STEMTECH MODEL IN EDUCATION 4.0:
DESIGNING HEIGHT MEASURING INSTRUMENTS IN GRADE 10

Huy Minh Lam[+],
Hue Thi Dang,
Tien Nhut Le,
Ngan Tuyet Huynh

Can Tho University, Vietnam
[+]*Corresponding author ● Email: lmhuy2306@gmail.com*

ABSTRACT

With the development in the fourth industrial revolution, there have been urgent demands for new human resources in the world. The mission set for the education sector is to prepare students with skills and knowledge in line with global standards to keep up with the industrial age 4.0. Among the educational trends that serve the fourth industrial revolution, STEM education has been demonstrating its superiority through various studies. This study applies the STEMTech model, which connects the fields of Science, Technology, Engineering, and Mathematics with a central technological factor, to create STEM products in the context of high schools in Vietnam recently. Firstly, the research trains students about STEM education, STEMTech model, and some new technologies; then divides the class into multiple groups of students to conduct a project based on STEMTech model; finally, surveys students. Statistical analysis was used to evaluate STEMTech model, whose results show that STEMTech model can engage students in learning, develop their creativity, and promote other competencies.

1. INTRODUCTION

In the current era of industrial revolution 4.0, a concept that has been initiated in Germany in recent years, Klaus (2016) stated that industry 4.0 would be developed on three main pillars including Digital, Biotechnology, and Physics. With the features emphasized by artificial intelligence, everything will be connected to the Internet, robotic sciences, self-propelled vehicles, 3D printing technology, nanotechnology, biotechnology, material science, energy storage, and Quantum computing. The development of the fourth industrial revolution urgently requires new human resources in the world. So which education model can educate such human resources? One of the answers is the STEM education model.

STEM is an abbreviated English term standing for Science, Technology, Engineering, and Mathematics. There are several scholars had researched and utilized STEM education model including Pang & Good (2000), Zemelman et al. (2005), Crinall & Henry (2008), Kurtts et al. (2009), Basham et al. (2010), Baskan et al. (2010), Corlu et al. (2012), etc. It can be seen that, STEM education model is of great significance. Even though this model has been extensively researched and widely applied in miscellaneous disciplines all over the world, the application of this model in ASEAN is still limited.

Furthermore, it is obvious that in the studies mentioned above, the "Technology" factor is viewed as equal to the remaining factors (Engineering, Science, and Mathematics) while the quality of STEM products today is determined by new Technology factors. Hence, a STEM education model combines the Technology factor, which has started to address the requirement from practice. Therefore, it is necessary to improve the STEM educational model with a focus on new technology. The most appropriate and updated model is the STEMTech model developed by Tuan, Pho, Huy & Wong (2019).
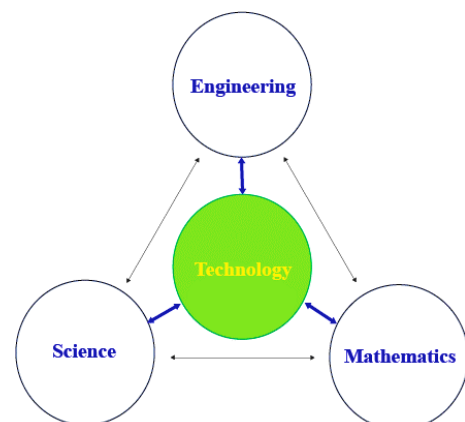

Diagram 1. STEMTech model

This STEMTech model was formed with the support of Arizona State University (USA) through the BUILD-IT project. It is characterized by emphasizing the technological element as shown above in Diagram 1.

The STEMTech model has two basic characteristics: (1) Learners practice and experience new technologies; (2) STEM products made by learners must be creative and based on these new technologies. New technologies here are understood as technologies that learners never knew. These new technologies are not necessarily new to the scientific community. It can be said that the STEMTech model, when put into teaching, has the advantage of helping learners create STEM products based on technology. Tuan et al. (2019) showed the effectiveness of this model when applying it in a university environment.

As a matter of fact, a research question is required in the practical situation: "How to apply the STEMTech model to create STEM products in the context of high school?".

To answer this question, the authors conducted an empirical study in Can Tho city, Vietnam. The paper is organized as follows. The literature on STEM products and Technology elements is reviewed in Section 2. In Section 3, data and methodology would be introduced before discussing the empirical analysis. Concluding remarks and inference will be presented in the last section.

2. LITERATURE REVIEW

2.1. STEM Education

In the 4.0 industrial revolution era, the STEM education model has been receiving growing interest and attention from educators around the world. The National Science Teachers Association (NSTA), founded in 1944, first proposed the definition of STEM education (Tsupros et al., 2009) which mentioned three crucial characteristics of STEM education, including interdisciplinary approach, integration with real-world lessons, and connection from school and community to global organizations. Through STEM education, students develop various skills namely problem-solving, creativity, critical analysis, independent thinking, teamwork, communication and information technology skills. STEM education originated in the United States nearly two decades ago combining the subjects of Science, Technology, Engineering and Mathematics to provide learners with basic, physical, programming, and robotics skills at preschool and high school levels.

In the study by Klaus (2016), teachers in the education systems of Indiana University in USA exploited the technologies and facilities available to teach efficiently, using virtual labs, computing resources from the National Programme for Technology Enhanced Learning (NPTEL) with National Mission on Education through ICT (NME-ICT), open educational resources, education through mobile, etc. In the Mathematics teacher training program of Arizona State University, the course "*Technology and Mathematical Visualization*" included STEM elements (Alacaci & Erbaş, 2010). According to Kuenzi et al. (2008), a STEM education program was passed and took effect in the United States in 2005. James (2009) stated that STEM was recognized in the United Kingdom in 2006 while Kim (2007) claimed that the Korean Federation of Technical Education had researched on STEM models in the context of Korean education in Korea in 2007. About the application of the STEM model, readers may refer to Ogilve & Monagan (2007), Walker (2007), Katehi et al. (2009), Langley et al. (2009), Offer & Mireles (2009), Berlin & White (2010), Edyburn, (2010), Marino (2010), Corlu et al. (2010), Stohlmann et al. (2011), Williams (2011) & Corlu (2014), etc.

These days, the model still occupies an extremely crucial position in academia. According to Marginson et al. (2013), the National Strategy for STEM education in schools from 2016 to 2026 in Australia included five principal objectives (cited in *Country comparisons: international comparisons of science, technology, engineering, and mathematics (STEM) education).*

Directive No. 16/CT-TTg issued on May 4, 2017 by the Prime Minister of Vietnam on strengthening the capacity to approach the 4th industrial revolution, the overall general education program and the Mathematics general education program of the Ministry of Education and Training in Vietnam also mention the development of STEM-related sectors and the implementation of STEM Education.

Through STEM education, students would develop various skills: problem-solving, creativity, critical analysis, independent thinking, teamwork, communication, and information technology skills.

This is truly an education model that meets the requirements of the Industrial Revolution 4.0. Thus it is extremely meaningful to gain the insight into this issue.

2.2. STEM Projects

The STEM project is a project designed for students in order to create STEM products for real life applications from knowledge in different fields. According to Robert M. Caparo et al. (2013), the STEM project provides

contextual and practical experiences for students to enhance learning and develop powerful scientific, technological, technical, and mathematical concepts. In the scope of this project, the role of teachers is no longer "hands-on" but together with students to identify and solve practical problems in the learning process. Students then have the opportunity to construct their knowledge, while in traditional classrooms, teachers disseminate knowledge content to students (Ozel, 2013). This is both a challenge and a motivation for students.

Some of the products that support teaching and learning mathematics in STEM models are presented in www.pbslearningmedia.org/collection/stemalive/, for example: an inclination meter, to measure height in untouchable places. Hence, students would have practical insight to understand and measure different angles.

In the next section, the data set and methodology will be described.

3. RESEARCH METHODS AND RESULTS

3.1. Research methods

To answer a part of the research question, this study was conducted on 39 grade-ten students of Tran Dai Nghia high school at Can Tho City from January to March 2020.

The framework utilized in this study is the STEMTech model. To apply this model in the study, there are three steps as follows:

1. Providing students with knowledge about STEM education, STEMTech model, and some new technologies.

2. Dividing the class into groups of students to carry out a project based on STEMTech model.

3. Survey students in the experiment.

Our main objective is analyzing and assessing the level of access to STEMTech model among students despite the implementation of the STEMTech project.

3.2. STEMTech projects

In Chapter II, page 83 of Grade 10 Math Textbook, "Triangular and Triangular Systems" there is a great amount of knowledge, which can be applied in solving practical problems.

3.2.1. Content

Students design instruments to measure the height of objects. Then perform a height measurement demonstrations of some objects and check the accuracy.

3.2.2. Goals

- Creating conditions to develop potentials and promote creative thinking, determining the thinking ability of students, thereby helping them better understand STEM education.

- Applying the triangular mass system formula.

- Applying the knowledge of Science, Physics, and Engineering to create height measuring instruments.

- Use mathematical and information technology skills to calculate parameters to measure target objects accurately and effectively.

- Developing some skills for students such as teamwork, communication and cooperation, critical thinking, and problem-solving.

3.2.3. Implementation

Step 1: Presenting the problem

The question is how to determine the height of buildings, towers, trees,… or the distance between the coast and an island that we can't go to for direct measurements.

Step 2: Teaching basic knowledge to solve the problem.

Step 3: Creating products using the STEMTech model.

Coming up with ideas and creating sketches for a complete design.

+ Designing each part of the height measuring instrument: Students choose the

Figure 1. The height measuring instrument of STEMTech project implementation teams

main raw materials for implementation, preferring common materials such as PVC water pipes; dividing the height measuring instrument into 3 individual parts for design and implementation.

+ Conducting measurement, inspection, and improvement of products.

3.2.4. Results

Once implemented, the teams completed the actual object height measuring instrument products.

Figure 2. Students are measuring parameters and reports results of STEMTech project

3.2.5. The composition of the measuring instrument

+ Measuring units: a flat angle degree measure, a round angle degree measure, a laser lamp, a plastic straw as binoculars, two pillars fixed laser, a five meters tape measure.

+ Measuring angle correction unit: a turntable, a heavy object and a thread, rotating shafts in the middle connecting the degree measure and laser lights.

+ Tribular: A pillar fixed in the middle is with an adjusting pillar inside which can move up or down, three small legs to keep balance and adjust low altitude, a balance tube in the centre of the big cylinder, six joints of the legs, three bubbles covering the feet of the measuring instrument, an iron bar to keep the fixed inner pillar.

Principle of operation: Adjust the 3 small legs for fixation and the central cylinder so that the height measuring instrument is suitable for the meter, adjust the feet for the balance tube just right at the middle line for accurate measurement, then adjust the laser or binoculars to the measured height and then observe how much the measuring angle is. Use the folding ruler to measure the length of the selected position. Then apply the formula for calculating height.

In addition to the height measuring device, the teams also created a height calculating program, the distance by GeoGebra software.
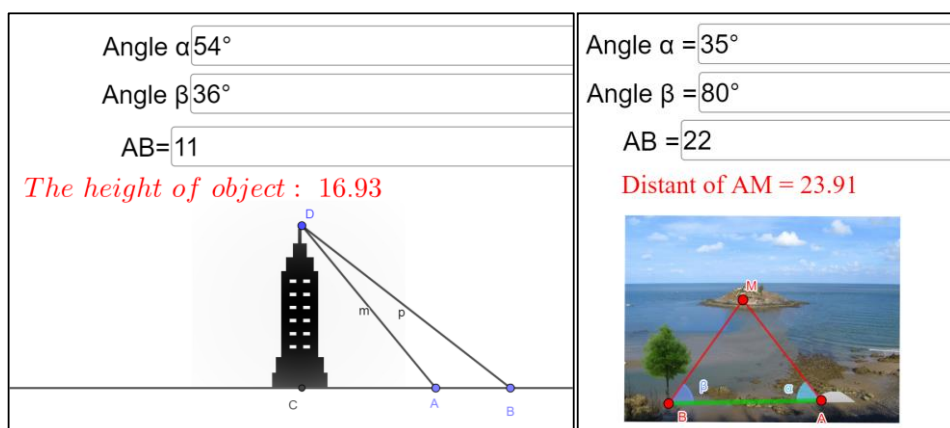

Figure 3. Programs identify the height of objects and distance to distant objects

3.3. Empirical analysis

This project is designed and developed to integrate the learning competencies formed during project implementation, as well as challenge students' dexterity, teamwork, and problem-solving skills. This project is more

stringent, more demanding for students to participate in the project than others due to the complexity of the instrument design and the time it takes to implement the project. With the innovative and unique task of designing a height gauge, it is crucial for students to explore the importance of motivation, confidence, teamwork, and problem-solving skills. Using such concept and design, learners are required to practice planning, material selection, shaping parts, using hand tools and electricity, and teachers have an opportunity to teach and reinforce motivation, confidence, team spirit, and problem-solving skills that students can apply into science, technology, engineering, and math (STEM).

3.3.1. Survey design

To objectively evaluate the project implementation according to the STEMTech model, the researchers conducted 2 surveys, the first about STEM education and the second about project implementation. These questions are designed on a 5-level Likert scale to evaluate the quantitative results of the statements. The levels are coded as follows: Strongly disagree = 1; Disagree = 2; No comments = 3; Agree = 4; Strongly agree = 5.

In the survey on the implementation of the project (survey 2), symbol "A" stands (Q1A, Q2A,…) for the results of the student survey before implementing the project, symbol "B" (Q1B, Q2B, …) for the results after the student implements the project.

3.3.2. Survey result analysis

3.3.2.1. STEM Education Survey result analysis

Question Q1 aims to evaluate the characteristics of STEM Education. The mean values of the three characteristics are as follows:

Table 1. STEM Education characteristics

STEM Education characteristics	Mean
Students should apply knowledge and skills in the fields of Science, Technology, Engineering, and Math to solve real-life problems.	4.11
Students need practice and creativity to create products.	4.30
Communication, cooperation (directly or indirectly) among students in a group to achieve a common goal is essential.	4.22

Q1A: the average of 4.11 shows that students agree with the idea "Students should apply their knowledge and skills in the fields of Science, Technology, Engineering and Math to solve problems in reality". That means the experimental model has contributed to raising students' awareness of STEM and STEM education. As a result, each student can discover the relationship between the sciences, especially math, and everyday life.

Q1B: The average of 4.3 shows that students agree with the idea "Students need to practice and be creative to create products". Most students have paid more attention to creating products that apply to reality in the learning process. This is also an important goal of STEM education.

Q1C: The average of 4.22 shows that students agree with the idea "It is necessary to communicate and cooperate (directly or indirectly) among students in a group to achieve a common goal". Students have paid more attention to improving communication and collaboration skills; been more focused in cooperation with classmates to complete STEM products.

It can be seen that students have acquired basic awareness about STEM Education. The model has contributed to raising awareness of students about the features of STEM Education in the overall education program.

The median value is 4, higher than the theoretical mean of 3, indicating that the general opinion is inclined to the positive side.
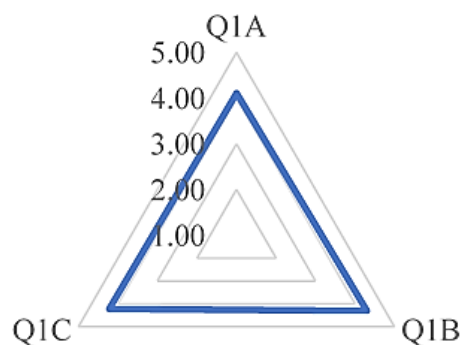

Chart 1. The relationship between 3 characteristics of STEM education

This chart is an equilateral triangle, which demonstrates that all three features of STEM Education are valued almost equally by students.

Q2 focuses on assessing the characteristics of teaching methods and STEM education activities. The survey results are shown in the table below.

Table 2. Features of teaching methods and STEM education activities

STEM Education features	Mean
The teaching method in STEM education is learning through practice to solve real-life problems.	4.29
Teaching methods in STEM Education is a method of integrating content in 4 fields of Science, Technology, Engineering, and Mathematics to create products.	4.24
Teaching activities in STEM Education should stimulate students to communicate, collaborate, develop critical thinking, and creative thinking.	4.19
Teaching activities in STEM Education should create excitement and fitness for students.	4.25

Q2A: The average of 4.29 shows that students relatively agree with the idea that "Teaching methods in STEM education are teaching through practice". Thereby, each student can raise their awareness about actively participating in activities, practice, experience, and knowledge. Therefore, students themselves can consolidate the knowledge learned in class and be more motivated in the learning process, especially in Math in the general education program today.

Q2B: The average of 4.24 shows that students agree with the idea that "Teaching methods in STEM education are integrated methods, integrating content in 4 fields of Science, Technology, Engineering and Mathematics to create products". The above results show that students are interested in integrated learning, integrating the content of subjects in a reasonable way, and adapting to current educational trends.

Q2C: The average of 4.19 shows that students agree with the idea that "Teaching activities in STEM Education should stimulate students to communicate, collaborate, develop critical and creative thinking". This shows that through the STEM project, students have become more active, and better at communication and teamwork to collaborate in the most effective way.

Q2D: The average of 4.25 shows that students are relatively agreeable with the idea that "Teaching activities in STEM Education should generate interest and suitable for students". Students were generally attracted to STEM projects. Thereby, each student strived to hone the skills necessary to complete the products in the best way.

This finding reveals that students possess a basic awareness of teaching methods and STEM education activities. With the method of "learning through practice", "learning and playing", STEM promotes students' interest in learning. The experimental model has clarified this issue, in which students were exposed to interesting practical activities associated with subject knowledge. STEM projects would help students learn faster, remember longer, and understand more deeply. Consequently, learning would become easier as a real passion rather than a compulsory task.

The median value is 4 and 5, higher than the theoretical average is 3, demonstrated the general opinion towards the positive side.
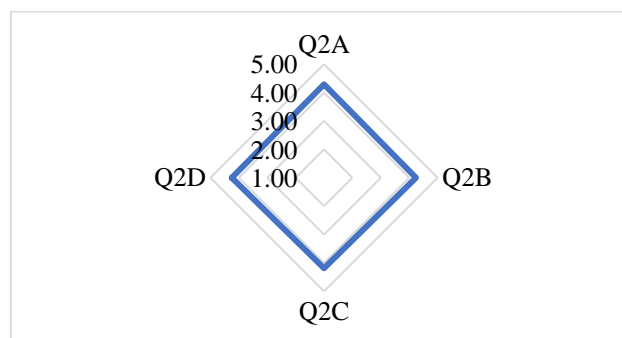

Chart 2. Relationship between 4 characteristics of STEM education methods and activities

This diagram is a "nearly even" quadrangle, demonstrating that teaching methods and activities in STEM Education are valued almost equally.

3.3.2.2. Project implementation Survey result analysis

The data obtained was encrypted and keyed into the statistical software SPSS version 26 for processing. The analyses focused on the differences between before and after the implementation of the project among the students using Paired Samples T-Test. The analysis was done at a meaningful rate of 5%. The results of the analysis are as follows:

Table 3. Paired Samples T-Test results for data analysis

		Mean (Average)	**N**	**Std. Deviation**	**Std. Error Mean**
Pair 1	Q1A	**3.53**	39	0.69669	0.15983
	Q1B	**4.53**	39	0.51299	0.11769
Pair 2	Q2A	**3.95**	39	0.77986	0.17891
	Q2B	**4.32**	39	0.47757	0.10956
Pair 3	Q3A	**3.58**	39	0.83771	0.19218
	Q3B	**4.21**	39	0.63060	0.14467
Pair 4	Q4A	**3.79**	39	0.85498	0.19615
	Q4B	**4.37**	39	0.49559	0.11370
Pair 5	Q5A	**3.68**	39	1.00292	0.23009
	Q5B	**2.84**	39	1.06787	0.24499
Pair 6	Q6A	**3.37**	39	1.25656	0.28828
	Q6B	**3.26**	39	0.65338	0.14989
Pair 7	Q7A	**3.95**	39	0.84811	0.19457
	A7B	**4.32**	39	0.58239	0.13361
Pair 8	Q8A	**3.89**	39	0.93659	0.21487
	Q8B	**4.42**	39	0.60698	0.13925
Pair 9	Q9A	**3.37**	39	1.01163	0.23208
	Q9B	**4.26**	39	0.65338	0.14989
Pair 10	Q10A	**4.05**	39	0.62126	0.14253
	Q10B	**4.11**	39	0.65784	0.15092
Pair 11	Q11A	**3.95**	39	0.62126	0.14253
	Q11B	**4.21**	39	0.63060	0.14467
Pair 12	Q12A	**2.95**	39	0.97032	0.22261
	Q12B	**4.26**	39	0.65338	0.14989
Pair 13	Q13A	**4.05**	39	0.84811	0.19457
	Q13B	**4.42**	39	0.60698	0.13925
Pair 14	Q14A	**4.16**	39	0.76472	0.17544
	Q14B	**4.47**	39	0.61178	0.14035
Pair 15	Q15A	**3.32**	39	1.05686	0.24246
	Q15B	**4.32**	39	0.58239	0.13361
Pair 16	Q16A	**3.74**	39	0.80568	0.18484
	Q16B	**4.63**	39	0.49559	0.11370

The above data shows that the average value Q1B, Q2B, Q3B, Q4B, Q7B, Q8B, Q9B, Q10B, Q11B, Q12B, Q13B, Q14B, Q15B, Q16B are larger than Q1A, Q2A, Q3A, Q4A, Q7A, Q8A, Q9A, Q10A, Q11A, Q12A, Q13A, Q14A, Q15A, Q16A. To assess the difference between before and after the implementation of the project among the students, tables 2 and 3 should be refered to.

Table 4. Analysis results

		Sig. (2-tailed)	**EFFECT SIZE**
Pair 1	Q1B - Q1A	**0.000**	1.225
Pair 2	Q2B - Q2A	0.149	0.346
Pair 3	Q3B - Q3A	**0.030**	0.542
Pair 4	Q4B - Q4B	**0.030**	0.541
Pair 5	Q5B - Q5A	**0.004**	0.753
Pair 6	Q6B - Q6A	0.755	0.073
Pair 7	Q7B - Q7A	0.149	0.346

Pair 8	Q8B - Q8A	0.066	0.449
Pair 9	Q9B - Q9A	**0.006**	0.720
Pair 10	Q10B - Q10A	0.804	0.058
Pair 11	Q11B - Q11A	0.262	0.265
Pair 12	Q12B - Q12A	**0.000**	1.053
Pair 13	Q13B - Q13A	0.090	0.412
Pair 14	Q14B - Q14A	0.163	0.334
Pair 15	Q15B - Q15A	**0.008**	0.688
Pair 16	Q16B - Q6A	**0.001**	0.955

As shown in this table, Pair 2, Pair 6, Pair 7, Pair 8, Pair 10, Pair 11, Pair 13, Pair 14 > 0.05 means that the value Q2A, Q2B, Q6A, Q6B, Q7A, Q7B, Q8A, Q8B, Q10A, Q10B, Q11A, Q11B, Q13A, Q13B, Q14A, Q14B have no difference, nor between before and after the implementation of the project by the student. The Sig value of Pair 1, Pair 3, Pair 4, Pair 5, Pair 9, Pair 12, Pair 15, Pair 16 is 0.000; 0,030; 0,030; 0,004; 0,006; 0,000; 0,008; 0.001 < 0.05, hence there is a difference between before and after project implementation by learners. To check whether the difference is large or not, we calculate the value Effect Size - Cohen's D by dividing the Mean value by the value Std. Deviation.

The answers analyzed specifically are as follows:

Q1: As for the statement "I'm interested in my project", there was a positive result with the Sig value of 0.000 < 0.05, which showed that the question was statistically meaningful. Effect's size of 1,225 > 0.8 showed a significant difference in the interest in math projects before and after implementation. This means that the STEMTech project motivated students to be more interested in learning math and keen on the project as they went.

Q2, Q5: The STEMTech-modeled project was applied to an activity, students were guided in the challenges related to practical issues in the project implementation process. Students noticed the complexity of the task and many processes in implementing the project, thereby helping them to be conscious and better prepare for the challenge in the future. To overcome the challenges, the teamwork environment is the best choice. The project implementation process allows them to find ways to adapt to the teamwork environment. This process also helps students enhance their abilities, teamwork, collaboration, and communication skills, the aspects of this assessment by Weber, B.A., (2016) aligned with the survey with the question "I respect the implementation of the team when implementing the project", "I prefer to solve my problems rather than ask others for help" with the results as shown in table1. Question Q5 returns a positive result with the Sig value of 0.004 < 0.05, which showed that the question was statistically meaningful. Effect's size of 0.753 > 0.8 showed an interest in the mathematical project before and after implementation were different.

Q3, Q4: Bandura (1988) argued that the role of self-confidence in activity is the level of motivation, emotional state, and actions of a person based on what he or she believes rather than objective truth. Therefore, a person's actions depend on their confidence rather than their true abilities. Awareness and confidence are important factors in expressing one's abilities. To evaluate the awareness and confidence of students, the researchers asked the question "I try my best even if it is a difficult task", "I do not stop my efforts when I fail" with the results as in table1. Q3, Q4 questions returned positive results with Sig value 0.030; 0.030 < 0.05, which showed a question of statistical significance. Effect's size is 0.542; 0.541 > 0.5 expressed interest in the math project before and after implementation with differences. This showed that the STEMTech project motivated students to work harder when facing difficult tasks and not give up when faced with failure. Q6, Q7, Q8, the students said that they were motivated to continue the project because they were interacting with the instructor. To find out about the instructor's necessity to learners, the research asked "I cannot do the project without the guidance from the teacher", "I ask questions when I don't understand something", "I try harder when the teacher encourages".

Q9, Q10, Q11: The main goal of formal learning is for students to use what they have learned at school to solve new situations in reality, so students can plan, find relevant information that has been learned to solve those real problems. In short, problem-solving is key to education because educators are interested in improving the ability of the student to solve problems. To evaluate the students' self-awareness to solve problems, the researchers raised the question "I can imagine what needs to be done to solve the problem", "I can find out the information related to the project from different sources", "I can plan the project from start to finish". Question Q9 returned a positive result with the Sig value of 0.006 < 0.05, which showed that the question was statistically meaningful. Effect's size was 0.720 > 0.5, expressing interest in the mathematical project before and after the implementation with differences.

Q12, Q13: The survey found out that the bravery and resilience of project participants is to confront obstacles and difficulties in the project and reality. Moreover, participating in the project would change their perception of their achievements at school. To understand the capacity of the project participants themselves and the ability to overcome difficulties and challenges when implementing their projects, the researchers raised the question "Difficult tasks do not exceed my ability", "My efforts in the implementation process affect the results". The Q12 question returned a positive result with the Sig value of 0.000 < 0.05, which showed that the question was statistically meaningful. Effect's size is 1,053 > 0.8 expressing an interest in the math project before and after implementation. This shows that the STEMTech project helped motivate students to try harder in project challenges.

Q15: The survey findings revealed the initial motivation of the project participants, reasons why they wanted to apply mathematics as the majority of them participated because they thought it would be fun or learn more from the project. Moreover, after the survey, the majority of respondents found it interesting to implement the project through the question "I feel interesting when implementing the project". Q15 question returned a positive result with the Sig value of 0.008 < 0.05, which showed that the question was statistically meaningful. Effect's size of 0.688 > 0.5 showed different levels of interest in the math project before and after implementation. This showed that the STEMTech project contributed to making maths more interesting for students, and students preferred to learn math.

Q14, Q16: Math, and geometry skills are integrated into the curriculum to guide students. Many of these concepts are as simple as adding the divisions used in measurements and as advanced as the Pythagorean theorem applied to triangular resolution or the content of the application of the quantity system to solve triangles and other parts related to the design of projects. The learner applied what they learned to the problem and were requires to design parts of the measuring instrument. Students then better understood how to make accurate measurements and how to read a standard measure. To assess the skills learned and the ability to apply mathematics in practice the study raised the question "Applying mathematics is an important skill in the process of implementing the project", "I can apply what I learned in this project in practice". The Q16 question returned a positive result with the Sig value of 0.001 < 0.05, which showed that the question was statistically meaningful. Effect's size value was 0.955 > 0.5 expressing interest in mathematical projects before and after implementation with great differences. This means the STEMTech project helped students apply what they had learned in real-life problem-solving.

Q17: The question provides a general assessment of the benefits of the STEMTech project for students. The survey results are as follows:
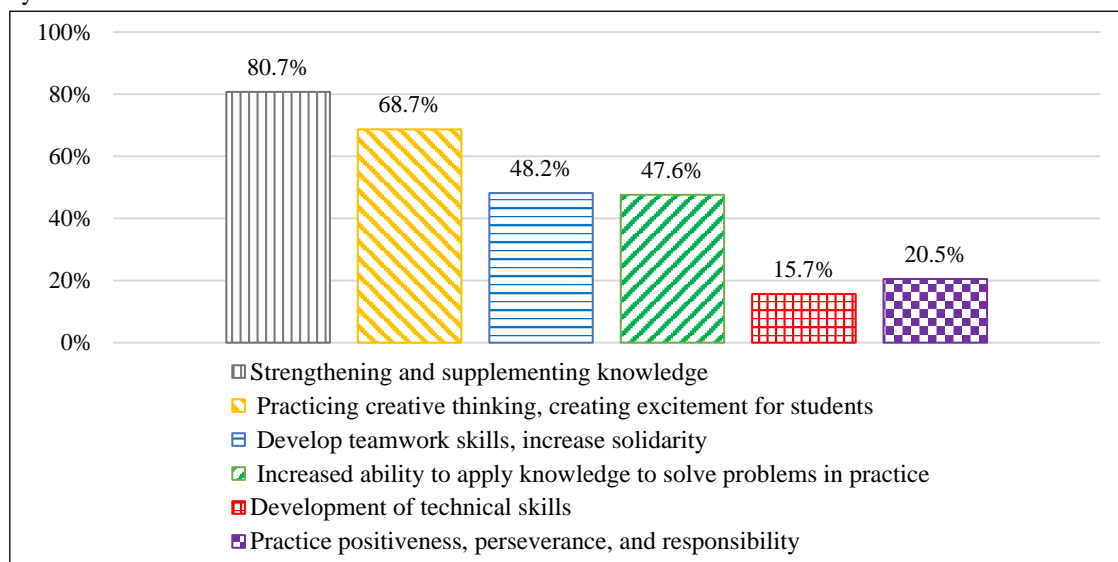

Chart 3. Benefits of implementing STEM projects

More than 80% of respondents said that the benefits of implementing STEM projects is to consolidate, supplement knowledge and increase the ability to apply the knowledge learned to solve problems in practice. This is one of the characteristics of stem education. 48.2% of respondents said that students develop teamwork skills, increase solidarity from implementing STEM projects. In the process of implementing the project, the ability to think

creatively and interest in designing is essential to create a new and high-quality product, so "training creative thinking, creating excitement for students" accounted for 68.68% of the votes. Besides, students also practiced positive, persistent, and responsible in the activities of the team.

Q18: The question focuses on the purpose of summing up the things to improve for STEMTech project with survey results as follows:

Table 5. Things to improve for STEM projects

STEM Education features	Percentage (%)
Increasing understanding of scientific knowledge	69.88
Improving creativity	42.17
Increasing team collaboration	67.47
Doing more project	25.30
Having more equipments and tools	19.28
Support of teachers	15.66

Increasing students' understanding of scientific knowledge as well as improving their creative thinking abilities is essential for STEM project implementation, which is the most important thing to help students develop their thinking and form complete STEM models. Increasing the level of team collaboration is also one of the issues needed to make improvements to the STEM project. Communication and cooperation among students in the group is one of the three pillars of STEM Education, which allows students to learn from each other and improve the knowledge they have learned. Besides, collaboration makes project progress faster, work efficiency is better, and STEM products are more fruitfully fulfilled. An important factor to implement the project is experience, students need to participate in activities to create STEM products to better themselves and meet the requirements of the industrial age 4.0. Also, students need the support of instructors, sufficient equipment, tools, and comfort in the designing space as favorable conditions to realise their ideas to create STEM products applied to real-life.

Q19: Through the process of implementing the learning project, according to the survey, the average time for the team to create a project-based learning product is 23.03 working hours, and the average number of times the organization of the learning project in each academic year is 2.07 times.

Q20: With this result, the organization of activities to implement learning projects should be held 2 times per school year, that is, 1 time each semester and with the implementation time of each project is about 3 weeks, that means about 3 sessions each week, each session about 3 hours.

3.3.3. Evaluation from Math teachers at experimental schools

Teachers evaluate the project is suitable for current educational trend. This shows that teachers evaluate this product as very appropriately and conveniently in the current trend of STEM education. Thus, most teachers at experimental schools were in favour of height measuring equipment. However, if the students themselves had implemented the project without the support of the teacher, the student's ability to complete the project would be relatively low.

Also, most teachers believed that STEMTech project helped students apply a lot of topical knowledge to solve practical problems and create learning interests, which is also an important goal of STEM education.

At the same time, through the STEMTech project, teachers can assess students' abilities in many aspects.

4. DISCUSSION AND CONCLUSION

In summary, this paper presents the results of an empirical research on the STEM Education model, STEMTech model, and STEMTech project. The results shows that the STEMTech model engaged students in learning, provided them with an in-depth knowledge of science, enhanced their creative thinking abilities, problem-solving abilities, and developed their soft skills. This contributes to helping students adapt to the development of today's world. Therefore, the STEMTech model has the potential to develop and replicate in high schools in Viet Nam.

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