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Science, Technology, Engineering, and Mathematics (STEM) Education in the New General Education Curriculum of Vietnam

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ABSTRACT

This qualitative research assesses the opportunities and obstacles for STEM education implementation in Vietnam under the new general education curriculum introduced in 2018. Methodology involves expert interviews and document analysis. Findings reveal that the new curriculum provides a favorable context for STEM education, but implementation faces challenges such as limited policy frameworks, inadequate resources, insufficient teacher capabilities, and weak partnerships. Opportunities include increasing government support and societal awareness. The research concludes that despite the conducive environment, significant challenges remain. Recommendations include developing comprehensive policies, investing in resources, enhancing teacher development, fostering partnerships, and continuously improving practices based on research. Further research is needed to evaluate the effectiveness of these recommendations and explore innovative approaches.

Keywords: New General Education Curriculum of Vietnam, STEM education, STEM education in Vietnam, STEM challenges, STEM integration

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Introduction

Globally, there has been a strong push to prioritize Science, Technology, Engineering, and Mathematics (STEM) education to prepare youth for future jobs and build talent in strategic fields tied to economic growth and development. Studies have highlighted the benefits of STEM education including developing scientific knowledge, increasing competitiveness for college, opening up diverse career opportunities, fostering interest in STEM fields, and improving math and science overall. STEM education is becoming increasingly crucial in nurturing future generations with 21st-century skills. As the world faces severe challenges from climate change to food security, developing human capital in STEM fields is extremely important for socio-economic development and global competitiveness (English, 2016). In response, education systems worldwide seek ways to implement STEM education, although the approach varies according to each country's context.

In Vietnam, STEM education has attracted attention recently as the country pursues further innovation and deeper integration with the world. Recognizing the role of STEM in national development, the government has issued policies to promote it. The Vietnam Ministry of Education and Training – (MOET) introduced a new curriculum of general education incorporating STEM education. According to the curriculum summary, STEM education aims to develop human resources in the fields of STEM to improve the scientific and technological level and increase the competitiveness of each country's economy (Vietnam Government, 2018; Vietnam Ministry of Education and Training, 2018). The new curriculum has all STEM subjects with enhanced positions and roles.

According to Bui Van Hong et al. (2023), a survey of teachers in Ho Chi Minh City showed that while over 90% of teachers only around 17% taught STEM lessons in classrooms. Most teachers found it challenging to design a STEM curriculum and lacked proper facilities - the survey showed 50% of schools had no dedicated STEM classrooms, only 10% had invested in equipment, and 20% shared laboratories or partnered with companies. The lack of training, lesson design skills, and proper facilities constitute major challenges for implementing STEM education in high schools in Ho Chi Minh City (Hong et al., 2023).

However, STEM education implementation has faced many challenges, especially amid ongoing education reform. There is a need to clarify STEM education and propose solutions to organize and strengthen STEM effectively in all K-12 public school systems in Vietnam. Given current opportunities and challenges, this paper aims to contribute to assessments to enhance STEM education. Given adequate focus and funding, the incorporation of STEM education into Vietnam's new general education curriculum has the potential to cultivate a highly skilled workforce capable of propelling the nation's development objectives forward.

STEM Education

STEM education is focused on science, technology, engineering, and mathematics. It has been developed to improve student's problem-solving and critical thinking skills by an interdisciplinary approach, integrating knowledge and skills from different fields to solve complex real-world problems with deep understanding of principal scientific concepts in the core sciences. STEM education is essential for students to adopt 21st-century skills needed

for the new information-based economy within the knowledge-based society. It enhances global competitiveness by driving technological and innovative advancements. By developing a skilled workforce, STEM education supports economic growth and prepares students for future careers.

First, the acronym STEM, which stands for Science, Technology, Engineering, and Mathematics, was introduced by Dr. Judith A. Ramaley, then-director of the National Science Foundation's (NSF) education and human resources division, in the early 2000s. This integrative approach brought together these four distinct fields to promote interdisciplinary learning and application. This interdisciplinary approach was first used in the US under the term SMET, or science, mathematics, engineering, and technology (Maass et al., 2019). Over the past ten years, the phrase STEM has become more and more common in education at all levels.

Second, STEM education involves a teaching approach in which teachers integrate one or all of the four fields of science, technology, engineering and mathematics based on connections between the subjects and real-world problems (Moore et al., 2014) .

Third, STEM education combines fields into a cohesive learning model, building on real-world applications rather than teaching them as discrete and discrete subjects (Hom, 2014).

Fourth, STEM teaching should adhere to STEM curriculum standards and create experiences that allow students to develop STEM competencies. These experiences include participating in research, logical reasoning, and problem solving. Although there are a few different concepts, STEM education is often understood as an approach to classroom teaching that combines STEM fields (Martín-Páez et al., 2019).

Fifth, STEM education as an interdisciplinary approach is applied to train students' problem-solving abilities and improve the quality of learning activities. STEM education aims to find solutions to real-life problems, while providing students with more relevant experiences, preparing them for future careers (Kelley & Knowles, 2016).

Sixth, STEM education has been recognized as an appropriate training platform to form high-quality human resources, thereby contributing to promoting economic development (Margot & Kettler, 2019).

Finally, STEM refers to career fields closely related to science, technology, engineering and mathematics. Over time, the STEM concept has expanded into STEAM (with the addition of arts) to encourage creative and innovative thinking in education (Henriksen, 2014).

STEM Education Globally

STEM education is an educational trend that many countries have been promoting over the past decade. Originating in the United States in the 1990s to enhance the economy's competitiveness by developing human resources in these key areas (Maass et al., 2019). STEM education has gradually become a global trend. Developed and developing countries view STEM education as a strategic priority to increase competitiveness in the Fourth Industrial Revolution. STEM education has a strong priority in the US educational system. When it comes to implementing STEM, college, primary, and secondary schools or college and public

schools. The National Nanoscience Center was founded by six prestigious research universities as part of the National Nanotechnology Initiative. These educational institutions support educators in creating new STEM courses, updating existing ones, and giving students access to university research labs in chemistry, physics, and nanoengineering (Zahav & Hazzan, 2017).

In the UK, STEM is designed as an interdisciplinary approach combining science, technology, engineering and math. The country focuses on public school-university research links, with various interaction and training forms for students and teachers (Zahav & Hazzan, 2017). The adoption of STEM education in the continental activities including implementing problem- and project-based learning, combining formal and informal education, creating a STEM education ecosystem, and facilitating international educational exchanges between instructors and schools have all been implemented in mainland China (Meng et al., 2022).

In Taiwan, the 2018 K-12 curriculum guide integrates STEM subjects (Taiwan Ministry of Education, 2018). Efforts to promote systems thinking and problem solving hope to enhance technological capabilities. Indonesian pre-service teachers have a poor understanding of integrated STEM approaches, according to research initiatives to support teacher education for STEM education (Putra & Kumano, 2018). In Singapore, STEM education is being implemented through STEM education centers, STEM integrated high schools, and two STEM schools that are modeled after the top STEM institutions in the United States. Additionally, the promotion of STEM education is greatly aided by the Ministry of Education Singapore (Teo & Choy, 2021). Although STEM has been promoted through the Malaysia Education Blueprint, students lack interest. Lack of motivation, poor learning experiences pose challenges. Integrated STEM activities are needed to increase student engagement (Idris et al., 2023).

Studies on STEM education worldwide point out that although stemming from the same goal of developing national competitiveness, the way STEM is implemented in each country has distinct differences and is suitable to each nation's specific context and conditions (English, 2016; Pham et al., 2023). Studies highlight certain similar implementation issues that various countries experience while implementing STEM education, in addition to variations in implementation tactics. The largest issue is the dearth of qualified STEM educators. Owing to its multidisciplinary character, STEM educators must possess a wide range of knowledge and abilities in addition to the capacity to create engaging lesson plans that incorporate several topic areas. However, current teacher training programs remain mainly subject-specific, lacking emphasis on equipping teachers with integrated teaching knowledge and skills (Hong et al., 2023). In addition, the lack of facilities and equipment for STEM teaching, especially in developing countries, causes many difficulties. Language and cultural differences in each country also affect the effectiveness of STEM education, requiring proper adjustments for fitness (Ryu et al., 2019). Finally, academically assessing learning outcomes in the interdisciplinary learning environment of STEM is also a challenge for many education systems, requiring new approaches to both formative and summative assessments.

However, with the globalization trend and the rapidly unfolding 4th Industrial Revolution, transforming to a STEM education model to develop high-quality human resources in key areas is inevitable for all countries. Therefore,

despite initial challenges, STEM education promises to continue to be a top priority for governments and education policymakers worldwide for many decades improve human resource quality, promote development, and increase the competitiveness of national economies. Importantly, each country needs to have a creative, context-appropriate approach to make STEM education genuinely effective in the circumstances of each nation.

STEM Education in Vietnam

Vietnam is progressively establishing STEM education as a new educational trend through integration and development. The government has released numerous rules and recommendations to support STEM education in the system, acknowledging its significance. With a focus on science, technology, engineering, and mathematics, Directive No. 16/CT-TTg from 2017 and Directive No. 131/2022/QD-TTg from 2022 specifically aim to increase preparedness for the Fourth Industrial Revolution through innovative curricula and teaching methods that train human resources capable of adopting new production trends, improving the use of digital transformation, and information technology in the classroom through 2030. This illustrates the dedication to innovative education in order to fulfill the need for top-notch human resources in the digital era. Enhancing STEM education will benefit Vietnamese students by fostering their ability to think critically, solve problems, be creative, and innovate. (Vietnam Government, 2017, 2022). Subsequently, the Vietnam MOET issued the general education curriculum in 2018 with many integrated STEM education content, such as strengthening STEM subjects, renovating teaching methods towards interdisciplinary integration, and adding creative experiential and practical activities (Vietnam MOET, 2018). In addition, MOET also guided the implementation of STEM education in schools through documents such as 3089/BGDĐT-GDTrH in 2020, 909/BGDĐT-GDTiH in 2023.

However, the promotion of STEM research fields in Vietnam's educational framework still faces many challenges. One of the biggest challenges is the lack of competent STEM teachers with good professional and pedagogical skills (Pham et al., 2023; Vietnam Ministry of Education and Training, 2020, 2023a). The majority of educators are still educated according to the specialization concept and lack the information and abilities necessary for integrated, multidisciplinary STEM education. Many schools lack the necessary facilities and equipment to teach STEM subjects. Although there are incentives, the number of students pursuing STEM majors after high school remains limited.

Overall, STEM education in Vietnam is still in the foundation-building stage. To maximize the effectiveness of this new educational approach, long-term and systematic investment from the State and the whole society is needed in key areas such as STEM teacher training, improving school facilities, and building long-term STEM education development policies and strategies. At the same time, research, evaluation of the current situation, and proposals of solutions to improve the quality of STEM education need more attention to develop STEM education in Vietnam in the right direction and achieve high efficiency in the coming time.

Research Questions

This research aims to assess the opportunities

and challenges of STEM education within Vietnam's new general education curriculum and propose solutions to strengthen effective STEM education implementation in public schools. Specific research questions aim to examine the position and roles of STEM subjects in the new curriculum, the opportunities and favorable conditions for successful STEM integration, the key obstacles and difficulties that need to be addressed for STEM implementation, and specific recommendations and solutions to enhance STEM education delivery in general schools. Addressing these research objectives, the research seeks to provide comprehensive analyses and actionable recommendations to drive effective adoption of the STEM education with inquiry-based science programs and project-based engineering activities. The conventional science classes need to be modified by changing the current Vietnam curriculum for the K-12 school system.

Participants

The research involved participants from various educational roles and levels within the Vietnam education system to gain comprehensive insights. Specifically, we interviewed 20 experts, including educational researchers, school administrators, and people working in the Vietnam MOET and the Provincial departments of education. Purposive sampling was used to select 20 participants for the expert interviews. The participants included one expert from a research institute under the Vietnam MOET, four from the Provincial departments of education, five researchers from leading educational institutions, and 10 practitioners (teachers and school administrators) actively involved in STEM education. The diverse participant profile ensured a comprehensive understanding of STEM education from multiple perspectives.

Methodology

In this article, we utilized expert interviews and qualitative research methods based on document analysis. Concurrently, we collected and analyzed official documents pertaining to Vietnam's new general education curriculum, including the overall framework, subject curricula, and textbooks for STEM subjects. This assessment helped clarify STEM subjects' roles and objectives within the new curriculum. Additionally, we referred to research documents on the current status of STEM implementation in Vietnam and other countries to evaluate the present challenges and opportunities for STEM.

Regarding proposed solutions, we applied a comparative analysis of domestic and international models to suggest potential directions for innovating STEM teaching and learning organizations appropriate for the Vietnamese context. We also utilized logical analysis to assess the relationships between obstructing factors in STEM implementation and proposed solutions. The solutions are feasible options that could support the execution of STEM education in the new general education curriculum.

This research employed a qualitative design, utilizing expert interviews and document analysis as the primary data collection methods.

To collect comprehensive information about STEM education in Vietnam, the study interviewed 20 experts from many different roles and levels in the education system. Experts were selected based on extensive experience and in-depth understanding of the field of STEM education, while ensuring diversity of participants from state management agencies and schools. The study used purposive sampling to ensure

representation and diversity of participants from relevant management agencies, schools, and educational research institutions.

Data were collected through semi-structured interviews, with open-ended questions surrounding the main topics of the research. Depending on availability and participant convenience, interviews were conducted in person or by telephone. Each interview lasted approximately 45-60 minutes with the participant's consent and was then transcribed into text for data analysis. In addition, the interviewer also recorded key points and observations during the interview process to supplement additional information.

With the participation of experts from a variety of fields and levels and a carefully designed sampling and data collection process, the study gathered comprehensive and in-depth insights into the current status, opportunities, and challenges of STEM education in Vietnam from the perspective of many stakeholders.

Semi-structured interview guides were developed to explore experts' perspectives on the opportunities and challenges of STEM education implementation in Vietnam. The interview questions were designed to elicit insights on policy frameworks, resources, teacher professional development, partnerships, and innovative practices. Additionally, a document analysis matrix was created to systematically review and extract relevant information from official documents related to Vietnam's new general education curriculum and existing research on STEM education.

The interview data were transcribed verbatim and analyzed using thematic analysis. The researchers independently coded the transcripts, identifying emerging themes and patterns. The codes were then compared, discussed, and refined to establish a final codebook. The document analysis followed a similar process, extracting relevant information and categorizing it according to the predetermined themes. The findings from the interviews and document analysis were triangulated to enhance the credibility and trustworthiness of the results.

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Findings and Discussion

After researching the new general education curriculum framework and related documents of the Vietnam MOET, STEM education is reflected

in both the curriculum content and educational methodology in the general education of Vietnam. The new general education curriculum framework specifically mentions Project-Based learning and Inquiry-Based learning as recommended pedagogical approaches to facilitate STEM education.

Regarding content, the curriculum includes all subjects in the STEM fields, such as Mathematics, Informatics, Pure Sciences, Technology, and Engineering. Pure Science, also known as Natural Science, is the core subject that enables students to deeply understand the natural phenomena of the real world. Students then apply the core concepts of pure science to applied sciences, such as engineering and information technology, to develop advanced technologies for solving real-world problems. Notably, from grade 6 onwards, Natural Science is divided into three separate subjects Physics, Chemistry, and Biology, to increase the time allotted for science subjects and enable students to access natural science knowledge more deeply (Vietnam Ministry of Education and Training, 2018).

The new curriculum strongly emphasizes STEM subjects, featuring significant changes designed to enhance practical application. It aims to equip students with the versatile skill set necessary to excel in the new information-based economy within the knowledge-based society by prioritizing these vital areas.

Regarding the principles of curriculum development, the focus is on ensuring the development of learners' qualities and capacities through educational content that includes essential, practical, and modern knowledge and skills. The approach emphasizes practical application, enabling students to utilize their acquired knowledge and skills to tackle problems encountered in both academic pursuits and real-life situations.

In the lower grade levels, subjects are

Table 1

Comparative Table Vietnamese Education Curriculum 2006 vs 2018

Aspect	2006 Curriculum	2018 Curriculum
Educational Philosophy	Content-based, focusing on knowledge and skills attainment.	Competency and quality-based, emphasizing holistic development.
Curriculum Goals	Develop moral, intellectual, physical, and basic skills.	Mastery of knowledge, application in life, continuous self-learning, and career orientation.
Content and Volume	14 educational fields including language, math, ethics, etc.	Expanded to include new subjects like informatics, civic education, and experiential activities.
Teaching Methods	Traditional, with an emphasis on knowledge transmission.	Active and innovative methods focusing on practical application and lifelong learning.
Role of Textbooks	Sole source of knowledge for teaching, assessment, and exams.	One of multiple resources; encourages diverse teaching approaches and content understanding.
Teacher's Role	Deliver pre-determined curriculum content.	Facilitators who organize and guide student learning, adapting to local conditions.
Requirements for Students	Focus on learning as per the textbook content.	Encouraged to engage in activities applying knowledge practically, with more choice in subjects at higher levels.
Role of Local Education Authorities	Implement national curriculum under guidance from higher authorities.	More autonomy in curriculum implementation, supporting experiential and career-oriented activities.

highly integrated, gradually differentiating and becoming more specialized as students' progress to higher grades (Hong & Ngan, 2021). Teaching strategies must support students' potential and foster positivity. Forming positive traits, acquiring general and specialized competencies, and identifying and developing talents are the objectives of teaching.

The educational transformations in Vietnam between 2006 and 2018 signify a profound evolution in the national education policy, transitioning from a conventional, content-heavy curriculum to a contemporary, skills-focused framework with a deep understanding of the core concepts in core science subjects. This shift is pivotal in harmonizing Vietnam's educational goals with international trends that prioritize critical thinking, problem-solving abilities, and the practical application of knowledge (Vietnam Ministry of Education and Training, 2006; Vietnam Ministry of Education and Training, 2018). The 2018 curriculum broadens the range of subjects to include critical areas like informatics and civic education while also incorporating experiential learning and career guidance, equipping students to tackle real-world issues. In the new curriculum, the knowledge content has been significantly reduced by 20-30% compared to the previous curriculum, particularly in pure science subjects (Vietnam Ministry of Education and Training, 2018). For example, in physics, the study of thermodynamics and quantum mechanics has been reduced, while in chemistry, the content related to organic chemistry and biochemistry has been streamlined. These reductions aim to provide more opportunities for students to apply their learning practically and engage in hands-on activities.

STEM education equips students to solve real-world problems by encouraging them to think like scientists in a laboratory, rather than just passively learning in traditional classroom settings. This approach involves engaging in hands-on, inquiry-based learning and project-based activities that mirror the processes used by professionals in the field. By simulating real-world scenarios and challenges, students develop critical thinking, problem-solving skills, and a deeper understanding of scientific and engineering concepts.

The new curriculum promotes the organization of such hands-on activities and project-based learning to foster these essential skills. By participating in these activities, students gain practical experience in applying their knowledge, working collaboratively, and developing innovative solutions to complex problems. This approach not only enhances their understanding of STEM subjects but also prepares them for future careers in these fields, enhancing student engagement and initiative. Structurally, the new curriculum adopts an interdisciplinary approach, weaving various subjects around shared themes or topics. Innovations in teaching methods, including project-based learning, have diversified teaching and learning organization. These changes mark a decisive transition from the old to the new curriculum, aiming to fully develop student's abilities and character to meet the demands of Vietnam's extensive educational reform.

Regarding the interdisciplinary, integrated, and theory-practice-linking nature of STEM education. The overall general education curriculum is suitable for integrating STEM education and promoting STEM. STEM education also helps implement the overall curriculum successfully since it meets the perspectives, requirements, and methodology orientations. Moreover, MOET also issued 3089/

BGDĐT-GDTrH in 2020, 909/BGDĐT-GDTiH in 2023 to guide and enhance STEM application in schools, contributing to achieving the general education curriculum's objectives (Vietnam Ministry of Education and Training, 2020, 2023a). Regarding educational methodology, the curriculum emphasizes renovating teaching methods towards interdisciplinary integration based on science, technology, engineering, and mathematics. Accordingly, STEM education is reflected at all three levels of integration between subjects, integration between educational activities and integration with real life (Vietnam Ministry of Education and Training, 2020). Specifically:

- Integration between two or more subjects: Interdisciplinary knowledge is connected through learning themes or projects to solve a practical problem. For example, the food safety topic relates to biology, chemistry, and physics knowledge.

- Integration between educational activities: Experiential, career orientation, and extracurricular activities are designed to develop practical competence in applying STEM knowledge to reality.

- Integration with reality: Connect schools with businesses and communities so students can gain hands-on experience by applying STEM knowledge.

The forms of organizing STEM education in schools are diverse and plentiful. They can be any educational activity aimed at promoting STEM education in schools to attract interest, improve learning quality, and orient students towards STEM careers. Below are some of the main forms of STEM education in schools guided by the Vietnam MOET through Official Letter No. 3089/BGDĐT-GDTrH:

- *STEM lessons:* This is the primary structure used in school. This method uses an interdisciplinary or single-subject strategy to teach and learn STEM subjects. STEM lessons use the scientific method to study natural occurrences and offers knowledge-building courses at different levels in the natural sciences, physics, chemistry, and biology. The development of science competencies through experimental activities is emphasized in the new curriculum. STEM lessons employ the engineering design process to identify real-world problems and apply scientific, mathematical, engineering, and technological principles to propose solutions. This process involves various aspects, such as creative thinking, problem-solving skills, research abilities, and design techniques. Additionally, students learn about manufacturing, programming, automation, 3D printing, the Internet of Things, and robotics, which are all essential components of STEM education. It is important to note that the core sciences, including physical science, life science, and earth & space science, form the foundation for understanding and applying STEM concepts. Students must deeply understand the core concepts of these pure sciences, as they serve as the basis for applied sciences

such as engineering and information technology. By mastering these core concepts, students develop the critical thinking and problem-solving skills necessary to tackle real-world challenges effectively.

- *STEM Experiential Activities:* STEM experiential activities are organized as clubs or hands-on experiences chosen by students based on their interests and aptitudes, included in the school's annual education plan. STEM clubs allow students to advance their knowledge, conduct research projects, and explore STEM-related careers, serving as a prerequisite for high school students to participate in science and technology competitions. These clubs also help students discover their interests and aptitudes to guide future career orientations. In addition to the sentence, STEM clubs provide students with the opportunity to engage in STEM activities that cannot be accommodated within the regular curriculum, offering them a chance to be challenged because of the traditional time schedule (1 hour class will be 50 mins) of the public schools. STEM days are engaging scientific events that draw attention from students, parents, schools, and society to science, technology, engineering, and math. Students can directly experience and explore STEM fields through lively, hands-on activities, enhancing their understanding, honing their skills, and developing creative thinking. These events often involve the participation and cooperation of related entities like businesses, production facilities, vocational education institutions, universities, and scientists.

- *Scientific and Technical Research Activities Students:* This is an activity that brings many benefits and has been widely implemented nationwide. Outstanding student research results are selected to participate in science and technology competitions at all levels. Scientific and technical research activities are carried out as research projects, undertaken individually or in pairs, under the guidance of qualified teachers or scientists. This activity is not universal but intended for students with the capacity, interests, and passion for discovering and exploring science and technology to solve practical issues. Schools are able to find students gifted and talented in STEM fields through STEM classes with hands-on activities which fostering and facilitate their participation in scientific and technical research.

Based on research, STEM education in Vietnam not only has opportunities but also faces challenges. The new general education curriculum provides a favorable legal framework, prioritizing STEM subjects and integrating theory with practice. However, a significant barrier in STEM education is the lack of effective teaching methodology (pedagogy) among in-service science and technology teachers. Additionally, 50% of schools lack specialized STEM rooms, and only 10% invest in equipment. These

Table 2

Table for the Generated Themes

Codes and Sample Verbatim Responses	Categories	Themes	Description of Themes
Learner-centered approach	Curriculum Design	Learner-Centered Curriculum	The curriculum is designed to focus on the needs and potential of each student, encouraging active learning and personal development.
Streamlined knowledge content by 20-30%	Curriculum Content	Streamlined Content for Practical Application	The curriculum reduces theoretical content to make room for practical application, allowing students to engage more deeply with the material.
Interdisciplinary approach	Teaching Methodology	Interdisciplinary Integration	Subjects are integrated through common themes promoting a holistic understanding and application of knowledge.
STEM emphasis and practical application	STEM Education	Enhanced Focus on STEM	The curriculum prioritizes STEM education to equip students with necessary skills for a technologically driven world.
Project-based learning	Pedagogical Approach	Active and Project-Based Learning	Teaching methods encourage hands-on learning and critical thinking through projects.

capacity and implementation challenges need to be addressed systematically with a specific roadmap to capitalize on the new education program's opportunities and promote STEM education development in Vietnam. (Hong et al., 2023; Vietnam Ministry of Education and Training, 2023b)

The new curriculum's learner-centered approach is designed to develop students' intellectual capacities and personal qualities. This shift from a purely knowledge-based curriculum to one that emphasizes personal development represents a significant educational reform. Literature supports this approach and highlights its effectiveness in promoting long-term learning and adaptability. A study by Freeman et al. (2014) found that active learning methods in STEM education improve student performance and reduce failure rates compared to traditional lecturing. Analysis of 225 studies emphasized the importance of hands-on, engaging activities in STEM education.

Integrating subjects through common themes facilitates a more cohesive understanding of knowledge, preparing students for complex problem-solving situations they will face in the real world. We can realize that interdisciplinary education can lead to greater creativity and innovation among students.

The strong emphasis on STEM subjects within the curriculum addresses the growing demand for skills in these areas, which are crucial for success in a technology-driven information society. This focus aligns with global educational trends, prioritizing STEM education as a fundamental aspect of modern curricula.

An active learning environment is encouraged by project-based learning, a pedagogical approach that boosts student engagement and memory retention. This approach efficiently fosters problem-solving and critical thinking skills. The new curriculum's implementation has the potential to drastically improve Vietnam's educational results by

bringing it into compliance with international norms and satisfying both student and employer demands. The findings imply that this reform has the potential to greatly improve Vietnam's educational system.

The Vietnam's new general education curriculum showcases a shift towards integrating STEM subjects and transitioning to a learner-centered approach that focuses on addressing individual students' unique needs and capabilities. This shift aims to foster engagement and personal growth creating an interactive learning environment that caters better to learners' requirements. Studies have indicated that this method plays a role in aligning the education system with demands for critical thinking and problem-solving skills. The curriculum also underscores the application of knowledge, interdisciplinary connections, and the reinforcement of STEM education, which aligns with educational patterns to equip students with essential skills for success in a technology-driven society and enhance their competitiveness. The inclusion of project-based learning in the curriculum aims to nurture student autonomy and involvement. This transformation holds promise for enhancing the quality of education, meeting needs, and adapting to the ever-evolving job market. However, execution necessitates thorough preparation of educators' resources and seamless collaboration among stakeholders.

The successful implementation of STEM education in Vietnam requires coordinated efforts from various stakeholders. Educators play a crucial role in delivering the curriculum and adapting their teaching methods to the new approach. They need continuous professional development to enhance their STEM knowledge and pedagogical skills. Parents are essential partners in supporting their children's learning and reinforcing STEM concepts at home. Their understanding and engagement with the new curriculum are vital for its success. Policy makers are responsible for creating supportive policies, allocating resources, and establishing assessment frameworks that align with STEM education goals. Educational companies contribute by developing innovative learning materials, digital tools, and platforms that facilitate STEM learning. Additionally, industry partners can provide real-world context and opportunities for students to apply their STEM skills through internships, mentorship programs, and collaborative projects. Universities also play a role in aligning their teacher training programs with the new curriculum requirements and conducting research to inform best practices in STEM education. This multi-faceted collaboration among stakeholders is crucial for creating a cohesive ecosystem that supports the effective implementation of STEM education in Vietnam's new general education curriculum.

Implications

This research explores the implementation of STEM education within Vietnam's new general education curriculum, facilitating students' access to modern global educational trends. It reaffirms educators' and teachers' confidence in the role of STEM education in the current context, particularly in developing students' critical thinking skills and problem-solving abilities. Additionally, this research highlights several challenges in the deployment of STEM education in Vietnam.

Conclusion

This research aims to find new features of Vietnam's new general education curriculum,

especially the inclusion of STEM education in preparing the young generation to adapt to educational trends. The research results contribute to the theoretical basis for documents on educational reform and other research in Vietnam.

Research shows that the new general education curriculum has been significantly streamlined compared to the previous version, creating opportunities for students to apply knowledge to practice. STEM education not only means promoting education in STEM fields but also demonstrates an interdisciplinary approach, capacity development, and student qualities. This result suggests that reducing curriculum content can help enhance students' ability to apply knowledge.

Research also shows that implementing STEM education on a large scale requires a lot of effort. One challenge is the need for diversity and flexibility, avoiding the application of rigid models that limit the creativity and autonomy of schools and teachers. These findings highlight the importance of empowering schools and teachers in implementing STEM education. In addition, flexibility in university curricula, including interdisciplinary studies and dual degrees, is required.

Overall, the research concludes that Vietnam's new general education curriculum, through the introduction of STEM education, aims to create science and technology-oriented human resources, thereby positively impacting both the quantity and quality of the country's development. The research results have important implications for educational theories, teaching practices, and educational development policies. This means that to effectively implement STEM education and the new general education curriculum, it is necessary to focus on improving teachers' competencies, skills, and teaching methods through professional development and training activities. In addition, it is essential to formulate and plan policies in a comprehensive manner to promote the development of the national education system, including the incorporation of STEM education into the school curriculum.

This research has certain limitations. First, the scope of the research is limited to document reviews and interviews with experts in Vietnam, so the ability to generalize the results is limited. Second, the research has not evaluated the long-term impact of the new program because the implementation time is still short. Future studies should expand the scope of the research to more countries and monitor the effects over longer periods of time. In addition, future research in Vietnam's STEM education needs to collaborate with experts from other countries. Assistance from experts in countries such as the USA, Finland, Japan, and South Korea, which have already implemented STEM education in the early 21st century, would be beneficial.

Future research directions should focus on comparing the effectiveness of different STEM education implementation models; Assess the long-term impact of STEM education on students' learning outcomes, career orientation and abilities; Research the factors that promote and hinder the adoption of STEM education in developing countries.

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