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Applying Technical Science Process in Teaching STEM Topics under Model School with Production Practice and Social Life in Vietnam

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Abstract. Currently, STEM (science, technology, engineering, and mathematics) teaching that applies scientific and technical processes is an approach to effectively implementing education in Vietnam. This paper describes the application of scientific and technical processes in teaching STEM topics in a school model associated with production, business, and social life in Vietnam. This experimental study elicited feedback by experts and high school chemistry teachers. Data were collected through expert evaluation forms and questionnaires answered with reference to a Likert scale, and the results were analyzed using quantitative analysis. The research proposed STEM topics associated with production practice and social life for teaching physics, chemistry, and biology in Vietnam. Through the proposed process, we designed and organized 33 STEM education topics associated with production and social life in teaching physics, chemistry and biology. Research results show that teaching STEM topics associated with production practices and social life has clear advantages. Teachers' knowledge and use of STEM topics was found to be at a high level. The study confirmed the effectiveness of applying scientific processes in teaching STEM topics and creating connections between schools and production practices.

Keywords: STEM topic; process for teaching STEM; students; production practice; social life

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1. Introduction

Vietnam is currently in the process of implementing a new educational curriculum. The application of scientific and technical processes in STEM (science, technology, engineering, and mathematics) education has become a focal point of concern and implementation in recent years. One promising approach to integrating a model school system with production practice and social life in Vietnam is through the application of the technical science process in STEM teaching.

STEM education encompasses scientific inquiry, technology, engineering design, mathematical analysis. It is interdisciplinary topics that align with 21st-century education standards (Johnson, 2013). Teachers understanding these four STEM fields is essential to successfully incorporate and integrate them into 21st-century teaching and learning (Baharin et al., 2018). The STEM themes chosen for the 2018 General Education Curriculum in Vietnam foster students' interdisciplinary, and they have generated interest in and support for STEM education (Huy et al., 2023). STEM education is a multifaceted discipline that is designed to equip students with a robust academic foundation in science, technology, engineering, and mathematics (Bybee, 2015). Vietnam's current education strategy emphasizes the importance of experiential learning by letting students use what they have learned in real-world situations. Doing so promotes students' ability to think critically, analyze facts, and solve problems. STEM education also places a strong focus on teamwork, and encourages participation in projects that call for a variety of skill sets (Hieu et al., 2020).

One effective approach to implementing STEM education in Vietnam is the application of technical scientific processes at model schools; the processes emphasize production practice (Hieu et al., 2020). This approach prioritizes experiential learning and the application of acquired knowledge in real-world scenarios. It involves the seamless integration of STEM education into the curriculum, and focuses on addressing real-life challenges and enhancing students' logical reasoning abilities across diverse domains, in line with the 2013 curriculum (Nugroho et al., 2021).

In Vietnamese high schools, STEM lessons are structured around an engineering design process consisting of eight steps: Identifying the problem; researching background knowledge; proposing solutions; selecting a solution; creating a model; testing and evaluating; sharing and discussing; and adjusting the design (Ministry of Education and Training, 2020). Implementing STEM lessons through practical topics helps students develop and enhance their chemical skills and improve their ability to apply knowledge in real lifeClick or tap here to enter text. Students actively engage in conducting experiments, such as producing acid-base indicators from purple cabbage or creating a mixture of phosphorus and potassium from straws and waste animal bones, which fosters practical experimentation skills (Duc et al., 2019). Model schools that emphasize production practice and social life are educational institutions that are designed to provide practical learning experiences that are relevant to the local community. This educational model enables students to apply their knowledge in authentic, real-world contexts, thereby fostering critical thinking and collaborative skills. Importantly, this approach offers a pragmatic solution to resource limitations, by encouraging students to learn through hands-on experiences and reducing their dependence on expensive equipment or materials (Linh, 2020).

There is a growing awareness of the significance of STEM education for equipping students for the future. Nevertheless, Vietnam faces impediments when it comes to the effective implementation of STEM education. These challenges impose limitations on resources and teacher training, and indicate the necessity for culturally relevant pedagogical approaches.

The successful integration of STEM education in Vietnam faces various challenges, of which resource limitations emerge as a prominent concern. The nation grapples with an insufficient supply of essential equipment and materials that are essential for practical learning encounters. Additionally, a significant portion of educators lacks the requisite qualifications to proficiently instruct STEM subjects, which affects students' level of engagement and interest. Initiatives have been launched to provide teacher training programs that are focused on STEM education (Duc et al., 2019). Cultural relevance is another significant challenge facing the effective implementation of STEM education in Vietnam. Developing an education paradigm that accounts for cultural disparities and offers culturally congruent learning experiences is crucial (Tho, 2016; Tu et al., 2022).

In response to these challenges, employing technical scientific processes in the domain of STEM education hold promise, particularly at model schools that engage in production practice and social life. Nevertheless, a comprehensive understanding of how this approach can tackle these challenges proficiently necessitates further scrutiny and elucidation. This paper delves into the realm of STEM education and assesses the efficacy of implementing the technical scientific process in the instruction of STEM subjects in the context of model schools that intertwine production practice and social life in Vietnam. To this end, the paper addresses the following research questions:

1) How effective is the application of the science process for teaching STEM topics in a model school system characterised by production practice and social life in Vietnam?
2) What do expert say about STEM topics related to production practice and social life as designed by the research team?

2. Literature Review

Applying the the science process in teaching STEM topics under a model school system characterised by production practice and social life can be highly effective. The conceptual framework of STEM education suggests that retaining the principles of STEM in engineering activities can improve the practice of STEM education (Yata et al., 2020). Several studies highlight the importance of integrating STEM education into the curriculum and providing opportunities for teachers to enhance their ability to teach STEM content effectively (Margot & Kettler, 2019; Shernoff et al., 2017). To promote lifelong participation in STEM learning, STEM education should incorporate real-world socialissues (Kurup et al., 2019). Research has shown that out-of-school time science activities can significantly affect students' career interest in STEM fields (Dabney et al., 2012). Additionally, gendered motivational processes can affect high school students' participation, aspirations, and career plans in mathematics and STEM (Gilchrist Watt et al., 2012). To promote equal participation and interest in STEM subjects, addressing these motivational factors is essential.

Integrating STEM education with sustainable development was explored by Buturlina (Buturlina et al., 2021) who provide foundational principles for future initiatives. Lee et al. (2014) developed an integrative STEM education model based on the science inquiry process. Luong and Dam (2021) developed a Grade 5 science program that included a teaching process for topics in material and energy, oriented towards STEM education with the aim of contributing to the improvement of science teaching in elementary schools (Luong & Dam, 2021). Stohlmann (Stohlmann et al., 2012) suggest that using a model is a good starting point for teachers who wish to implement and enhance integrated STEM education. Sujarwanto (Sujarwanto et al., 2021) applied the literature review method to develop a conceptual framework of STEM education based on the Indonesian curriculum. Huy et al. (2023) employed the 6E teaching model, which emphasizes technical design and practice, to design a teaching process for STEM-oriented education. An and Yang (2019) propose the 5E teaching process for STEM education, which involves engaging, exploring, explaining, engineering and evaluating (An & Yang, 2019). Khmelnikova and Maslak (2022) observed the didactic possibilities of a STEM-oriented approach to teaching chemistry disciplines (Khmelnikova & Maslak, 2022). They highlight its potential for developing a holistic scientific outlook, innovative thinking, research and analytical skills and creativity in students, the development of their STEM competence, the implementation of innovative and experimental activities, and integration of knowledge from natural sciences, technologies, engineering, and mathematics.

In Vietnam, there is an increasingly recognized imperative regarding the significance of STEM education as a preparatory tool for students in anticipation of their future roles. Nevertheless, the effective implementation of STEM education in Vietnam faces several notable challenges, including constraints related to limited resources, teacher training inadequacies, and a demand for an educationally relevant approach that is rooted in cultural considerations. A promising strategy to surmount these challenges involves the application of the technical scientific process within a framework of a model school that integrates production practice and social engagement (Le et al., 2021; Nguyen et al., 2019).

This approach emphasizes experiential learning opportunities that afford students the capacity to apply their scientific knowledge in tangible, real-world contexts. By incorporating production practice and social life into the educational model, students are exposed to authentic scenarios, thereby cultivating their critical thinking acumen. Furthermore, this education model actively fosters collaboration among students, thereby encouraging teamwork and the utilization of a diverse array of skill sets in the context of project-based learning. The model school featuring production practice and social life endeavors to provide students with practical learning experiences that are deeply intertwined with the fabric of their local community, thereby facilitating a bridge between their academic pursuits and the tangible realities of the world they inhabit.

The successful implementation of STEM education in Vietnam faces a series of notable challenges. A central issue is the constraints imposed by limited resources, whereby numerous educational institutions lack the essential equipment and materials requisite for facilitating hands-on learning experiences (Nguyen, 2019). Furthermore, a scarcity of proficient educators who would be capable of effectively instructing STEM subjects constitutes an additional formidable obstacle (Hieu et al., 2020; Le et al., 2021). In response to these predicaments, initiatives have been introduced to institute teacher training programs that are specifically tailored to the demands of STEM education. These programs are designed to augment teachers' pedagogical proficiency and content knowledge and ultimately enhancing their capacity to present STEM subjects effectively.

The application of the science process in teaching STEM topics under a model school system with production practice and social life can be highly effective. It is important to integrate STEM education into the curriculum, provide professional development opportunities for teachers, and make STEM subjects relevant and valuable to students' lives. By addressing motivational factors, promoting equal participation, and incorporating interdisciplinary approaches, STEM education can be enhanced and students' interest and achievement in STEM can be improved.

Our research examines the effectiveness of applying the scientific and technical process to teaching STEM topics in schools in Vietnam. Furthermore, we propose some STEM education topics related to social life practices that can apply the scientific and technical process in teaching.

3. Methodology

3.1. Research Design

The research process is carried out according to the following stages:

Phase 1: Research the scientific and technical process for teaching STEM topics.

The process of teaching STEM topics associated with production practice and social life

According to the interdisciplinary approach, STEM education aims to apply knowledge from various STEM disciplines to solving real-world problems. Therefore, STEM education is directed to promoting active participation and experiential learning, facilitating exploration and discovery, doing hands-on experimentation, and pursuing result-oriented achievements. These distinguishing features highlight the fundamental underpinning of STEM educational activities, which are rooted in the STEM cycle, scientific methodologies, and engineering design processes. The scientific method is centered on a quest for knowledge, while engineering design is aimed at the application of scientific knowledge to address real-world issues. Simultaneously, the STEM cycle underscores the interrelatedness and amalgamation of STEM disciplines.

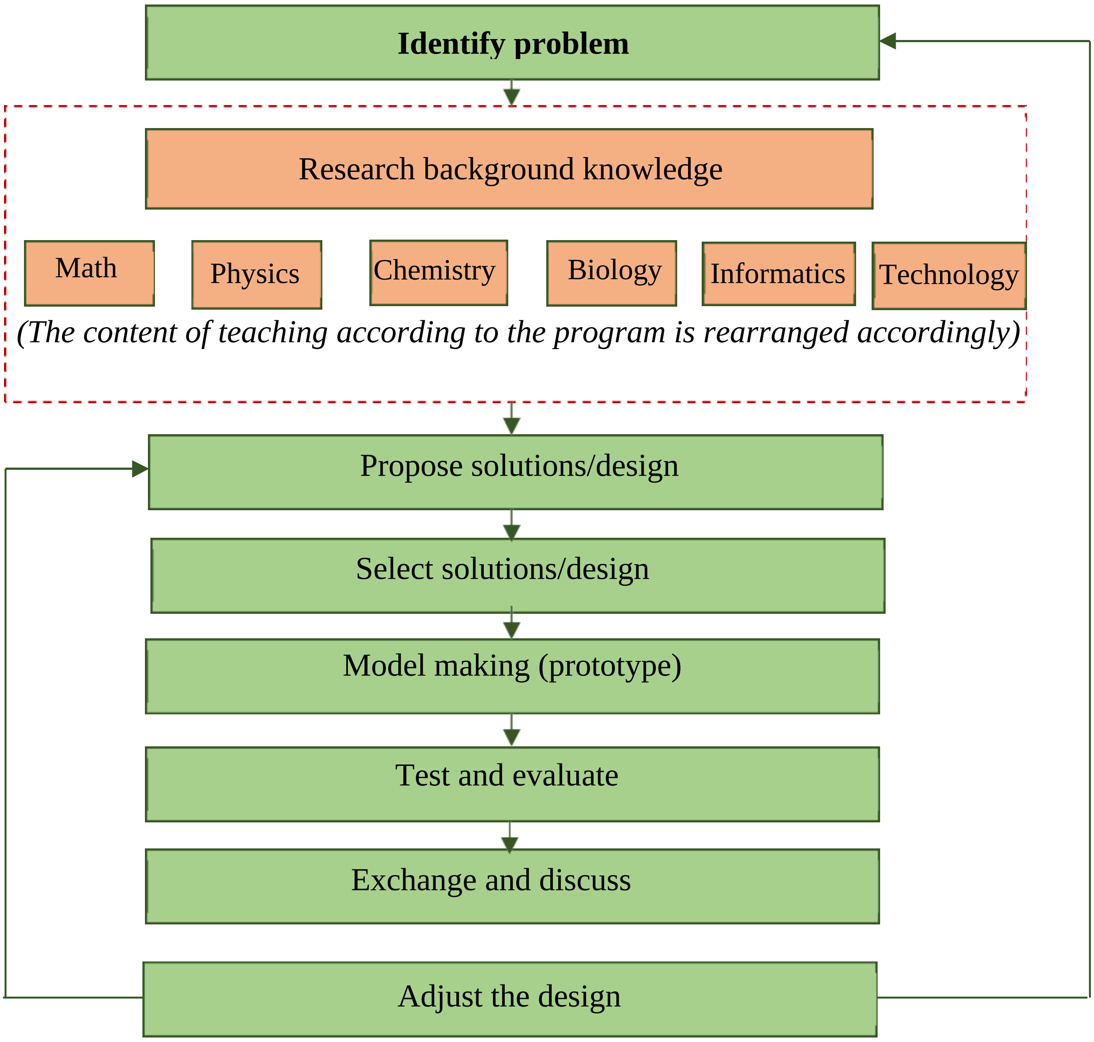

Figure 1. The process of teaching STEM

Activity 1: Identify the problem
In this activity, the teacher presents four activities for students to engage in STEM learning. The first activity involves assigning students a problem with specific criteria, which requires them to use new knowledge to propose and develop solutions, and make a model. The goal is to define product criteria and detect problems/demands, which help students understand practical situations,

technological processes, and the structural and operational principles of technological equipment.

The content of this activity focuses on learning about phenomena, products, and technology, and assessing these phenomena and products. Students are expected to complete levels of content completion through practice, and reading documents and reports, watching videos, engaging in discussions, and problem detection/statement. Teachers need to anticipate the completion levels of this product to plan appropriate solutions.

Activity 2: Study background knowledge and propose solutions
In this activity, students carry out active, self-reliant learning activities under the guidance of teachers, and focus on developing knowledge and skills according to high school standards. This activity includes studying textbooks, reports and supplementary materials, doing experiments, and taking part in discussions. Teachers operate, finalize new knowledge, and support students in proposing solutions/prototypes.

Activity 3: Select solutions
In this activity, students present, explain, and defend their viewpoints using new and learned knowledge. For STEM topics that require students to research and answer scientific questions, students must propose and implement a problem-solving solution, complete the product according to the task, and present their chosen design.

For STEM topics that require students to complete a technical product, students must propose solutions, choose a feasible solution, design a prototype, test and evaluate it, and finalize their designs (publish products). The expected student product is the solution and selected design.

Teachers have to anticipate levels of scientific hypotheses and problems the students will solve, which are based on the experimental plans that each student had prepared. It is important that teachers help the students identify the best plan to solve each problem. They should organize student exchanges and discussions to select the appropriate direction, present the final product, and then evaluate, comment, and improve it.

Activity 4: Model making, testing and evaluation
In this activity, students create a model according to the design completed after step 3During manufacturing, they test and adjust the original design to ensure the prototype is feasible. The goal is to manufacture and test the model, select experimental instruments/equipment, and support students in the implementation process.

These activities provide students with opportunities to explore and develop new knowledge and skills through STEM learning. By organizing tasks, providing guidance, and fostering a collaborative environment, students will be better equipped to tackle complex challenges and achieve their goals in STEM education.

Activity 5: Exchange, discuss and adjust
In this activity, students present their research products, evaluate them, and presente them for further adjustments. The goal is to present, exchange, discuss, and evaluate the final product. Teachers assign tasks, while students report and discuss their findings in appropriate forms, and teachers evaluate, conclude, and provide feedback for further improvement.

Phase 2: Build a system of STEM teaching topics based on a school model associated with production practices and social life in Vietnam.
The basis for building a system of STEM topics according to the school model associated with production practice and social life

Principle 1: The content of STEM lessons is linked to practical issues of social life, science and technology. Students are required to find solutions for problems, acquire knowledge, and meet the requirements of the lesson.

Principle 2: STEM lessons are built around the engineering design process comprising eight steps: problem definition; background research; proposing solutions; selecting solution; making models (prototypes); testing and evaluating; sharing discussion; design modification.

Principle 3: Teaching methods involve students in activities of inquiry and discovery, and are action-oriented according to the scientific and technical process.

Principle 4: It is crucial for STEM topics to be tailored to the cognitive level of students and to captivate their interest and attention.

Principle 5: In Vietnam, it is essential to develop abundant resources on STEM topics, and these subjects must be compatible with the physical infrastructure conditions and teaching needs of schools and connected to the practical realities of social life.This approach creates opportunities for students to explore and utilize these resources while they generate new ideas and create meaningful products that are connected to production practices and social life.

Phase 3: Scientific and technical processes are applied in teaching STEM topics according to the school model associated with production practices and social life.

Phase 4: Pedagogical experiments and experimental data are processed to evaluate feasibility and effectiveness.

3.2. Participants
A total of 31 experts who were lecturers at three universities – Hanoi National University of Education, Hue University of Education and Hanoi Metropolitan University – and 218 chemistry teachers from 10 high schools across the three regions: North, Central, and South of Vietnam,assessed the practicality, accuracy and science, relevance and feasibility of 33 constructible topics.

Data analysis: After analyzing the experimental data, we concluded that developing STEM teaching topics can be more effective if scientific and technical processes are applied.

3.3. Instruments

Evaluate the results of STEM education topics by administering expert evaluation sheets, teacher evaluations on STEM topics with responses on a Likert scale, evaluation forms and product evaluation forms.

3.4. Data gathering procedure

- Collect evaluation sheets from experts.
- Collect teacher ratings (responses on a Likert scale) on STEM topics - Google Forms.

3.5. Data analysis

Experimental data was processed and analyzed using SPSS software to determine the effectiveness of teaching and applying scientific and technical processes in teaching STEM topics.

4. Results

4.1. Building a system of STEM teaching topics according to the school model associated with production practices and social life in Vietnam

Suggested STEM topics include the application of biological techniques in food production, chemical reactions in the production of industrial products, or the application of physics in modern technologies, such as renewable energy, electronics and telecommunications.

These STEM topics not only help students understand the production process and product application better, but also help them develop the skills of logical thinking, inquiry, analysis and problem-solving, and creating skills for generating new and innovative solutions. This will better prepare students for the future when they access jobs related to science, technology and manufacturing. Therefore, the proposed STEM topics that correspond with the school model associated with production practice and social life in teaching physics, chemistry and biology subjects is consistent with the new general education curriculum in Vietnam.

With the STEM model, students learn physical chemistry or biology in a holistic, integrated way, together with math, technology, engineering and other sciences. Furthermore, students experience and interact with society and businesses, which stimulates students' interest, confidence and initiative in relation to learning, forming and developing general and specific learning competencies, in response to the new general education curriculum in Vietnam.

Through the process of conducting research and pedagogical experimentation, our research team designed STEM topics associated with production practice and social life in Vietnam for teaching physics, chemistry and biology to high school students (Tables 1, 2 and 3).

Table 1. STEM education topics associated with real life and social life in teaching physics

	Activities	Topic in physics
1	Modeling of hydraulic lifters	Liquid pressure
2	Crafting a flood-resistant house	Floating
3	Building an economical wood-burning stove	Heat conductivity
4	Manufacturing electrical warning, protection and control devices	Circuits connected in series The circuit is connected in parallel
5	Fabricating clothes wringer	Centripetal force
6	Making a simple electrochemical battery	Constant current
7	Fabricating devices using solar cells	Current in a semiconductor
8	Making a simple electrochemical battery charger	Power transmission, transformers
9	Making a model of a self-cooling house	Infrared and ultraviolet rays
10	Making a model of a smoke machine	Electric field
11	Making a model of an electrostatic sprayer	Electric field
12	Fabricating alarm control circuit by sensor	Electric current, electrical circuit
13	Manufacturing automatic timer switches	Force balance, torque force

Table 2. STEM education topics associated with practical production and life in teaching chemistry

	Activities	Topic in chemistry
1	Designing a periodic table for use by people who are visually impaired	Periodic table of chemical elements
2	Creating colorful beverage made of vegetables	Chemical balance
3	Making a mini nightlight from vegetables	Electrode potential and electrochemical source
4	Making scented candles to repel insects	Alkanes
5	Preparing herbal pesticides from materials available in nature	Halogen derivatives
6	Creating a mini missile	Carboxylic acid
7	Making soap from waste fat	Ester – Lipid
8	Electroplating	Electrolysis
9	Producing a slow-release fertilizer	Fertilizer
10	Preparing glucosamine hydrochloride from shrimp shells	Experience and practice organic chemistry
11	Domestic water treatment	Experience and practice inorganic chemistry

Table 3. STEM education topics associated with real life and production in teaching biology

	Activities	Topics in biology
1	Designing a drip irrigation system	Absorption of water by mineral salts and roots
2	Rainbow flowering	Transporting substances in the body
3	Painting from leaves	External features of leaves
4	Making pictures from snail shells	General characteristics and roles of molluscs

5	Building a model of the circulatory system	Circulation and lymphatic circulation
6	Designing a nutritious menu for the family	Food standards. Principles of rationing. Analysis of a given serving
7	Building a model of DNA	ADN
8	Designing a dust filter for the home	Environmental pollution

School-level STEM topics associated with production practices and social life in Vietnam are becoming more popular and attracting the attention of many educators. These topics not only help students understand the production process better, but also help students apply the knowledge they have learned in practice, develop logical thinking skills, practical skills, and problem-solving abilities, motivate students to learn, develop teamwork skills, impart knowledge and solve problems arising during practice.

STEM topics enable students to understand process impacts and apply science and engineering knowledge to practice, benefiting students and society. Students can use chemistry, biology, physics, and engineering to comprehend, investigate, implement, and solve production and real societal problems in Vietnam.

The STEM topics associated with production practices and social life proposed in Tables 1–3 can be implemented on a small or large scale, with different implementation times depending on the research purpose. In addition, teachers can combine topics into broader topics, to match students' abilities.

After developing STEM topics associated with production practice and social life, the list of topics and research issues were evaluated by experts for practicality, accuracy and science, suitability and feasibility. The results of the feedback provided by 31 experts on the practicality of STEM topics are listed in Table 4.

Table 4. Feedback of experts on practicality of STEM topics

	Topics	Ratio (%)			
		Totally disagree	Disagree	Uncertain	Agree
1	Modeling hydraulic lifters	9.6	6.5	16.1	29
2	Crafting a flood-resistant house	0	9.6	16.1	32.2
3	Building an economical wood-burning stove	3.2	9.6	19.3	38.7
4	Manufacturing electrical warning, protection and control devices	6.4	9.6	12.9	32,2
5	Fabricating a clothes wringer	3.2	6.5	16.1	38.7
6	Making a simple electrochemical battery	6.4	3.2	19.3	32.3
7	Fabricating devices using solar cells	3.2	0	9.6	51.6
8	Making a simple electrochemical battery	0	0	9.6	48.4

	charger				
9	Making a model of a self-cooling house	0	9.6	19.3	32.3
10	Making a model of a smoke machine	0	0	16.1	48.4
11	Making a model of an electrostatic sprayer	3.2	6.4	9.6	32.2
12	Fabrication of alarm control circuit by sensor	3.2	0	9.6	51.6
13	Manufacturing automatic timer switches	0	0	16.1	54.8
14	Designing a periodic table for use by people who are visually impaired	0	6.5	6.4	32.3
15	Creating colorful beverages from vegetables	0	6.4	9.6	48.4
16	Making a mini nightlight from vegetables	3.2	0	12.9	51.6
17	Making scented candles to repel insects	0	0	22.6	45.1
18	Preparing herbal pesticides from materials available in nature	0	0	12.9	41.9
19	Mini missile	3.2	0	6.5	45.7
20	Making soap from waste fat	9.6	0	12.9	41.9
21	Electroplate	0	6.4	9.6	45.1
22	Producing slow-release fertilizer	3.2	6.4	9.6	32.2
23	Preparing glucosamine hydrochloride from shrimp shells	0	0	12.9	48.4
24	Treating domestic water	9.6	0	9.6	45.1
25	Designing a drip irrigation system	0	0	9.6	41.9
26	Rainbow flowering	6.5	0	19.3	49.4
27	Painting from leaves	0	0	16.1	48.4
28	Making pictures from snail shells	0	0	16.1	54.8
29	Building a model of the circulatory system	0	0	9.6	48.3
30	Designing a nutritious menu for the family	3.2	3.2	9.6	38.7
31	Building a model of DNA	0	0	12.9	45.1
32	Designing a dust filter for the home	0	0	9.6	51.6

Table 4 shows that experts agree and agree fully on the practicality of STEM topics. Thus, STEM topics associated with production practices and social life were planned in accordance with the curriculum and teaching conditions in high schools in Vietnam.

The statistical analysis of data collected from the responses of 32 teachers indicates that most of the proposed STEM topics received agreement. The topic that received the highest level of agreement is "Crafting a flood-resistant house" with a total of 74.3% agreement. Following that are the topics "Manufacturing electrical warning, protection, and control devices" with 71.1% agreement and "Making a model of an electrostatic sprayer" with 80.8% agreement. This finding also highlights that the highest-rated topics are closely related to real-life practical applications. The other highly rated topics also involve the application of learned knowledge in practical scenarios, such as "Designing a periodic table for use by people who are visually impaired" with 87.1% agreement, "Manufacturing automatic timer switches" with 84.6% agreement, and "Designing a drip irrigation system" with 90.4% agreement.

The topics with the highest levels of agreement could be prioritized for curriculum development and implementation. Topics with higher percentages of "Totally disagree" and "Disagree" responses may need further refinement or reconsideration. These findings can help guide the selection and development of STEM education topics, taking into consideration expert opinions and the potential for successful implementation in teaching.

4.2. Teacher assessment of the level of understanding and application of scientific and engineering processes applied in STEM education

We surveyed 218 teachers nationwide; their demographic traits are summarized in Table 5.

Table 5. Statistics of survey subjects

Information about survey objects		Count
Gender	Female	160
	Male	58
Years of experience	Less than 5 years	68
	From 5 to 10 years	36
	From 11 to 20 years	82
	More than 20 years	32
Educational qualification	Bachelor	142
	Master’s	70
	Doctorate	6

The survey data provides key insights into the demographics of the respondents. A significant gender imbalance is evident, with women comprising 73.39% and men 26.61% of the respondents. This imbalance suggests a potential trend or sampling bias that warrants further investigation. The majority of respondents held a Bachelor degrees (65.14%), indicating that higher education qualifications, such a Master's degree (32.11%) or Doctorate (2.75%), are not prerequisites in this field. Experience levels are diverse, but lean towards more experienced professionals: 37.61% had 11–20 years of experience, while newcomers with less than 5 years accounted for 31.19%. Only a minority (14.68%) had more than 20 years of experience, which possibly indicates career transitions over time. Table

6 below will present the participants' level of understanding concerning the essence of the scientific and engineering processes.

Table 6. Level of understanding of the nature of the scientific and engineering process

	N	Mean	Std. Deviation
1. Concepts and fundamental principles of the scientific and engineering process	218	3.2936	.7596
2. Understanding the applications of the scientific and engineering process in STEM education	218	3.2294	.7755
3. Knowledge about the development of science and engineering in Vietnam	218	3.1193	.7402

Table 6 shows how well 218 respondents understood scientific and technical procedures. Fundamental ideas, STEM education applications, and Vietnam's scientific and engineering progress were examined. Numerically, these features have mean scores of 3.2936, 3.2294, and 3.1193, with standard deviations ranging from 0.7402 to 0.7755. The highest mean score of 3.2936 indicates that respondents were most confident about their understanding of fundamental concepts. However, the lowest mean score of 3.1193 – for knowing about local scientific and technical advances in Vietnam – implies a knowledge deficit. The low standard deviations imply a relative clustering of replies around the mean, which demonstrates fair comprehension among respondents. This may indicate that the educational system has provided a consistent foundation level of understanding, though it also suggests a more customized approach is needed to address a variation in learning requirements.

These findings suggest that educational and policy improvements are required. There exists a good foundation regarding scientific and technical ideas, but the curriculum needs additional localized context, to improve knowledge of Vietnam-specific advancements. Table 7 below presents an analysis of the application of scientific and engineering methodologies within the context of STEM education, emphasizing the integration and extent of these processes in instructional practices.

Table 7. Level of application of the scientific and engineering process in STEM topic teaching

	N	Mean	Std. Deviation
4. Implementing a STEM teaching approach based on the scientific and engineering process.	218	3.1284	.8043
5. Applying the scientific and engineering process to STEM lessons.	218	3.1284	.9218
6. Applying teaching methods in STEM education in conjunction with the scientific and engineering process.	218	3.0917	.8318
7. Defining objectives when applying the scientific and engineering process in teaching.	218	3.2752	.8355

8. Designing lessons and teaching activities by applying the scientific and engineering process.	218	3.1927	.8086
9. Assessing the effectiveness of applying the scientific and engineering process.	218	3.2661	.8439
10. Providing feedback and make timely adjustments during the application of the scientific and engineering process.	218	3.1468	.7659

Seven aspects of STEM education using scientific and engineering procedures were reviewed by 218 respondents. The mean scores ranged between 3.0917 and 3.2752, with standard deviations between 0.7659 and 0.9218. The highest mean score – 3.2752 – is for defining objectives when applying the scientific and engineering process in teaching, which demonstrates educators are best at creating goals. The lowest mean score, for applying teaching methods in STEM education in conjunction with the scientific and engineering process – 3.0917 – suggests weaker confidence, or room for development in this area of teaching.

Standard deviations lower than 1 indicate that responses cluster around the mean. This suggests that educators apply and comprehend in a similar way, but it may also mean that teaching methods may not be diversified enough to meet differing educational requirements and settings.
From a policy and education perspective, these numerical insights suggest that, while educators are confident about defining objectives and assessing effectiveness when integrating scientific and engineering processes into STEM teaching, they may need more professional development in relation to implementation and application.

4.3. Evaluating the effectiveness of applying scientific processes in teaching STEM topics according to the school model with production practices and social life

Table 8. Practicality and application of STEM topics

	N	Mean	Std. Deviation
11. Identifing issues in production process and social life that STEM can address.	218	3.2202	.8408
12. Integrating and updating real-life situations into STEM topics to reflect community needs and practices.	218	3.2385	.8467

Table 8 shows mean scores of 3.2202 and 3.2385 for recognizing social and production concerns STEM may address, and incorporating real-life scenarios into STEM studies. The standard deviations, 0.8408 and 0.8467, indicate that answers cluster around these means. This shows educators are moderately confident about using STEM realistically, though there is room for growth. These ratings indicate that educators view the real-world applicability of STEM as closely related to its instruction, which is positive for practical application-focused pedagogies.

Table 9. Linkages with the community and businesses

	N	Mean	Std. Deviation
13. Collaborating with businesses and social organizations to update information and resources.	218	2.6239	.9580
14. Organizing programs, projects, or internships involving the participation of businesses and the community.	218	2.6606	.9716
15. Assessing the sustainability of applying STEM topics in practical production and social life.	218	3.2752	.8679
16. Developing and updating development plans for the application of STEM topics in education.	218	3.1835	.9124

The complexity of the data in Table 9 has increased. The means drop to 2.6239 and 2.6606 for business–social organization collaboration (13) and community-involved program or project organization (14). These lower ratings, together with higher standard deviations of 0.9580 and 0.9716, indicate less participation of external groups and more experience variety among respondents. Assessing the sustainability of STEM themes in real-world applications has a higher mean of 3.2752, showing that, while educators may not be as connected with companies and communities, they understand the long-term viability of STEM education.

Table 10. Awareness and consciousness

	N	Mean	Std. Deviation
17. Awareness of the importance of connecting STEM to production practice and social life.	218	3.4220	.8179
18. Awareness of updating and applying STEM topics related to real-world practices.	218	3.4037	.8159

Table 10 reports data on the understanding of 218 respondents in relation to real-world relevance and curriculum revisions of STEM education. The mean scores are high, with 3.4220 for STEM's relevance to production practice and social life, and 3.4037 for updating and implementing STEM ideas in real life. With high mean scores and low standard deviations, of 0.8179 and 0.8159, answers cluster around the mean. The closeness of these mean scores and standard deviations suggests educators agree STEM education should be practical and relevant.

Table 11. Linkages between schools and practical production

	N	Mean	Std. Deviation
19. Create opportunities for students to visit and experience at production enterprises.	218	2.9908	1.0383
20. STEM education content accurately reflects labor market demands and trends.	218	3.2477	.9021

Table 11 shows that respondents believed that student interaction with manufacturing firms, and conformity of the STEM curriculum with labor market demands was crucial to practical STEM education. Based on 218 replies, providing students with chances to tour producing firms has a mean score of 2.9908 and a standard deviation of 1.0383. These results show moderate but variable involvement, demonstrating that some schools are proactive and others are underperforming due to budget restrictions or instructional objectives.

Aligning STEM education with job market developments had a higher mean score, of 3.2477, and a lower standard deviation, of 0.9021. This suggests that instructors are more consistent and optimistic about the relevance of the curriculum to the job market. The higher mean and smaller standard deviation imply that this STEM education feature is well executed or perceived.

5. Discussion

The goal of STEM education as it pertains to the education environment in Vietnam is to combine academic ideas with practical application. This study aimed to describe and validate the use of scientific and technical methods in STEM subject instruction, particularly in Vietnamese schools that are closely linked to the country's commercial, production, and social life.

It is clear that incorporating scientific and technology-based methods into the teaching of STEM subjects has many benefits, especially when subjects are connected to social and production processes. This is consistent with the ideas of Leung (2023), who contends that STEM education should be more than the sum of its parts; Leung calls for an integrated method of instruction that places a strong emphasis on real-world applications. The findings of this study support the notion that this pedagogical approach helps students to acquire the abilities necessary for problem-solving, logical thought and invention, in addition to facilitating a better understanding of academic ideas (National Research Council, 2012).

The STEM topics that were suggested act as concrete links between academic ideas and practical applications (e.g., the use of biology methods in food production or chemical reactions in industrial products). According to Zhou et al. (2023), this connection promotes an authentic learning environment in which students can understand the direct relevance and ramifications of what they are learning (Zhou et al., 2023).

The instructor feedback provided in this study offers intriguing insights. While teachers feel confident about setting goals and evaluating student progress, there appears to be a little difference in how these STEM subjects are actually applied in the classroom. Numerous factors, such as a lack of funding, a lack of professional development of teachers, or possibly the difficult task of incorporating real-world applications into conventional curricular frameworks may be to blame for this gap. Effective professional development, according to Darling-Hammond (2017), is essential to closing this gap.

One of the main conclusions of this study is acknowledgement of the need for a more regional curriculum that reflects developments and applications unique to Vietnam. Localization of the curriculum can increase the relevance and applicability of what is taught in the classroom considerably, as noted by Darling-Hammond.

The findings also suggest that teachers may require more in-depth professional development. Training programs could concentrate on methods to effortlessly integrate scientific and technological concepts into lessons, as well as on how to create strong connections between education institutions and industrial settings (McGuigan & Hoy, 2006).

However, in order for these advantages to be fully attained, the education system, particularly in the context of Vietnam, must address the difficulties that teachers face and make sure that the curriculum is relevant to the local context and in line with the country's socioeconomic structure (Rahmalia & Elida, 2022).

6. Conclusion

Vietnam is currently undergoing a significant phase of rapid advancement in the realm of STEM education. Nevertheless, the application of the science and technology process as an instructional framework for STEM subjects remains relatively constrained. The primary objective of our study is to investigate the feasibility and assess the efficacy of applying this process in an educational context that forges meaningful connections between education institutions and real-world scenarios, and specifically encompassing production practices. The process of teaching STEM is underpinned by the systematic application of scientific research procedures to address and resolve problems. This framework encompasses a series of methodical steps, namely observation, problem definition, hypothesis formulation, experiment design, data collection, results analysis, and culminating in the derivation of conclusions. By adhering to this process, a dynamic, exploratory, and creative mode of learning is engendered in students. Research findings unequivocally demonstrate the manifold advantages conferred by the application of the science and technology process in the pedagogical instruction of STEM subjects.

This study illuminates the significant strides Vietnam has made in redefining STEM education through the integration of technical science processes within a model that aligns schooling with production practices and social life. The development of STEM topics that resonate with real-life production and societal functions marks a transformative approach in the educational landscape; the aim is to equip students with the competencies required in a rapidly evolving world. In addition to affirmation by experts that the proposed STEM topics are practical and relevant, is evidence of potential effectiveness of the topics in the education setting.

Meanwhile, the assessment of teachers' proficiency reveals a commendable understanding of basic scientific concepts and a readiness to apply scientific and engineering processes in teaching. However, there is clear room for improvement regarding teachers' grasp of Vietnam's specific scientific and technological advances. This finding underscores the need for continuous professional development initiatives to update educators on local innovations and industry practices. Enhancing teachers' confidence and competence in these areas is crucial for the successful implementation of the STEM approach.

The evaluation results also suggest a need to strengthen the connections between schools, communities and production entities. While educators recognize the importance of real-world applications of STEM education, there is a discernible gap in active collaborations between education institutions, industry and societal organizations. Bridging this gap is essential if students are to be provided with a more immersive and practical learning experience, thereby making education more relevant and responsive to real-world challenges and market needs.

Furthermore, the study highlights educators' consistent acknowledgment of the importance of aligning STEM education with market demands, and the sustainability of educational themes. This alignment is crucial for ensuring that students are not only academically proficient, but also equipped with skills and knowledge that are marketable and relevant in the professional world.
In conclusion, the integration of technical science processes in teaching STEM topics within a model that mirrors production and societal practices holds great promise for education in Vietnam. The positive evaluations by experts and the readiness of educators provide a solid foundation for this education model.

7. Recommendations

Teaching associated with production practice and social life helps students realize the value of learned knowledge and skills, to practice thinking to solve practical problems that require an investment of time, and resource materials and technical facilities. However, many schools in remote areas cannot meet these demands.

Students can gain a better understanding of STEM concepts and how they are utilized in other fields if case studies and real-world examples are integrated in the curriculum. Students can enhance their analytical and problem-solving abilities, as well as their creativity and invention through the usage of this methodology – two benefits that are essential for advancing Vietnam's national development.

Students can more easily make the connection between abstract ideas and real-world applications if case studies from real life and practical applications are included in STEM coursework. This method will help students in Vietnam make the connection between abstract ideas and practical applications, thereby making their education more engaging and meaningful. Additionally, it will enable them to get a deeper understanding of the applications of STEM principles across a range of industries, and prepare them for potential job options in the future.

This study offers some practical suggestions for Vietnamese teachers and students in schools to use STEM teaching topics. Teaching associated with production practice and social life can be carried out in the classroom or in extracurricular teaching. Applying the scientific and technical process in teaching STEM topics can be carried out in different subjects – not only chemistry, physics, biology – it can also be effectively implemented in natural science at the lower secondary level.

Students can develop the critical thinking, problem-solving, and cooperation skills necessary for their future employment if they are exposed to STEM instruction in a variety of topics. This multidisciplinary method improves scientific understanding and encourages creativity and innovation in technology, engineering, and mathematics.

However, for its sustainable implementation, concerted efforts are necessary to enhance teacher training, facilitate active industry–academic partnerships, and continuously refine the STEM topics, to ensure they remain locally relevant, scientifically accurate, and aligned with market needs. By doing so, STEM education in Vietnam will be positioned to cultivate a future workforce that is innovative, skilled, and ready for the challenges of the modern world.

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