Teachers’ views on implementing STEM education at secondary schools in Nam Dinh province

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Abstract: The goal of STEM education not only helps students master knowledge, but also aims at practical access through practical activities. Although the policy of introducing STEM education into the subject is available, teachers and educational administrators at the secondary schools still face many challenges in implementing STEM education in the subjects. Based on the main contents of the STEM education training materials of the Ministry of Education and Training, we designed a survey on the implementation of STEM education in secondary schools. The survey results from 150 teachers and educational administrators at secondary schools in Nam Dinh province indicate the advantages and challenges in implementing STEM education in schools, and also reflect the actual effectiveness of training courses, training materials for STEM education. Teachers’ opinions from the survey also suggest practical themes in order to implement STEM education efficiently.

Keywords: STEM education; secondary school; educational renovation; teachers’ views.

1. Introduction
The new general education curriculum will officially be applied from the 2020-2021 school year for primary education and the 2021-2022 school year for secondary education [21]. The content of the new general education curriculum emphasizes the practical and actual learning of learners, thereby developing learners’ competences and qualities. It is clearly that teachers determine the success of educational innovation because they are the recipients and implementers of all programs, plans and activities to achieve the innovation goals. However, it can be seen that stepping out of conform area is not an easy task. With the current education curriculum and working time, many teachers are afraid to invest in new teaching methods or new educational activities. In addition, there are objective factors such as the large number of students in the class, lack of facilities that limit the effectiveness of trying new teaching methods.

The objectives of STEM education are not only to equips students with knowledge of science, technology, engineering and mathematic, but also to develops the competence to apply knowledge to solve real-life problems, thereby increasing learning motivation, researching passion within students and connecting the school with society and community [1] [4] [7] [11], [33], [34]. A key feature of STEM education is the association of theory with practice and interdisciplinary integration. The curriculum for secondary school subjects in the new general education curriculum also emphasizes interdisciplinary integration and enhances practice. Therefore, applying STEM education in secondary schools will increase the probability of achieving the educational innovation goals. Since The Prime Minister's Directive No.16/ CT-TTg of May 4th 2017, STEM education has been particularly concerned and widely deployed [27]. The question is what is the real effect of those innovation movements? What is the teacher's attitude and awareness of new teaching methods? Is the need to change the teaching and assessment methods to positively enhance student activities?
This study focuses on understanding the perceptions of the teachers and educational administrators in secondary schools on the implementation of STEM education in the subject and designing educational activities. In addition, a number of factors that influence the implementation of STEM education in schools are also considered. The goal of this study is to provide some suggestions for improving the effectiveness of STEM education in secondary schools.

2. Literature review
There are number of research on the role of STEM education in the fulfillment of educational goals, developing learners' competence or the significance of teaching work [2][5][6][9][14][17][28][29][32]. Most of these studies have confirmed that STEM education increases the students' activeness in learning activities, thereby improving important skills for the 21st century on students [16][18][19]. Besides, STEM education has a positive impact on the teaching of teachers. Korthagen (2010) said that applying integrated teaching methods makes teachers expand their knowledge base, invest more in lesson design and teaching activities to improve lesson effectiveness [15]. Several studies explaining the teacher and administrator attitudes and perceptions of STEM [10][12][13][29][30][31][32].

In Vietnam, STEM education is implemented wildly in schools since the Prime Minister’s Directive No.16 / CT-TTg [27]. Most research on STEM education focuses on suggesting STEM education solutions in particular subject or topics [23][25][26]. Nguyen, Dao & Phan (2018) initially analyzed the status of implementing STEM education in high schools in Vietnam [24].

It is essential to study the appropriate conditions to implement STEM education into schools or lessons effectively when preparing to implement a new general education program. In addition, there has been no evaluation study on the process of applying STEM education to lessons that some documents have given.

3. Method
3.1. Objectives of the study
The specific objectives of the study were as follows:
- Understanding the awareness / views of secondary school teachers about STEM education
- Getting teachers’ feedback on facilitating factors or barriers to STEM education implementation in schools
- Assessing the difficulty of the steps in the implementation of the STEM lesson
- Identifying topics that can be easily applied STEM education effectively
- Getting teachers' opinions on the content of STEM education training courses they participated in

3.2. Significance of the study
The results of this study suggest a solution to the implementation of STEM education in lessons at secondary level, and also make some recommendations for the arrangement of training and retraining for teachers, especially on innovating teaching methods to achieve better results. In addition, secondary school teachers can refer to a number of teaching topics to apply STEM education. From administrative perspective, education administrators can overcome barriers to innovate teaching methods in schools.

3.3. Method of the study
The population of the study included the teachers and administrators in the secondary schools of Nam Dinh province. A random sample of 150 teachers and administrators was taken for the purpose of research. In order to collect the data, a questionnaire was developed, which consisted of 3 parts with 11 questions and 35 items

Part 1. Views on STEM education. The content of this section includes 3 questions. Based on MOET (2018) training materials on STEM education, teachers give their views on the goals of STEM education.

Part 2. Implementation of STEM education in secondary schools. This section contains 5 questions. The content of the questions includes ideas on factors affecting the implementation of STEM education in secondary schools. Based on the training materials on STEM education that secondary school teachers have been trained or approached, teachers give feedback on the difficulty of each step in designing STEM lessons and teaching activities. In addition, teachers also give their opinions on teaching contents/topics
that can be applied easily and effectively STEM education. In addition, the teachers also comment on the content of training materials on STEM education that were participated.

Part 3. Teacher’s teaching experiences.

The questions are designed on Google Form platform, then the questionnaire link is sent to teachers and educational managers via email, social networks, etc. The survey took place from June to August 2019. Respondents can easily answer questions on electronic devices, such as smartphones, laptops, and desktops. Answers are updated, aggregated and quickly analyzed on Google Form. Both questions and answers are done in Vietnamese. Characteristics of using questionnaires on Google form are time-saving and effortless, easily processing results. However, the limitation of this survey method is that it cannot divide geographical areas, the response rate depends on many factors such as connection on social networks, working time on electronic devices, etc.

The total number of responses received was 142 (94.6%), including 63.4% (n=90) secondary teachers and 36.6% (n=52) secondary school administrators. The number of working years of the respondents was divided into 3 groups: less than 5 years (6.3%); from 5 to 15 years (46.1%) and over 15 years (47.6%). The majority of respondents had been trained on STEM education (67.6%; n=96).

3.4. Research questions

The research questions focus on the following:

What are secondary teachers’ views on STEM education?

What is the teachers’ opinion on the theory of applying STEM education in lessons?

What are the teachers’ opinions on factors that effect on implementing STEM education in secondary schools in Vietnam?

4. Results and discussion

4.1. Views/ perceptions of secondary teachers on the objectives of STEM education

With the rate of 67.6% of the respondents who have been trained in STEM education at least once, we asked the question "When referring to STEM education, which of the following ideas should be perceived and acted on?" The answer options are all the objectives and characteristics of STEM education in the training material presented. The answer has 3 options: agree; disagree; and no ideas. The aggregated results reflect the level of understanding of the goals of STEM education of secondary teachers and administrators.
The survey results show that the majority of secondary school teachers and administrators understand the importance of STEM education to the fulfillment of educational goals. One of the highlights of STEM education is that Enhancing creativity, accepting failure also achieved 87.3% agree opinion of the respondents. This result is quite similar to some previous studies on the meaning of STEM education [6][9][28][29][32].

### 4.2. Opinions on the factors affecting the implementation of STEM education in secondary schools

Sinay et al. (2016) studied on STEM education implementation in Toronto, Canada and identified some barriers to STEM education implementation, including a lack of resources (funding, equipment, supplies), lack of teachers’ knowledge in STEM disciplines, etc [29]. Other researches on STEM education also suggest a number of solutions that need to be implemented synchronously to apply STEM education effectively, such as strengthening training teachers about STEM education, supporting facilities for STEM teaching and redesigning the curriculum [3][4][22]. Based on these results, we asked the question "To apply STEM education into the subject, how do the following factors work?" With two choices of "favorable" or "difficult" for responses: Competences of teachers; Reception of student; The direction of administrators; Facilities; Training documents; Timetables of teachers and students. The answer provides the opinion of the secondary teachers about elements that influence the implementation of STEM education in secondary schools.
Among the factors that influence the application of STEM education to secondary schools, the opinions of teachers and administrators about teachers' competences, students' reception and direction of administrators is almost equal between favorable and difficult. However, when evaluating the facilities, training documents, and timetables of teachers and students, it comes to a common idea that these factors are still barriers for teachers when implementing STEM education.

### 4.3. Teacher's opinion on STEM lesson implementation

According to MOET's STEM education training materials (2018), the STEM lesson design process consists of 4 steps: 1, Selecting the lesson topic; 2, Determining the problem to be solved; 3, Developing criteria of equipment/ solution to solve problems; 4, Designing the process of organizing teaching. Most of the teachers have more than 5 years of teaching experience, and many schools in Nam Dinh province have organized activities related to STEM education. From that context, we asked the question: "If teachers have been trained or learned about STEM education, how do you assess the difficulty of the steps in the process of designing STEM lessons?" 100% of respondents answered this question because on Google form is set up in compulsory mode.
Figure 3. Assessing the difficulty of the steps in the STEM lesson design process

Assessing the difficulty of the steps in the STEM lesson design process, most of the opinions supposed that Step 1 (Selecting the lesson topic) and Step 2 (Determining the problem to be solved) are the tasks that teachers are able to complete. However, Developing criteria of equipment/solution to solve problems (step 3) and Designing the process of organizing teaching (step 4) are very difficult steps for teachers.

In order to analyze more details the process of designing STEM lessons, we also asked questions to assess the difficulty of each of activity. Obviously, teachers responded that there is no easy task in the procedure of designing STEM lessons. About 50% of the respondents said that the Fact finding, problem identification and Researching fundamental knowledge activities were ranked as normal when implemented. For activity of Problem solving, 70% of respondents said that it was difficult to implement.
4.4. Other opinions about STEM teaching content, teaching techniques and training content on STEM education

In this study, we also asked teachers about lessons that could be applied STEM education effectively and easily (Question 8); STEM teaching methods/techniques (Question 6). However, the answers are very diverse so we will sum them up in another report. In addition, an issue of concern is the quality of the STEM education training courses that the teachers participated in. Therefore, we also questioned the evaluation of the training time; training materials; training instructors; training organizing; training method. The answers are Ineffective/inappropriate; Acceptable; Efficiency/relevance; Highly effective and No comments. The results showed that the content of Training time was classified as Ineffective/inappropriate. However, no criteria are evaluated at a high level of efficiency.

5. Conclusion

The survey results show that secondary teachers and administrators understand the goals and characteristics of STEM education. The research results also show that for the application of STEM education to secondary schools, it is necessary to renovate the curriculum, teaching plans, invest in facilities and enhance training for teachers about STEM education. Regarding the content of the training courses, the contents that teachers need to be trained include identifying criteria of equipment or problem-solving solutions, designing teaching organizing process. In addition, attention should be paid to the training time to suit the schedule of teachers. The contents of STEM education training that bring real benefits to secondary school teachers could be the next research direction.

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