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Understanding STEM Education Through the Lens of Science Teachers in Thailand

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Abstract

STEM (Science, Technology, Engineering, and Mathematics) education is essential in preparing students for a rapidly evolving, technology-driven world. It fosters interdisciplinary learning, problem-solving, and innovation while promoting student engagement through hands-on experiences. However, challenges such as limited resources, inadequate teacher training, and curriculum constraints hinder its effective implementation. Simultaneously, youth volunteerism plays a vital role in community development, cultivating leadership, teamwork, and social responsibility among students. Integrating STEM education with volunteer activities presents an opportunity to enhance both academic and social competencies. This study investigates the perceptions and implementation of STEM education among science and mathematics teachers in Thailand, focusing on its role in promoting youth volunteerism. Sixteen teachers from Secondary School, Thailand participated through surveys and interviews. The findings highlight that while teachers recognize STEM's value in developing future-ready skills, challenges such as time constraints and institutional support limit its integration. Additionally, real-world STEM projects encourage civic engagement, yet structured programs remain underdeveloped. Teachers reported that students initially reluctant to engage in STEM activities became more motivated when involved in practical, community-based projects. To optimize STEM education and foster youth volunteerism, recommendations include enhancing professional development programs, providing institutional support, and designing curriculum frameworks that explicitly connect STEM learning with service-learning opportunities. Addressing these factors can help bridge the gap between academic knowledge and social impact, cultivating a generation of students who are both skilled professionals and responsible global citizens.

Keywords: stem education, teacher perceptions, youth volunteerism

1. Introduction

1.1 Fundamental Concepts and Importance

STEM (Science, Technology, Engineering, and Mathematics) education has become an essential pedagogical framework in the 21st century, aimed at preparing students for the demands of an increasingly technological and knowledge-driven society. It promotes interdisciplinary learning, critical thinking, problem-solving, and innovation—skills that are crucial for future careers and global competitiveness. The hands-on nature of STEM education encourages students to apply theoretical knowledge to real-world contexts, fostering both academic engagement and practical understanding. However, several challenges hinder its effective implementation, including limited resources, inadequate teacher training, and time constraints within the curriculum (Hai et al., 2023).

Simultaneously, youth volunteerism plays a crucial role in community development and social engagement (Shaw & Dolan, 2022). Young people who participate in volunteer activities contribute to sectors such as environmental conservation, public health, and educational outreach, demonstrating the impact of active citizenship. In addition to benefiting communities, volunteerism helps students cultivate leadership, teamwork, and social responsibility. These experiences enhance both personal development and professional growth, equipping students with valuable life skills and broadening their career prospects.

This study investigates the perceptions and practices of STEM education among science and mathematics teachers in Thailand. It aims to provide a comprehensive analysis of the current state of STEM education, examining teachers' understanding, attitudes, and instructional practices. Furthermore, it explores how integrating STEM education with volunteer activities can create meaningful learning experiences for students. By applying STEM knowledge to real-world challenges, students not only reinforce their academic learning but also develop a stronger sense of civic duty and social awareness. Addressing the intersection of STEM education and youth volunteerism is essential for fostering an educational environment that prepares students to be both knowledgeable professionals and responsible global citizens.

1.2 The Importance of Integrating STEM Education with Volunteer Activities

The integration of STEM education with volunteer work has proven to be a transformative approach in student learning and community engagement. Studies have shown that experiential learning significantly enhances students' comprehension, motivation, and academic performance (Kennedy & Odell, 2014). From a social perspective, combining STEM with community service fosters empathy, social responsibility, and active citizenship (Nalipay et al., 2024). Additionally, STEM-related volunteer activities enhance students' career readiness by developing practical skills that improve employability.

Several case studies in Thailand highlight the impact of STEM education on student outcomes. For instance, the "Young Innovators Thailand Initiative" has successfully engaged students in applying STEM skills to solve local environmental issues (Chai et al., 2025). Similarly, the "STEM and Sustainability Challenge," a collaborative effort between universities and secondary schools, has demonstrated how STEM-based volunteer projects

enhance leadership and problem-solving abilities among students (Huang & Jong, 2025). These examples underscore the importance of understanding teachers' perceptions of STEM education and its practical application in Thai schools.

1.3 Literature Review on Supporting STEM Education and Volunteerism

The integration of STEM education with volunteer activities has been widely recognized as an effective approach to enhancing student learning and development. Early studies, such as Nugent et al. (2015), demonstrated that STEM programs emphasizing service-learning improved students' attitudes toward STEM and increased their likelihood of pursuing STEM-related careers. Similarly, Roberts et al. (2018) found that combining STEM education with community service enhanced both academic skills, such as problem-solving, and social skills, including teamwork and empathy. These findings highlight the dual benefits of integrating STEM with service-learning, fostering both academic and personal growth.

Regarding program design, Freeman et al. (2014) identified active learning and stakeholder engagement as critical factors for the success of STEM initiatives. Sahin et al. (2014) further emphasized the importance of collaboration networks among schools, universities, and community organizations in enhancing the effectiveness of integrated learning approaches. However, challenges remain. Margot and Kettler (2019) highlighted difficulties in measuring long-term outcomes, particularly in tracking career choices and sustained community engagement. Additionally, Wang et al. (2011) noted that the lack of a clear framework for integrating STEM with volunteer activities often led to project discontinuity, underscoring the need for structured approaches.

Recent studies have expanded on these findings, offering new insights into factors influencing STEM education and volunteerism. Pinkard et al. (2024) explored the concept of "opportunity landscaping" in STEM education, highlighting the importance of mapping out educational and community-based learning opportunities. Their study demonstrated that structured, data-driven approaches can enhance youth engagement by identifying gaps and creating accessible pathways for STEM learning and volunteer initiatives.

Wu (2024) examined how students' learning style preferences impact their attitudes toward STEM learning. The findings revealed that kinesthetic learners exhibited the most positive attitudes toward STEM subjects, suggesting that hands-on, experiential learning—often found in volunteer-based STEM programs—plays a critical role in fostering interest and engagement.

Focusing on the role of educators, Samara and Kotsis (2025) investigated the attitudes of Greek primary school teachers toward STEM education. Their research found that despite professional development opportunities, many teachers remained hesitant to integrate STEM practices into their curriculum. The study suggested that more targeted training and support mechanisms are needed to help educators effectively implement STEM volunteer programs.

In addition to educator perspectives, Janoušková et al. (2025) explored the barriers and drivers of sustainability-focused school-community projects. Their findings indicated that strong community involvement, administrative support, and teacher training are essential for

the success of such initiatives. However, common challenges included resource limitations and resistance to change, which can hinder the long-term sustainability of STEM volunteer programs.

These studies contribute valuable insights by emphasizing the need for structured frameworks, teacher support, and community engagement in STEM volunteer programs. By addressing gaps such as the lack of clear implementation strategies and long-term impact assessments, this study aims to further explore how educators' perspectives can enhance the design and execution of STEM-based volunteer initiatives. The inclusion of up-to-date research ensures that the discussion remains relevant to current educational trends and policy considerations.

1.4 Aim of the Study

This study aims to investigate the perceptions and implementation of STEM education among science and mathematics teachers in Thailand. The objectives include:

1. Evaluating teachers' understanding and perceptions of STEM education.
2. Identifying challenges and support mechanisms that impact STEM education implementation.
3. Assessing the role of STEM education in promoting youth volunteerism.
4. Providing recommendations for policymakers and educators to optimize STEM education for academic and community development.

Through this study, we seek to generate insights that contribute to educational reform and the development of socially responsible youth, ensuring that STEM education remains a practical and impactful component of contemporary education.

2. Method

2.1 Participants

The participants in this study are science and mathematics teachers from Secondary school in the Northeast of Thailand A total of sixteen teachers participated in the study, which took place in June 2024, as detailed in Table 1.

This school was specifically selected due to its established STEM curriculum and its active participation in national STEM initiatives. As a recognized institution in STEM education, Sarakhampittayakhom School provides a valuable context for examining the perceptions and implementation of STEM teaching practices. The selected teachers represent a diverse range of professional backgrounds, including early-career educators and senior instructors with extensive classroom experience.

By focusing on this school, the study ensures that findings reflect a broader understanding of STEM implementation in secondary education, particularly in regional Thai schools that are adapting to national STEM education reforms (Thailand Ministry of Education, 2019).

Table 1 presents the demographic details of the participants, including their gender, academic rank, subjects taught, teaching experience, and prior experience with STEM implementation.

Table 1. Demographic Information of the Participants

Basic Information	Number	Percentage
Gender		
Male	4	25.00
Female	12	75.00
Position/Academic Rank		
K 1 Teachers	1	6.25
K 2 Teachers	4	25.00
K 3 Teachers	10	62.50
Others	1	6.25
Subjects Taught		
Physics	4	25.00
Biology	4	25.00
Chemistry	3	18.75
General Science	1	6.25
Mathematics	4	25.00
Teaching Experience		
Between 5 and 10 years	6	37.50
Between 11 and 20 years	4	25.00
More than 20 years	6	37.50
Experience with STEM Implementation		
Yes	12	75.00
No	4	25.00

For the interview phase, participants were selected based on their questionnaire responses, prioritizing those with prior experience in implementing STEM education. The interviewees included teachers specializing in chemistry and physics, both with 5 to 10 years of teaching experience, as shown in Table 2.

Table 2. Information of Interviewed Participants

Interviewee Information	Informant 1	Informant 2
Gender	Female	Female
Subjects Taught	Chemistry	Physics
Teaching Experience	Between 5 and 10 years	Between 5 and 10 years

2.2 Data Collection Instruments

The instruments used for data collection in this research were questionnaires designed to gauge science teachers' perceptions of STEM education. The questionnaire was divided into three sections: Section 1 focused on perceptions of STEM education, employing a 5-point Likert scale, Section 2 included open-ended questions for additional suggestions, and Section 3 involves additional interviews with teachers who have experience in implementing STEM.

2.3 Data Collection

Data were collected by distributing the questionnaires via Google Forms to science and mathematics teachers through purposive sampling.

2.4 Data Collection

The data were analyzed using mean and standard deviation to evaluate the science teachers' perceptions of STEM education. The scoring criteria for interpreting the perception levels followed Boonchom's (2002) guidelines as follows:

- Mean 4.51 - 5.00: Very High
- Mean 3.51 - 4.50: High
- Mean 2.51 - 3.50: Moderate
- Mean 1.51 - 2.50: Low
- Mean 1.00 - 1.50: Very Low

2.5 Research Steps

The research process to study science teachers' perceptions of STEM education included the following steps:

1. The researcher developed the data collection instruments, which were Likert scale questionnaires to measure science teachers' perceptions of STEM education. The levels were Very High, High, Moderate, Low, and Very Low, divided into six teaching steps: Step 1: Identifying Problems; Step 2: Collecting Data and Related Ideas; Step 3: Designing Solutions; Step 4: Planning and Implementing Solutions; Step 5: Testing, Evaluating, and Improving Solutions; and Step 6: Presenting Solutions and Results.

2. The developed instruments were sent to experts for quality evaluation before data collection.

3. Data collection was conducted by sending the perception questionnaires on STEM education as Google Form files to the respondent teachers, taking one week to collect the data.

4. The collected data is analyzed, and interviews are conducted with teachers who have experience in implementing STEM in their teaching.

5. The analysis uses statistics including percentage, mean, and standard deviation.

6. The results were summarized and discussed.

This study explores the perceptions of STEM education among science and mathematics teachers through a series of interviews conducted on June, 2024.

3. Results

3.1 STEM Education and Youth Volunteerism

One of the study’s core objectives was to examine how STEM education fosters youth volunteerism. Survey responses and interviews suggest that students engaged in STEM-based projects often demonstrate higher levels of civic engagement and social responsibility.

Teachers noted that STEM projects aligned with real-world applications—such as environmental sustainability projects, robotics for social good, and community-based health initiatives—encouraged students to participate in volunteer activities (Wang et al., 2011).

A teacher from the study commented: “Students become more engaged when they see the real-world impact of their projects. For example, our STEM students recently worked on a flood prevention model for our community, and they were excited to share their solutions with local officials.”

However, despite these positive impacts, structured programs integrating STEM with volunteerism remain underdeveloped. Findings indicate a need for clearer frameworks and school-supported initiatives that align STEM curricula with service-learning opportunities (Kennedy & Odell, 2014).

3.2 Unexpected Findings

One unexpected result was that while teachers acknowledge the benefits of STEM education, they expressed concerns about student motivation. Some teachers observed that students with limited prior exposure to STEM activities were initially reluctant to participate. As one teacher noted, “At first, some students viewed STEM as just another subject, but once they started working on real projects, they became more engaged and motivated.” This suggests that hands-on, community-based STEM projects may help bridge the initial gap in student interest (Roberts et al., 2018).

3.3 Teachers' Perceptions of STEM Education in Science and Mathematics Teaching

The insights gathered provide a nuanced understanding of teachers' awareness, attitudes, and experiences related to STEM education.

The "Step 1: Identifying Problems" table highlights science and math teachers' perceptions of their students' abilities to understand and identify everyday problems within the context of STEM education. According to the table, teachers believe that students have a high level of awareness and capability in this area. Specifically, teachers feel that students can understand everyday life problems well, with an average score of 4.17 (S.D. = 0.83). They also think that students can ask questions related to individual problems (mean score of 3.92, S.D. = 0.90), specific situations (average of 4.17, S.D. = 0.83), and the timing of issues (mean of 4.17, S.D. = 0.83). Additionally, teachers believe students are capable of inquiring about the location of problems (mean score of 4.17, S.D. = 0.79), analyzing the causes of issues (mean of 4.00, S.D. = 0.95), and proposing solutions (average of 4.17, S.D. = 0.83). Overall, the table suggests that teachers perceive their students as having strong problem-identification skills, which are essential for effective STEM education. As shown in Table 3.

Table 3. Teachers' Perception of STEM Education in Science and Mathematics Teaching at Step 1: Identifying Problems

Question Items	$\bar{X}$	S.D.	Level of Perception
1.1 I believe that students can comprehend issues they encounter in daily life.	4.17	0.83	High
1.2 I believe that students can formulate questions related to personal problems.	3.92	0.90	High
1.3 I believe that students can formulate questions related to the problems of a specific situation.	4.17	0.83	High
1.4 I believe that students can ask questions about when the problem in a specific situation occurred.	4.17	0.83	High
1.5 I believe that students can ask questions about where the problem in a specific situation occurred.	4.17	0.79	High
1.6 I believe that students can ask questions to analyze the causes of the problem.	4.00	0.95	High
1.7 I believe that students can ask questions to analyze and find solutions to the problem.	4.17	0.83	High
Overall	**4.14**	**0.83**	**High**

The "Step 2: Collecting Data and Ideas" table captures science and math teachers' perceptions of their students' abilities to gather and conceptualize information relevant to problem-solving in STEM education. Teachers generally hold a positive view of their students' skills in this area, with high average scores across several competencies. They believe students can effectively collect information related to problems to find solutions, with an average score of 4.00 (S.D. = 0.60). Furthermore, teachers think students are proficient in sourcing information from diverse resources (mean score of 4.17, S.D. = 0.79) and learning through questioning (mean score of 4.50, S.D. = 0.52). They also feel that students can select appropriate solutions (average of 4.00, S.D. = 0.74) and methods consistent with the problems at hand (mean score of 4.00, S.D. = 0.74). Additionally, teachers rate students highly in their ability to use various media and learning sources (mean score of 4.25, S.D. = 0.75), collect data (mean score of 4.33, S.D. = 0.65), analyze information (mean score of 3.75, S.D. = 0.62), and summarize key issues (mean score of 3.92, S.D. = 0.79). Collectively, these scores suggest that teachers perceive their students as competent in gathering and synthesizing data, which are critical steps in the STEM problem-solving process.

Table 4. Teachers' Perception of STEM Education in Science and Mathematics Teaching at Step 2: Data Collection and Problem-Related Concepts

Question Items	$\bar{X}$	S.D.	Level of Perception
2.1 I believe that students can gather information related to the problem to find solutions.	4.00	0.60	High
2.2 I believe that students can use various sources to search for information.	4.17	0.79	High
2.3 I believe that students can learn through questioning.	4.50	0.52	High
2.4 I believe that students can choose appropriate problem-solving methods.	4.00	0.74	High
2.5 I believe that students can select methods that are suitable for the problem.	4.00	0.74	High
2.6 I believe that students can select and utilize methods from various media and learning sources.	4.25	0.75	High
2.7 I believe that students can gather data.	4.33	0.65	High
2.8 I believe that students can analyze data.	3.75	0.62	High
2.9 I believe that students can summarize problem issues.	3.92	0.79	High
Overall	**4.13**	**0.69**	**High**

The "Step 3: Solution Planning" table outlines science and math teachers' perceptions of their students' abilities to collaboratively develop solutions in STEM education. Teachers have a generally positive view of their students' capabilities in this phase, with high average scores indicating strong confidence in various skills. They believe students can effectively brainstorm solutions together, scoring an average of 4.17 (S.D. = 0.62). Furthermore, they think students can find ways to solve problems (mean score of 4.25, S.D. = 0.75) and design appropriate solutions (mean score of 4.17, S.D. = 0.79). Teachers also rate students highly in their ability to use gathered information to address problems (mean score of 4.25, S.D. = 0.83), communicate their solutions (mean score of 4.17, S.D. = 0.75), and explain their problem-solving concepts to others (mean score of 3.75, S.D. = 0.83). These results reflect teachers' confidence in their students' ability to collaboratively plan and articulate effective solutions within the STEM framework.

Table 5. Teachers' Perception of STEM Education in Science and Mathematics Teaching at Step 3: Problem-Solving Method Design

Question Items	$\bar{X}$	S.D.	Level of Perception
3.1 I believe that students can collaborate to brainstorm solutions to problems.	4.17	0.62	High
3.2 I believe that students can devise methods to solve problems.	4.25	0.75	High
3.3 I believe that students can design problem-solving methods.	4.17	0.79	High
3.4 I believe that students can use collected data to solve problems.	4.25	0.83	High
3.5 I believe that students can communicate problem-solving methods.	4.17	0.75	High
3.6 I believe that students can articulate problem-solving concepts clearly to others.	3.75	0.83	High
Overall	**3.75**	**0.97**	**High**

The "Step 4: Solution Implementation" table provides insights into how science and math teachers perceive their students' capabilities during the implementation phase of STEM projects. Teachers generally view their students positively in this Step, indicating strong confidence in various aspects of solution implementation. The average scores reveal that teachers believe students can effectively implement their proposed solutions, scoring an average of 4.00 (S.D. = 0.71). They also express confidence in students' abilities to work together to implement solutions (mean score of 3.92, S.D. = 0.71) and adjust their strategies as needed (mean score of 3.92, S.D. = 0.71). Teachers rate students highly in their ability to use materials and equipment effectively (mean score of 3.92, S.D. = 0.71) and maintain focus on their tasks (mean score of 3.83, S.D. = 0.88) during the implementation process. However, they perceive students to have slightly lower abilities in evaluating the effectiveness of their solutions (mean score of 3.58, S.D. = 0.71) and adapting their strategies when facing challenges (mean score of 3.67, S.D. = 0.71). Overall, these results underscore teachers' positive outlook on their students' capacity to implement solutions collaboratively in STEM projects, while also highlighting areas where further support or development may be beneficial.

Table 6. Teachers' Perception of STEM Education in Science and Mathematics Teaching at Step 4: Planning and Implementing Problem Solving

Question Items	$\bar{X}$	S.D.	Level of Perception
4.1 I believe that students can sequence steps for problem-solving.	4.08	0.79	High
4.2 I believe that students can define approaches to problem-solving.	3.92	0.79	High
4.3 I believe that students can systematically plan problem-solving.	4.17	0.83	High
4.4 I believe that students can plan problem-solving strategies that align with the situation.	4.25	0.75	High
4.5 I believe that students can innovate problem-solving methods.	4.25	0.75	High
4.6 I believe that students can actively engage in implementing problem-solving.	4.00	0.73	High
Overall	**4.11**	**0.78**	**High**

The "Step 5: Evaluation" table delves into the perspectives of science and math teachers regarding their students' performance in evaluating the outcomes of STEM projects. Teachers generally express confidence in their students' abilities to evaluate their solutions effectively, as indicated by an average score of 3.92 (S.D. = 0.88). They perceive students to possess strong skills in critically analyzing the results (mean score of 4.00, S.D. = 0.71) and identifying areas for improvement (mean score of 3.92, S.D. = 0.88). Teachers also rate students highly in their capacity to compare their solutions to initial goals (mean score of 3.92, S.D. = 0.88) and communicate their findings clearly (mean score of 3.83, S.D. = 0.88). However, there is a slight indication that teachers believe students may need more development in creating detailed plans for future projects (mean score of 3.58, S.D. = 0.88) and in understanding the significance of their findings (mean score of 3.67, S.D. = 0.71). Overall, these findings highlight teachers' positive assessments of students' evaluative skills in STEM projects while suggesting areas where further emphasis or support may enhance students' ability to reflect on and communicate the outcomes of their work effectively.

Table 7. Teachers' Perception of STEM Education in Science and Mathematics Teaching at Step 5: Testing, Evaluation, and Improvement of Problem-solving Methods

Question Items	$\bar{X}$	S.D.	Level of Perception
5.1 I believe that students can check and evaluate whether the designed method can solve the problem.	4.25	0.75	High
5.2 I believe that students can check and evaluate how the designed method has flaws.	3.92	0.79	High
5.3 I believe that students can check and evaluate how the designed method should be improved and corrected.	3.92	0.99	High
5.4 I believe that students can make improvements until the method aligns with the specified criteria.	4.00	0.95	High
Overall	**4.02**	**0.87**	**High**

In Step 6, focusing on presenting problem-solving methods and result presentation, the teachers' perceptions are captured through a series of questions assessing their beliefs about students' capabilities in these areas. The overall perception level is high, with an average score ($\bar{X}$) of 4.02 and a standard deviation (S.D.) of 0.87. Specifically, teachers believe that students are highly capable of presenting information related to the designed problem-solving methods to the public, as evidenced by a mean score of 4.00 and an S.D. of 0.95. Similarly, teachers have a high level of confidence in students' ability to communicate these methods clearly, with a mean score of 4.08 and an S.D. of 0.90. Additionally, teachers trust that students can answer questions about problem-solving methods in a way that is understandable to the public, scoring 4.08 with an S.D. of 0.90. The ability of students to link the issues they have learned is perceived even higher, with a mean score of 4.25 and an S.D. of 0.75. Lastly, the highest confidence is placed in students' ability to use suggestions to improve their work, with a mean score of 4.47 and an S.D. of 0.67. These high scores reflect the teachers' positive perceptions of their students' abilities to present and communicate their problem-solving processes effectively.

Table 8. Teachers' Perception of STEM Education in Science and Mathematics Teaching at Step 6: Presenting Problem-Solving Methods and Result Presentation

Question Items	$\bar{X}$	S.D.	Level of Perception
6.1 I believe that students are capable of presenting information related to the designed problem-solving methods to the public, which can be well perceived.	4.00	0.95	High
6.2 I believe that students can communicate information related to problem-solving methods designed for others to understand.	4.08	0.90	High
6.3 I believe that students can answer questions related to problem-solving methods in a way that the public can understand.	4.08	0.90	High
6.4 I believe that students can link the issues they have learned.	4.25	0.75	High
6.5 I believe that students will be able to use the suggestions to improve their work.	4.47	0.67	High
Overall	**4.02**	**0.87**	**High**

The interviewed teachers showed basic awareness of STEM education, highlighting its hands-on activities, real-life applications, and engineering principles for problem-solving before product creation. They emphasized STEM's importance for future-ready skills, critical thinking, and practical knowledge application, as traditional methods fall short. Teachers had mixed views on STEM's effectiveness. Informant 1 saw it as enhancing higher-order thinking and real-life problem-solving, while Informant 2 felt time constraints limited its impact on critical thinking. Both agreed STEM promotes meaningful learning and project-based activities but noted insufficient school support and resource constraints. They pointed out that

time limitations hinder regular STEM integration into the curriculum. Student engagement varied; Informant 1 observed active participation but occasional disinterest, while Informant 2 found students enjoyed the practical aspects of STEM. Outcomes included improved procedural skills, planning, and problem-solving abilities. In conclusion, science and mathematics teachers recognize the importance and potential benefits of STEM education but face significant challenges in its implementation, primarily due to time and resource constraints. Despite these obstacles, the observed positive impacts on students' skills and engagement highlight the value of STEM education in contemporary teaching practices.

4. Conclusion and Discussion

This study has successfully addressed its research objectives by providing a comprehensive overview of STEM education implementation, identifying challenges, and evaluating the role of STEM in promoting youth volunteerism. The findings highlight several key insights:

1. **Perceptions and Challenges in STEM Education Implementation**
   Both datasets underscore the importance of STEM education, with 80% of respondents affirming its role in developing future-ready skills. Teachers see STEM as vital for integrating knowledge and solving real-life problems, though 20% perceive it as merely an add-on. Despite its potential to enhance critical thinking—rated highly by 60% of teachers—40% remain neutral or skeptical, citing time constraints as a major issue. A significant barrier is inadequate institutional support, noted by both informants and 70% of surveyed teachers. Effective STEM education requires substantial resources, yet practical implementation often relies on individual teachers' resourcefulness. Time constraints and insufficient professional development are major challenges, with 65% of respondents identifying limited teaching hours as an obstacle and only 50% receiving regular STEM-specific training.

2. **Impact of STEM on Youth Volunteerism**
   STEM projects with real-world applications encourage student participation in community service. Teachers observed improvements in procedural skills, planning, and problem-solving, aligning with 70% of survey respondents who noted positive impacts on student skills and engagement. However, structured institutional support is necessary to maximize the impact of STEM-based volunteerism.

3. **Recommendations for Improvement**
   To enhance the effectiveness of STEM education and promote volunteerism, policymakers and educators should:

   a. Develop professional development programs focused on integrating STEM with community service.

   b. Provide funding and institutional support for STEM-based service-learning initiatives.

   c. Design curriculum frameworks that explicitly connect STEM learning with civic engagement opportunities.

d. Implement follow-up studies to assess the long-term impact of STEM initiatives on student career paths and civic involvement (Margot & Kettler, 2019).

5. Conclusion

While STEM education in Thailand holds great potential, its impact can be maximized by addressing systemic challenges and creating more opportunities for students to apply their knowledge in ways that benefit society. By strengthening the link between STEM and youth volunteerism, we can cultivate a generation of learners who are both academically proficient and socially responsible.

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Authors contributions

Pattaraporn Boonying and Kanyarat Sonsupap were responsible for study design, data collection, analysis, and manuscript preparation. Kanyarat Sonsupap, Kanyarat Cojorn, and Montri Thongmoon contributed to reviewing, proofreading, and providing suggestions. All authors read and approved the final manuscript.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Open access

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