*

Aim

To achieve the utmost efficiency in implementation, develop school education programs and professional team plans that focus on and establish circumstances for implementing STEM education.

Content and implementation

High schools must develop school education programs and strategies that emphasize and balance experiential activities, STEM scientific research activities, and STEM teaching.

As a result, professional teams must assign duties to members of the professional team (individuals or groups of teachers) at the beginning of each semester and school year. Some STEM learning activities. High schools, in particular, require relationships with universities and STEM education experts for advice and professional help.

Organize STEM education capacity building for school/subject teachers. The following is the training procedure:

(1) STEM education theory research: Teachers learn and conduct research to systematize concepts, aims, application circumstances, and the process of developing and organizing STEM education in high schools.

(2) witness STEM lessons: Following STEM education orientation, teachers witness STEM lessons and topic lessons. From there, observe and collect data on: how to organize STEM teaching activities; student activities; difficulties and problems encountered when applying STEM teaching subjects... As a result, you will have mastered the process of organizing and teaching STEM concepts. Furthermore, the outcomes of student activities, such as good cooperation, active activities, and competency with processing equipment... provide compelling evidence of the benefits of STEM education.

(3) Experience sharing: Teachers share their experiences with designing and producing things, developing STEM themes, organizing STEM activities for students, and so on.

(4) Create STEM themes and sample STEM lesson plans: distribute STEM subjects and sample STEM lesson plans to groups of teachers.

(5) Put a sample into action STEM lesson plan: example organization STEM teaching hours are used to watch classes, gather data, and provide feedback to the team of teachers that develop and organize the class.

(6) Packaging and sharing: After viewing STEM lesson plans, the experiences will be shared with instructors in the school together with subjects and lesson ideas. Topics and lesson plans should also be posted on educational forums in order to gather input for future improvement.

Implementation conditions

The unique STEM program must be expressed in the school education program and the professional team plan, which clearly outlines the content, implementation technique, assessment, and reporting regime.

3.2.6. *Promote collaboration between teachers inside and outside the school into a STEM education community of high school teachers*

Aim

Promote collaboration between teachers inside and outside the school into a STEM education community

of high school teachers. Schools or clusters of schools, or groups of teachers in an educational unit such as the Department of Education and Training, District or Province need to establish a specialized STEM group for teachers to share learning. Together, we can design sample, typical STEM educational activities, which will then be adjusted and deployed in schools to suit their own contexts.

Content and implementation

- Create STEM education idea banks for various types of lessons, experiential activities, and scientific research.

- Create public, legal forums with prominent STEM professionals via social networks such as Zalo groups, Facebook, and STEM education websites so that teachers can exchange, discuss, and promote social STEM socialization. Furthermore, educational institutions must urge teachers to invest in and devote more time to STEM instruction. Teachers who have made significant contributions to STEM education, in particular.

- Develop and organize a training course to develop the capacity to design and organize STEM educational activities for teachers (including website <https://stemtuyenquang.com/>, teacher training materials on STEM education, toolkit for assessing teachers' STEM education competencies). Create STEM websites and social networking groups to share lesson plans and experiences with implementing excellent STEM education in various schools. Teachers can then turn to extra advice materials, lesson plans, visuals, and so on while planning STEM activities at school.

- Plan inter-school professional development activities and invite educational professionals to instruct students on STEM education subject.

Implementation conditions.

There needs to be a unit to act as a contact point, connecting the STEM teacher education community into groups and organizations to maintain activities and provide necessary materials.

3.2.7. Develop a set of criteria to evaluate the quality of STEM education

Aim

The Department of Instruction and Training must lead the development of a set of standards to assess the quality and efficacy of STEM instruction in schools. As a result, recognizing flaws and limits in order to take appropriate direction and modification steps or reproduce good models.

Content and procedure

Based on prior scientists' research, we suggest a set of criteria for evaluating the quality of STEM education that includes the following areas:

The following is the procedure for defining a set of standards to assess the quality of STEM education:

- Step 1: Research the present state of STEM education quality and efficacy, as well as the current state of STEM education capability among teachers and administrators.

- Step 2: Create a profile of the following aspects of the teaching plan: teaching material; teaching methods; checking and evaluating teaching results; teaching environment.

First area: Teaching plan

Criterion 1: Each topic, subject, and school year, semester, month, and week has its own set of teaching plans.

Criterion 2: The teaching plan clearly forecasts the qualities and abilities that students must develop through STEM themes and interdisciplinary disciplines.

Criterion 3: The teaching plan is flexible enough to meet the needs of developing students' traits and abilities in STEM education.

Criterion 4: The teaching plan prioritizes students' experimental, practical, knowledge application, problem solving... activities; allot adequate time for independent activities and creative experiential STEM activities.

Second area: Teaching content

Criterion 5: STEM topics are designed with teaching content that is tailored to each student's interests, development of traits, talents, and learning style.

Criterion 6: Teaching content guarantees that students make consistent progress at each stage of learning and throughout the learning process.

Criterion 7: Teaching content teaches students how to make things based on what they've learned in STEM experiential activities.

Third area: Teaching methods

Criterion 8: The teaching techniques and instructional support conditions are appropriate for the subject matter.

Criterion 9: Teaching techniques should emphasize teaching pupils how to learn and think.

Criterion 10: Teaching approaches that inspire students to be creative in their creation and application of STEM concepts.

Criterion 11: Teaching approaches that stimulate self-study and research.

Criterion 12: Teaching approaches tailor learning activities to each student's requirements and abilities. The fourth field is the type of teaching organization.

Criterion 13: A variety of teaching methods used both within and outside the classroom (class time; discussion time; group work time; self-study time, self-research on STEM issues...).

Criterion 14: The form of educational organization includes social activities, extracurricular activities, scientific research exercises, and so on.

Criterion 15: Information technology and digital transformation are employed to support teaching organization forms.

The fourth field is testing and assessing instructional outcomes.

Criterion 16: The organization of teaching promotes dependability and validity.

Determine students' capacities based on learning outcomes for each level and subject (criterion 17).

Criterion 18: The teaching organization's structure promotes the growth of students' intelligence and creativity in addressing real-life problems and applying knowledge of STEM design issues.

Methods (observation, questions and answers, multiple choice, demonstration, learning projects, student records...), forms (assessment diagnostics, formative assessment, and summative assessment...), and tools (questions, tests, essays, practice reports,

observation forms, self-assessment...) diversify the form of teaching organization.

Criteria 20: Create procedures for assessing student capacity.

The fifth field is the teaching environment.

Criterion 21: Interaction between professors and students, as well as between students in extracurricular activities, research, and innovation...

Criterion 22: Teachers and students share their experiences in activities.

Criterion 23: Provide teachers and students with opportunities for creative expression and initiative.

- Step 3. Design a rubric to evaluate the quality of STEM education

A questionnaire to assess the quality of STEM education is being developed based on the five fields and 23 criteria listed above. The evaluation form has 23 criteria and covers five topics. Each criterion is graded on three levels: satisfactory, outstanding, and excellent.

How to categorize and assess the quality of STEM education

Achieving a good level requires that all criteria meet a good level or above, and that at least two-thirds of the criteria meet a good level.

To achieve the good level, all criteria must be met at the pass level or above, with at least two-thirds of the criteria meeting the good level or better.

To achieve the passing level, all criteria from the passing level onwards must be met. Teachers will be evaluated on a yearly basis at the end of the school year.

Every two years, at the end of the school year, the head of the general education institution organizes a periodic review. In exceptional circumstances, and with the approval of the superior management agency, the school shortens the teacher assessment cycle.

Implementation conditions

The set of criteria is designed based on the practical situation of the school and locality.

3.2.8. *Fostering the ability to design and organize STEM educational activities for pedagogical students*

Aim

To achieve the passing level, all criteria from the passing level onwards must be met. Teachers will be evaluated on a yearly basis at the end of the school year. Every two years, at the end of the school year, the head of the general education institution organizes a periodic review. In exceptional circumstances, and with the approval of the superior management agency, the school shortens the teacher assessment cycle.

As a result, pedagogical schools must quickly incorporate STEM education elements within their training programs. The training program must be improved to include core modules of basic sciences so that students have a broad enough prior knowledge to carry out STEM education easily. This is an important issue because our country's teacher training approach mostly educates single-subject teachers. General courses in Physics or Informatics, for example, might be added to the Bachelor of Mathematics Education curriculum to provide students with a broader multidisciplinary scientific background.

Content and implementation

Based on theoretical research and the practice of teacher training in STEM education, the research team recommends that teacher training institutions add STEM education modules to their training programs and develop STEM education capacity for high school teachers when reviewing and adjusting undergraduate and postgraduate training programs.

The school and lecturers must design the program, as well as the substance of each class, with STEM emphasis in mind. If there is no single subject that highlights the usage of STEM in the teaching process, STEM ideology should be expressed throughout the majority of subjects.

Designing and organizing STEM instructional activities in high schools are additional topics that can be included. Students can learn more about STEM teaching and participate in STEM educational activities by using this module. As a result, students have a better understanding of how to select STEM topics and develop the method of arranging the teaching of that topic. Finally, in high school, pupils are taught the designed topic and graded on its feasibility. Students will be able to answer basic STEM questions and have STEM abilities by the end of the modules, such as: What is a STEM problem? How will teachers plan activities in which kids may participate while

still being practical? What skills will students require to take part in those activities? By what process can STEM-oriented teaching activities be designed? How do students evaluate during that process?...

Implementation conditions

The training program must include STEM education modules, professional teachers, and qualified resources, textbooks, and facilities.

4. Conclusion

The study examined and offered eight options for developing teachers' capacity to arrange STEM activities. The solutions mentioned above have a dialectical relationship in which they influence one another. The simultaneous implementation of the aforementioned solutions will help to promote STEM education in high schools. This is an important and urgent task in the current setting since STEM can be done using a variety of pedagogical methodologies that are appropriate for local conditions.

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