

PROPOSAL FOR MEASURES OF FOSTERING THE CAPACITY DESIGN AND ORGANIZATION OF STEM EDUCATION ACTIVITIES FOR ELEMENTARY TEACHERS OF LANG SON PROVINCE

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Abstract

The article presents three groups of measures to foster capacity in designing and organizing STEM education activities for primary teachers in Lang Son province. The proposed groups of measures are based on: the theoretical basis of the opportunity to apply STEM education in primary schools, the capacity structure to design and organization STEM education activities; the practical basis of the actual situation of assessing the capacity to design and organization STEM education activities of 87 primary teachers in Lang Son province, as well as the teachers' desire to improve this capacity.

Keywords: *STEM education, primary teacher, design and organization of STEM education activities capacity.*

1. Introduction

STEM education with the mission of providing necessary knowledge and skills for people in the 21st century is and will be a large-scale education model in the near future of the world. Learning STEM to catch up with the trend of advanced education development is a step to lay a solid foundation for the future development of the country [1]. In line with that trend, STEM education has been put into the 2018 general education curriculum in Vietnam. For primary school, STEM education helps to equip students

with the necessary knowledge and skills in the current information technology era to stimulate students' creativity. At the same time, equipping students with soft skills such as critical thinking, teamwork, communication ability, etc. Through group activities, students will be guided by teachers to conduct research. understand background knowledge, perfect drawings and products of each STEM topic [2].

In the world and in Vietnam, there have also been studies on improving capacity of organizing and designing STEM education

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activities, and STEM education competencies for teachers. Kurup *et al.* (2019) pointed out the fact that primary school teachers are not equipped with enough knowledge about STEM education, they need the courses to develop expertise in STEM teaching, capable of integrating disciplines, providing an understanding of pedagogical approaches, and connecting to real-life relevance with the twenty-first century competencies [3]. Primary teachers need to be supported early in STEM teaching so that they can attract students to participate in science activities in the classroom [4]. They want to have more resources and teaching materials to support them to carry out STEM teaching with appropriate methods [5].

Duong Thi Hien (2020) through her research also has pointed out that the structure of STEM education competence includes 7 components. Since then, she has also proposed training objectives, training content, fostering methods and forms of fostering the STEM education competencies for teachers in primary schools in general [6]. Nguyen Mau Duc *et al.* (2021) based on the basis of assessing the reality of teaching STEM subjects of teachers in high schools in the Northern mountainous region, the assessing teachers' perceptions about education STEM and factors affecting the development of teachers' STEM education capacity, the assessing the capacity to design and organize STEM education activities in high schools in the Northern mountainous provinces have proposed a "Some measures to implement fostering and design STEM education activities for high school teachers in the northern mountainous provinces of Vietnam" to meet the requirements of the new general education program [7]. Kieu Thi Thu Giang (2021) has proposed to build criteria

for assessing skills in designing STEM education activities for students majoring in primary education at Hanoi Capital University based on 5 skill elements, which include: observation skills, questioning skills, practicing skills, evaluation and improvement skills [8].

Since then, it can be seen that the task of developing the capacity to organize and design STEM education activities for high school teachers in general and elementary school teachers, in particular, is required and needs to be researched further. Additionally, in order to perform this task, it is necessary to clarify the component structure of competence, and assess the level of achievement corresponding to the components of competence of current primary teachers to propose appropriate remedial measures. In the framework of the article, we are interested in measures to foster the design and organization of STEM education activities capacity of primary teachers in Lang Son province.

2. Methods

2.1. Theoretical research method

The method is applied to research and learn about STEM education, opportunities to apply STEM education in teaching at primary school; research, analyze the structure of design and organization of STEM education activities capacity; propose solutions to foster this capacity for primary teachers.

2.2. Investigation and survey method

Purpose: to assess the teacher's understanding of STEM education, the capacity of primary teachers to design and organize STEM educational activities,

and the advantages and disadvantages of organizing STEM education activities in primary schools, teachers' wishes to develop the design and organization STEM education activities capacity. +) Subjects of the survey: 87 primary school teachers in Lang Son province who are students in the primary education college class at Hung Vuong University. +) The survey tool is a questionnaire using closed questions, open-ended questions and a 5-level Likert attitude scale: Level 5: Do very well/understand very well/very proficiently (5 points); Level 4: Do well/well-understood/competent (4 points); Level 3: Do normally/slight understanding (3 points); Level 2: Do not do well/have any understanding/not proficient (2 points); Level 1: Not good at all /completely ignorant/very unskilled (1 point). +) Survey form: an online survey using the Google Forms tool. +) Data processing: calculate the percentage of the answers and the average score (means); The assessment results based on the means are determined as follows: Very well done/very well understood/very proficient ($4.2 \leq \text{means} \leq 5$); Do well / understand well / proficiently ($3.4 \leq \text{means} < 4.2$); Do normally/have a little understanding ($2.6 \leq \text{means} < 3.4$); Do not do well/do not have any understanding/do not master ($1.8 \leq \text{means} < 2.6$); Totally not good/completely ignorant/very unskilled ($1 \leq \text{means} < 1.8$).

3. Results and discussion

3.1. Opportunities to apply STEM education in teaching at primary school

The primary education curriculum is designed to include compulsory subjects and education activities: Vietnamese; Maths; Foreign languages (in grade 3, grade 4, grade 5); Natural and social (in grades 1, 2,

and 3); History and Geography (in grades 4, 5); Science (in grades 4, 5); Informatics and Technology (in grade 3, grade 4, grade 5); Physical education; Arts (Music, Art); Experiential activities. Electives include; Ethnic minority languages, Foreign languages (in grade 1, grade 2) [9]. The STEM topic is about applying integrated knowledge in the fields of Mathematics, Science, Engineering, and Technology to solve real-life problems. In the Primary curriculum, STEM education can be applied in the subjects "Nature and Society" (grades 1, 2, 3), "Science" (grades 4, 5), "Informatics and technology" (grades 3, 4, 5).

3.2. The structure of design and organization of STEM education activities capacity

Different studies on the concept of competence agree that each competency consists of 3 main components [10]:

- i) Competency components describe one or more activities in the specific area of expertise, demonstrating the latent human capabilities;
- ii) Competence elements are the basic skills that make up each component;
- iii) Behavior indicators are the expected outputs of elements, components, etc.

Competent persons in a certain field of activity must have all the following basic signs [11]: Having systematic/in-depth knowledge or understanding of that type/field of activity; Knowing how to carry out that activity effectively and achieve results consistent with the defined purpose (including defining specific goals, appropriate ways/methods of action/choosing solutions, etc.) and conditions and means to achieve the goal); Act effectively, respond flexibly and effectively in new and strange conditions.

According to Nguyen Van Bien *et al.* [12], the process of developing a STEM topic includes the following steps: 1) Choosing a topic; 2) Identifying the problems (questions) to be solved in the topic; 3) Identifying the knowledge needed to solve the problem; 4) Determining the teaching objectives of the topic; 5) Determining the content of the teaching activities of the topic; 6) Making a plan to teach the topic; 7) Organizing teaching and evaluating topics.

Based on the structure of the capacity in general, the signs of a person who has

competence in a certain field, and the process of building STEM topics, we propose the design and organization STEM education activities capacity. The capacity structure is as follows:

Based on the structure of the capacity in general, the signs of a people who has competence in a certain field and the process of building STEM topics, we propose the design and organization STEM education activities capacity consisting of 7 competence components. Corresponding to each elements has behavior indicators. As follows:

Table 1. Structure of design and organization STEM education activities capacity

Elements	Behavior indicators
TKTC1: Select STEM topics	<ul style="list-style-type: none"> - Identify topics that match the way knowledge is formed, the level of knowledge, and the complexity of the technology. - Identify topics that meet the criteria of STEM topics.
TKTC2: Identify the problems (questions) to be solved in the STEM topics	Identify questions and content that students need to find answers in STEM topics.
TKTC3: Identify the knowledge needed to solve STEM problems	Identify the knowledge of subjects in the STEM field (Science, technology, engineering, math) to answer questions in the STEM topic.
TKTC4: Determine the teaching goals of a STEM topic	Express goals to consistent with quality development, general capacities development, and specific capacities development in STEM education.
TKTC5: Determine contents of teaching activities in STEM topics	<ul style="list-style-type: none"> - Anticipate a series of learning activities in line with the goals. - Anticipate the conditions to carry out the learning activities to ensure goals.
TKTC6: Create STEM topic teaching plans	<ul style="list-style-type: none"> - Select teaching methods and techniques suitable for activities in STEM topics. - Design learning activities clearly about the purpose, contents and expected learning products that students must complete. - Design a clear way to organize learning activities suitable inside and outside the classroom. - Design learning tasks, testing tools, and appropriate assessments to achieve goals.
TKTC7: Organize to teach and evaluate STEM topics	<ul style="list-style-type: none"> - Organize to teach STEM topics according to the proposed lesson plan. - Conduct teaching flexibly in accordance with the conditions of equipments, facilities, students' levels and allowed time. - Evaluate STEM topics according to the following aspects: The relevance of teaching practice to the expected duration; the level of achievement of students' goals; students' interest in the topic; feasibility level with facilities. - Adjust and supplement STEM topics accordingly.

3.3. The current situation of the ability to design and organize STEM education activities of primary teachers in Lang Son province

From conducting the survey, we have obtained the results shown in the table below:

Table 2. Survey results on the capacity to design and organize STEM education activities of primary teachers in Lang Son province

Surveyed contents	Means	Classification
1. Self-assessment of your understanding of STEM-oriented teaching in primary school	3.36	Slight understanding
2. Self-assessment of the level of components of the design and organization of STEM education activities capacity		
TKTC1: Select STEM topics	3.31	Do normally
TKTC2: Identify the problems (questions) to be solved in the STEM topics	3.24	Do normally
TKTC3: Identify the needed knowledge to solve STEM problems	3.29	Do normally
TKTC4: Determine the teaching goals of a STEM topic	3.29	Do normally
TKTC5: Determine contents of teaching activities in STEM topics	3.30	Do normally
TKTC6: Create STEM topic teaching plans	3.30	Do normally
TKTC7: Organize to teach and evaluate STEM topics	3.28	Do normally
3. Self-assessment of the application level of teaching methods in STEM education		
Teaching based on project	2.86	Do normally
Teaching based on problem - solving	3.00	Do normally
Teaching based on inquiry	2.99	Do normally
Teaching based on experience	2.97	Do normally

Table 3. Actual situation of organizing STEM education activities at some primary schools in Lang Son province

Questions	Opinions	
	Number	Percentage (%)
1. Frequency of organizing STEM education activities at the school/locality where you are working		
Very often	1	1.15
Regularly	23	26.44
Sometimes	57	65.52
Seldom	5	5.75
Never	1	1.15
2. Scale of organization of STEM education activities at the school you are working for		
School size	35	40.23
Grade size	22	25.28
Class size	44	50.57
Never	1	1.15
3. How do you known to teach STEM-oriented education? (can choose more than one option)		
Self-study	25	28.73

Questions	Opinions	
	Number	Percentage (%)
Participating in the program organized by the education department	49	56.32
Living in specialized groups	51	58.62
Through mass media	20	22.99
Through other routes	7	8.05
4. What are the advantages that your school has when implementing STEM education activities? (choose multiple options)		
Teachers have been trained in STEM education activities	56	64.37
The close attention and direction of the Board of Directors	56	64.37
The convenience of facilities and space in the school	21	24.14
The enthusiastic teachers, actively innovate in teaching	45	51.72
The support from the student's family	26	29.89
The support of the forces in the school	30	34.48
The support from outside forces	7	8.05
The other factors	7	8.05
5. Difficulties that your schools encounter/will encounter when implementing STEM educational activities (choose multiple options)		
The facilities, organization space	55	63.22
The students (level, interest level,...)	41	47.13
The cooperation of the student's parents	32	36.78
The local coordination	18	20.68
The coordination of other forces in the school	9	10.34
The financial problem	42	48.28
The design of school-appropriate themes	23	26.44
The other factors	9	10.34
6. Your desire to improve your abilities to design and organize STEM education activities (choose multiple options)		
Equipped more knowledge about STEM education	64	73.56
Equip more knowledge about the process of organizing and implementing STEM education	47	54.02
Equipped more knowledge about active teaching methods and forms in STEM education	46	52.87
Get more practice on designing STEM education topics by lesson	46	52.87
Get more practice on designing STEM education topics according to experiential activities	34	39.08
Get more practice on designing STEM education topics according to scientific research topics/projects	30	34.48
Practiced more about organizing STEM education activities	36	41.38
Practiced more on building assessment tools for students' competence in STEM education activities	32	36.78
Other wishes	5	5.75

From the survey results in Table 2, the teachers all rated themselves as having little understanding of STEM education. Regarding the level of implementation of the steps in the process of building STEM topics (the level of the component competencies of the capacity to design and organize STEM educational activities: TKTC1, TKTC2, TKTC3, TKTC4, TKTC5, TKTC6, TKTC7), the teachers self-evaluated as “do normally” (level 3). This is also consistent with our evaluation results when directly guiding students in the process of teaching the subject “STEM-oriented teaching in primary school”.

About the cause: With this self-assessment result, it can be explained that teachers have unequal access to STEM education. In which: self-study (28.73%); participating in the program organized by the education department (56.32%); living in specialized groups (58.62%); through mass media (22.99%); through other routes (8.05%). Teachers who have access to STEM education through many different ways, self-assessed their competency levels at level 4 (doing well) but at a very modest rate. Inadequate understanding of STEM education can be considered as the biggest barrier for teachers when designing and implementing STEM education activities in primary schools in different ways. In addition, in the process of implementing STEM education activities at primary schools, there are also difficulties such as: Facilities, organization space (63.22% of opinions); difficulties from the students' side (level of knowledge, level of interest,...) (47.13% of opinions); financial difficulties (48.28% of the respondents) (Table 3). These difficulties will limit teachers' ability to organize STEM education activities.

From the results of Table 3, in order to improve the capacity of designing and organizing STEM education activities, teachers want to be: equipped with more knowledge about STEM education (73.56%); equipped with more knowledge about the process of organizing and implementing STEM education (54.02%); equipped with more knowledge about active teaching methods and forms in STEM education (52.87%); get more practice on lesson-based STEM education topic design (52.87%); get more practice on designing STEM education topics according to experiential activities (39.08%); get more practice on designing STEM education topics according to scientific research topics/projects (34.48%); practiced more about organizing STEM education activities (41.38%); practiced more on building tools to assess students' competence in STEM education activities (36.78%).

3.4. Proposing measures to foster capacity in designing and organizing STEM education activities for primary teachers in Lang Son province

Based on the current situation and the need for fostering capacity in designing and organizing STEM education activities of primary teachers in Lang Son province, we propose a number of measures to focus on fostering knowledge about STEM education, fostering STEM education topic design, fostering the organization of STEM educational activities. As follows:

- Firstly, continue to organize training sessions for teachers on STEM education.
- + Purpose: To improve teachers' knowledge about STEM education including: knowledge of general issues about STEM education (concepts of STEM education,

trends in the development of STEM education in the world, goals of STEM education, methods and forms of active teaching in STEM education), knowledge about building a teaching plan for STEM topics/lessons, practice building STEM topics/lessons in elementary education programs.

+)How to perform: In the school year plans, teachers propose to the direct management agency to organize sessions for teachers on STEM education organizations in primary schools. Associate with higher education institutions that train primary school teachers, and invite their experts to train teachers on STEM education. Accordingly, the training plans should closely follow the needs of the implementation of STEM education in each school. During the course of training, it is necessary to strengthen the problem-solving, individual study of documents, and group discussions of trainees, focusing on the trainees' existing experience. After the training course, there is an assessment of the effectiveness of the training, closely following the capacity structure of design and organization STEM education activities, to give recommendations to the trainees to continue to take measures to self-improve which competency components that the trainees have not yet performed well.

- Secondly, strengthen professional activities in the subject group on STEM education.

+) Purpose: Enhance the sharing among teachers in the subject group on knowledge and experience in designing and organizing STEM educational activities for elementary students; strengthen sharing of experiences in choosing STEM topics suitable for students, school's physical conditions and associated with practical issues of the locality of Lang Son province.

+) How to perform: In the work plan of the school year, the subject team assigns specific tasks to teachers who have participated in training / or have certain experiences in STEM education to develop and organize teaching topics/lessons STEM; nominate subject teachers to attend classes and learn from experience; organize a professional meeting to learn from and share about how to organize STEM education activities. The professional meeting needs the participation of representatives of the management board to listen to the teachers' opinions in the implementation process as well as to have further directions on how to promote STEM education in the school.

- Thirdly, enhance the practical experience for teachers about STEM education activities.

+) Purpose: Improve the ability to apply typical teaching methods in the organization of STEM education activities such as: teaching based on project, teaching based on problem-solving, teaching based on inquiry,... in specific STEM topics. Through the experience of STEM education activities, teachers can draw for themselves experiences in the building and implement specific STEM topics in different forms: teaching science subjects through STEM lessons, and organizing STEM experience activities, organizing scientific and technical research activities.

+) How to perform: Step 1 - Experience, primary school teachers design a specific STEM education teaching plan in different forms, experience observing the organization of STEM lessons by colleagues, experience organizing STEM educational activities using available teaching plans...; Step 2 - Sharing, teachers share the results obtained after their experience, attention and observations and feelings in their performed

activities; Step 3 - Analysis, teachers discuss together, look back on the whole experience process; Step 4 - Generalization, relate to the knowledge equipped in STEM education, draw points to note when applying theory into practice; Step 5 - Application, teachers use the acquired knowledge and skills in similar or other situations.

The group of measures that we propose are also suitable for the fostering needs of primary school teachers in general (domestic and foreign) on STEM education knowledge, in line with the methods of fostering STEM education competencies for primary school teachers in general proposed by Duong Thi Hien. At the same time, these measures is also based on the specific characteristics of primary school teachers in Lang Son province.

4. Conclusions

Currently, in Vietnam, there is no training program for teachers specializing in STEM education in general and teachers teaching STEM education in primary schools in particular. Teachers who organize STEM education activities are subject teachers. The knowledge and skills that they acquire are through different ways such as training classes, seminars, self-study, etc. Based on the survey results, the research has shown the level of competence in designing and organizing STEM education activities of primary school teachers in Lang Son province as well as assessing the difficulties and advantages of organizing STEM education activities. Since then, the research has proposed a number of measures to contribute to improving this capacity for teachers. Regular training to improve competence through different methods is expected to help primary teachers in Lang Son province effectively apply STEM education in primary

schools, successfully realize education goals, bring education in Lang Son province to develop and more.

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Appendix

SURVEY QUESTIONS

(For University students majoring in Primary Education)

To improve the capacity of designing and organizing STEM education activities for primary school students. Please answer the following questions! The questions are not used to evaluate students.

Part I. General information about students

1. Student’s full name (optional):
2. Working unit (name of agency and specific address):.....
3. Characteristics of your working unit:
 - Belongs to a particularly difficult area
 - Border area
 - Mostly ethnic students
 - Other characteristics
4. Working seniority:.....

Part II. Evaluations of students

Question 1. Frequency of organizing STEM education activities at the school/locality where you are working

- Very often
- Regularly
- Sometimes
- Seldom
- Never

Question 2. Scale of organization of STEM education activities at the school you are working for

- School size
- Grade size
- Class size
- Never

Question 3. Self-assess your level of understanding about STEM-oriented teaching in primary school

- Understand very well
- Well-understood
- Slight understanding
- Do not have any understanding
- Completely ignorant

Question 4. How are you known to teach STEM-oriented education? (can choose more than one option)

- Self-study
- Participating in the program organized by the education department
- Living in specialized groups
- Through mass media
- Through other routes

Question 5. Self-assess your level of implementation of the steps in the process of building STEM topics

Contents	Your opinions				
	Do very well	Do well	Do normally	Do not do well	Not good at all
TKTC1: Select STEM topics					
TKTC2: Identify the problems (questions) to be solved in the STEM topics					
TKTC3: Identify the knowledge needed to solve STEM problems					
TKTC4: Determine the teaching goals of a STEM topic					
TKTC5: Determine contents of teaching activities in STEM topics					
TKTC6: Create STEM topic teaching plans					
TKTC7: Organize to teach and evaluate STEM topics					

Question 6. Self-assess the level of application of the following teaching methods in your teaching practice.

Contents	Your opinions				
	Very proficient	competent	Do normally	Not proficient	Very unskilled
Teaching based on project					
Teaching based on problem - solving					
Teaching based on inquiry					
Teaching based on experience					

Question 7. What are the advantages that your school has when implementing STEM education activities (choose multiple options)

- Teachers have been trained in STEM education activities
- The close attention and direction of the Board of Directors
- The convenience of facilities and space in the school
- The Enthusiastic teachers, actively innovate in teaching

- The Support from the student's family
- The support of the forces in the school
- The Support from outside forces
- The other factors

Question 8. Difficulties that your schools encounter/will encounter when implementing STEM educational activities (choose multiple options)

- The facilities, organization space
- The students (level, interest level,...)
- The cooperation of the student's parents
- The local coordination
- The coordination of other forces in the school
- The financial problem
- The design of school-appropriate themes
- The other factors

Question 9. Your desire to improve your abilities to design and organize STEM education activities (choose multiple options)

- Equipped more knowledge about STEM education
- Equip more knowledge about the process of organizing and implementing STEM education
- Equipped more knowledge about active teaching methods and forms in STEM education
- Get more practice on designing STEM education topics by lesson
- Get more practice on designing STEM education topics according to experiential activities
- Get more practice on designing STEM education topics according to scientific research topics/projects
- Practiced more about organizing STEM education activities
- Practiced more on building assessment tools for students' competence in STEM education activities
- Other wishes.

ĐỀ XUẤT BIỆN PHÁP BỒI DƯỠNG NĂNG LỰC THIẾT KẾ VÀ TỔ CHỨC HOẠT ĐỘNG GIÁO DỤC STEM CHO GIÁO VIÊN TIỂU HỌC TỈNH LẠNG SƠN

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Tóm tắt

Bài báo trình bày về ba nhóm biện pháp bồi dưỡng năng lực thiết kế và tổ chức hoạt động giáo dục STEM cho giáo viên tiểu học tỉnh Lạng Sơn. Nhóm các biện pháp được đề xuất dựa trên: cơ sở lý luận về cơ hội áp dụng giáo dục STEM ở tiểu học, cấu trúc năng lực thiết kế và tổ chức hoạt động giáo dục STEM; cơ sở thực tiễn về thực trạng đánh giá năng lực thiết kế và tổ chức hoạt động giáo dục STEM của 87 giáo viên tiểu học tỉnh Lạng Sơn, cũng như mong muốn của các giáo viên nhằm nâng cao năng lực này.

Từ khóa: *Giáo dục STEM, giáo viên tiểu học, NL thiết kế và tổ chức hoạt động giáo dục STEM.*