

STEM TEACHING: PERCEPTION, CHALLENGES AND SELF EFFICACY AMONG IN-SERVICE TEACHERS

Kaur BK*

Department of Education, HELP University, Malaysia

Abstract: STEM education plays a significant role in today's accelerating century in diverse sectors. This study aims to investigate the perceptions, challenges, and self-efficacy of the in-service teachers in implementing STEM teaching with their students. A mixed-method research design referred to as an explanatory sequential design is used in this study. The questionnaires were directed to 22 in-service teachers in the Klang Valley and Johor who taught STEM subjects to their students. The quantitative findings show that 90.5% of the in-service teachers have the insight that STEM is interesting and hands-on, while 81.0% believe that it encourages creativity. The results further noted that 95.2% of teachers agreed that students enjoyed studying STEM, while 100% of them acknowledged that teachers play an important role in delivering STEM lessons to their students. A mean value of 4.14 revealed that the teachers were satisfied with carrying out the STEM teaching. The challenges faced by the teachers were reported qualitatively through open-ended interview questions, while the focus group interview was conducted to understand teachers' self-efficacy in carrying out the STEM activities with their students. Thematic analysis by Braun & Clarke was adopted to identify the qualitative themes. It was noted that the teacher faced some challenges, such as space constraints, time constraints, technical challenges and environmental safety challenges. It was explained through the focus group interview that the teachers gained instructional confidence, technological confidence and collaborative confidence. This was supported by the quantitative data, which revealed that 90.5% of the in-service teachers' STEM teaching boosts their knowledge and confidence level, which leads to implementing STEM activities. In conclusion, STEM activities have a positive impact on the mindset of the teachers, notably because of the hands-on and interactive sessions with their students. The study, however, implied that more training sessions are required for STEM activities and lessons by the in-service teachers. Despite having data consistent with the findings, the small and localised sample size limits the generalizability.

Keywords: 21st century skills, science, technology, STEM education

Introduction

STEM education encompasses science, technology, engineering, and mathematics, and has become a vital interdisciplinary, practical approach in today's education, focusing on solving problems and overcoming

*Corresponding Author's Email: balvinderkaur.sshelp.edu.my



challenges. STEM education is now a requirement to train students to manage sophisticated issues of the 21st century, beyond the academic benchmarks (Lavi et al., 2021).

21st-century skills refer to the four Cs: Communication, Creative thinking, Critical thinking, and Collaboration (Barus, 2024). STEM education promotes 21st-century skills on the grounds of its hands-on, practical, and problem-solving nature. Similarly, the interdisciplinary STEM education offers a stimulating atmosphere enhancing the critical thinking, collaboration, creativity and communication (Stehle & Peters-Burton, 2019). One of the highlighted skills of the 21st century is collaboration, which is essential in STEM education through team-based learning to boost educational attainment and develop students who are ready for employment (Ramachandran, 2025). Additionally, creativity is improved through the engineering element as it demands students to capture their attention to be critical thinkers in suggesting feasible prototype ideas (Stretch & Roehrig, 2021).

Teachers are the primary individuals delivering STEM instruction to equip students with the skills to solve problems creatively and prepare them for future, real-world, practical issues (Abbas et al., 2023). Based on Kavak (2023), teachers contribute to fostering and nurturing students' curiosity and inquisitiveness in STEM, directing their learning journeys and career pathways.

Bandura (1997) affirms self-efficacy as a personal assurance about the aptitude of executing a project, assignment or activity efficiently. Self-efficacy promotes confidence and facilitates the accomplishment of a task (Rezaull Karim et al., 2021). According to Jerrim et al (2023), the successful execution of STEM teaching and the development of students' educational competencies hinge on teachers' self-efficacy as the crucial fundamental component. Teachers with high self-motivation manifest high self-confidence, sustaining promising capabilities in conveying STEM teaching successfully (Calkins et al., 2024).

The purpose of this study is to understand the perception, challenges and self-efficacy of the in-service teacher in STEM teaching. Now that professionals in STEM are in demand to solve real-world problems (Rahimah Jamaluddin et al., 2023), teachers need to create strategies to provide actual, practical experiences for students where both teachers and students understand and acquire STEM knowledge. Moreover, the

issue seen by the researcher is that not all teachers are well versed with the incorporation of all the disciplines in STEM (Srikoom et al.,2017).

Furthermore, the Minister of Science, Technology, and Innovation, Malaysia, reported that students in upper secondary level prefer technical and vocational options compared to the STEM field (Rahimah Jamaluddin et al., 2023). Due to this, teachers were linked to the decreased number of students enrolled in the STEM fields: teachers' moderate capabilities in incorporating STEM teaching were insufficient to meet the needs of the students. In order to close the gap, we must understand what the teachers think of STEM, the challenges they encounter and their self-assurance in STEM teaching.

The objectives of this study are:

1. To assess the reported level of in-service teachers' perception of STEM activities as practical, inspiring and engaging.
2. To analyse the level of in-service teachers' self-efficacy in STEM teaching in terms of roles, knowledge and confidence.
3. To describe the challenges faced by the in-service teachers which influence their perceptions of STEM activities
4. To explore in-service teachers' experience related to roles, knowledge and confidence in implementing STEM teaching

The research questions are:

1. What is the reported level of in-service teachers' perception of STEM activities as practical, inspiring and engaging?
2. What is the level of in-service teachers' self-efficacy in STEM teaching in terms of roles, knowledge and confidence?
3. How do the challenges faced by the in-service teachers influence their perceptions of STEM activities?
4. How do in-service teachers describe their experience related to roles, knowledge and confidence in implementing STEM teaching?

LITERATURE REVIEW

Stem Education

According to the Ministry of Education Malaysia, STEM Education in Malaysia was planned in three phases: wave 1 to 3 phases by the Minister of Education (2015). According to the Malaysian Education Development Plan (PPPM), 2013-2025, (2013), phase 1 (2013-2015), focused on curriculum, training teachers and multimodal learning models, phase 2 (2016-2020), collaboration with organization were performed to promote the awareness of STEM education and finally phase 3 (2021-2025), STEM was heightened to a proficient level via improved versatility.

A study with 50 students aged 14 to 15 years old from a secondary school in Hulu Selangor District, Malaysia, successfully fostered students' interest towards STEM, through interactive and entertaining activities (Nurulsaidah Abdul Rahim & Suzaliza Mustafar, 2024). This study revealed that there were high chances that students who participated in STEM learning would continue a STEM profession (Nurulsaidah Abdul Rahim & Suzaliza Mustafar, 2024).

21st Century Skills

Research by Dare et al. (2021) with 19 science teachers found that teachers employed a cross-disciplinary approach to STEM education, promoting 21st-century skills, applying practical issues to inspire students. These teachers believed that 21st-century skills were included in their instructional approaches (Dare et al., 2021). It was noted that students communicated during the implementation of STEM activities, which encouraged them to work in teams and enhanced their collaboration skills.

Quasi-experimental research with 76 students employed teacher-centred learning with the control group and STEM learning as the treatment, identified that students' creative thinking skills were enhanced through STEM education and creative thinking is considered as one of the important tools to be established with the assistance of the teachers (Sirajudin et al., 2021).

Perceptions of STEM

Teachers noticed that students felt driven, positive and confident with their skills in solving complicated problems, indicating that students have an interest towards STEM, which also led to impressive academic results (Margot & Kettler, 2019).

Additionally, Srikoom et al. (2017) stated that teachers claimed the major rationale of incorporating STEM into the curriculum was due to the students' expanded involvement and satisfaction in STEM. According to Srikoom et al. (2017), teachers have an understanding that STEM teaching is an interesting technique,

although many of them had an uncertain view of the term integrated STEM and reported concern about the engineering discipline.

STEM Challenges

Baskaran and Abdullah (2023) identified facilities as the main challenge faced by secondary school teachers in the Manjung district, Perak. The teachers responded during the survey that insufficient amenities, such as a proper laboratory and equipment and a classroom with technological facilities (LCD) were not available to them for conducting STEM education. Although the study showed that the teachers were ready to teach STEM, they still faced time constraints during the planning and implementation (Baskaran & Abdullah, 2023).

The findings by Margot & Kettler (2019) reported that the teachers encountered the challenges of a shortage of time to plan and set up the resources or materials for students during STEM education. Teachers felt anxious with their volume of work and packed schedule with other subjects to cover in between Margot & Kettler (2019).

Teacher's Self-efficacy in STEM

A study by Papagiannopoulou & Vaiopoulou (2024) declared that teachers with mental preparedness and intellectual readiness instantly influence teachers' confidence level and trust in teaching STEM. In line with this, teachers who attended professional development on STEM show greater confidence to incorporate STEM into their teaching (Buechel et al., 2024)

Based on Sellami et al. (2024), 322 teachers participated in quantitative exploratory research in Qatar, which indicated that these teachers have high self-efficacy; however, several remarkable differences subsist, such as educational level, qualifications and school type. It was reported that private school teachers with higher educational degrees exhibited full confidence in teaching STEM (Sellami et al., 2024). On the other hand, it was found that there was a need for professional development programs with different groups of teachers, directed to strengthen the self-efficacy of teachers in middle and government schools (Sellami et al., 2024).

Based on Ramachandran (2025), collaboration or teamwork in STEM education aids the students in developing a creative mindset, becoming critical thinkers and improving socialising skills. Teachers play a vital role in introducing collaborative learning in small groups by structuring weekly activities for planning purposes and managing time constraints (Ramachandran, 2025).

METHODOLOGY

This study applied quantitative and qualitative research designs. It utilised the exploratory research design (Figure 1). Creswell & Creswell (2018) highlighted the importance of the quantitative phase and then proceeded to the qualitative phase.

Figure 1: Explanatory Sequential Design (adapted from Sharma et al., 2023)



22 in-service teachers from private and international schools from Klang Valley and Johor who took Teaching of Mathematics and Science (TMS) as one of their electives in their master's program willingly participated in this study. Purposive sampling was more appropriate for selecting in-service teachers enrolled in the TMS course. The inclusion criteria included in-service teachers who planned STEM lesson plans and implemented them in groups with their students in the early years, primary and secondary levels.

The instruments used to collect quantitative data were 5 Likert-scale survey questionnaires. According to Koo & Yang (2025), a 5-point Likert scale is appropriate for collecting data and enables participants to indicate their level of agreement, opinion, understanding, and differences. The survey questionnaires were adapted from Buechel et al. (2024) and STEM for Future (2022). Two education experts validated the instruments. The experts agreed, with no comments, on Sections A (Demography), B (Perception of STEM), C (About the STEM Activities you Conducted), and D (Self-Efficacy in STEM). The reliability test for 40 items, with a Cronbach's alpha of ($\alpha = .887$), is shown in Table 1. The value of α is considered reliable and has good internal consistency when it is $\alpha > 0.8$ and within an acceptable value of $\alpha > 0.7$ (Taber, 2017). Table 2 shows good internal consistency, with Cronbach's Alpha for the items among the 22 in-service teachers.

The SPSS (Statistical Package for the Social Sciences) was used to analyse quantitative data. Meanwhile, for qualitative data, open-ended and focus-group interview questions were developed following the analysis of the quantitative data. Ten teachers (T1, T2, T3, T4, T5, T6, T7, T8, T9 and T10) were invited to an interview session to collect qualitative data on the challenges they faced and their self-efficacy. Thematic analysis based on Braun and Clarke's approach (Braun & Clarke, 2006) was utilised in this research to

analyse the qualitative data. Eventually, both quantitative and qualitative results were integrated and reported.

Table 1: Reliability Statistics of Cronbach's Alpha for 40 items

Reliability Statistics	
Cronbach's Alpha	N of Items
.887	40

Table 2 portrays the interpretation of mean score indicators. The table shows scores between 1.00 and 1.89 as a very low mean score level, scores between 1.90 and 2.69 as a low mean score level, scores between 2.70 and 3.49 as a moderate mean score level, scores between 3.50 and 4.29 as a high mean score level and scores between 4.30 and 5.00 as a very high mean score level.

Table 2: Mean score indicators

Mean Score	Interpretation
4.30 – 5.00	Very High
3.50 – 4.29	High
2.79 – 3.49	Moderate
1.90 – 2.69	Low
1.00 – 1.89	Very Low

FINDINGS

The results for research question one are discussed below.

To what extent do in-service teachers perceive STEM activities as practical, inspiring and engaging?

Table 3 shows that 90.5% of in-service teachers believe STEM activities are interesting and hands-on. Most of the teachers agree (5, 23.8%) and strongly agree (14, 66.7%) with this. Only 1 teacher, with 4.8%, who does not agree and has uncertainty (selected neutral opinion) about whether STEM activities were practical in classrooms for students.

Table 3: STEM activities are interesting and hands-on

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	4.8	4.8	4.8
	3	1	4.8	4.8	9.5
	4	5	23.8	23.8	33.3
	5	14	66.7	66.7	100.0
	Total	21	100.0	100.0	

Table 4 demonstrates 81.0% of in-service teachers believe that STEM activities promote creativity among students. The teachers, respectively, agree and strongly agree that STEM activities were inspiring (10, 47.6%). Teachers were aware that their students showed interest in the engineering element during the implementation of STEM activities. Contrarily, only four teachers, 19%, were not sure if STEM activities inspire creativity among the students

Table 4: STEM activities encourage creativity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	4	19.0	19.0	19.0
	4	8	38.1	38.1	57.1
	5	9	42.9	42.9	100.0
	Total	21	100.0	100.0	

The in-service teachers also confirmed that the students enjoyed the STEM activities. Table 5 shows that a total of 95.2% of teachers agree and strongly agree (10, 47.6%) with this. Besides, only 1 teacher, with 4.8%, was uncertain if the students enjoyed STEM activities.

Table 5: Students enjoyed STEM activities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	1	4.8	4.8	4.8
	4	10	47.6	47.6	52.4
	5	10	47.6	47.6	100.0
	Total	21	100.0	100.0	

Table 6 displays the mean value of 4.14, indicating a high level of satisfaction among the teachers in implementing the STEM activities for students.

Table 6: Satisfaction with Implementation of STEM activities for students

N	Valid	21
	Missing	0
Mean		4.14
Std. Deviation		.655

The results for question two are discussed below.

What is the level of in-service teachers' self-efficacy in STEM teaching in terms of roles, knowledge and confidence?

Table 7 displays that 100% of the in-service teachers acknowledged that teachers play important roles in teaching STEM to the students. Teachers have the content knowledge, and in this study, these teachers planned their lessons for about 6-7 weeks before implementing them. As the educators for middle and high schools, they had confidence in their roles as the individuals who deliver the lessons.

Table 7: Teachers Play Important Roles

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4	6	28.6	28.6	28.6
	5	15	71.4	71.4	100.0
	Total	21	100.0	100.0	

Table 8 demonstrates that 90.5% of the in-service teachers were in agreement that they gained knowledge and confidence implementing STEM activities. This number was generated from (42.9%, 9) teachers who agreed and (47.6%, 10) teachers who strongly agreed.

Table 8: Teachers gained knowledge and confidence in implementing STEM activities

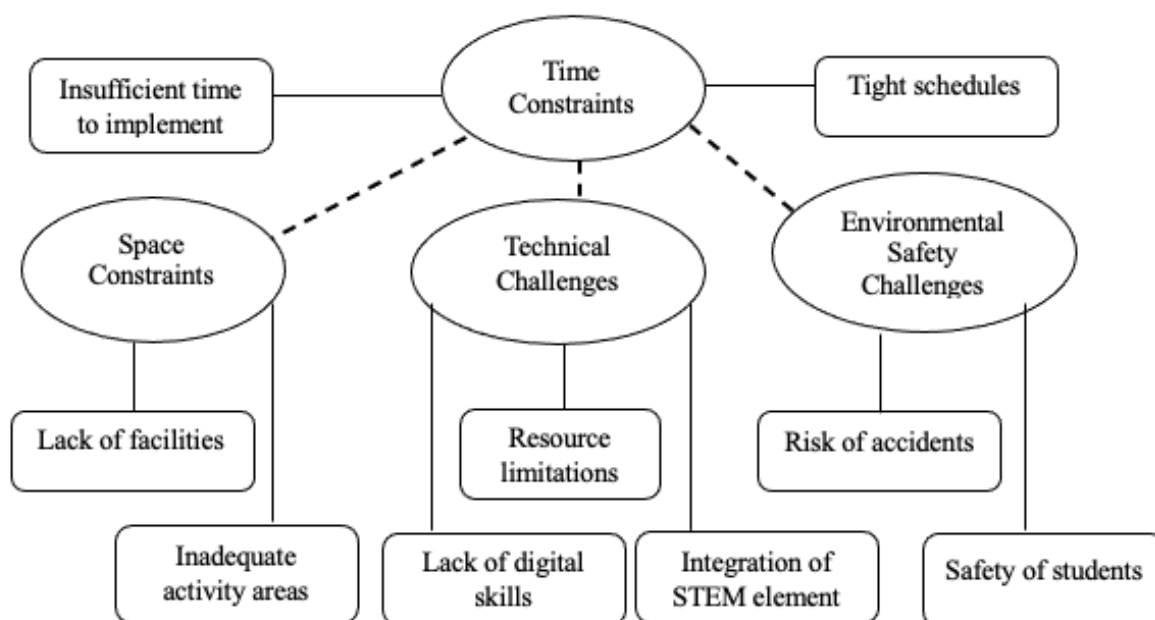
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	2	9.5	9.5	9.5
	4	9	42.9	42.9	52.4
	5	10	47.6	47.6	100.0
	Total	21	100.0	100.0	

The results for research question three are discussed below.

How do the challenges faced by the in-service teachers influence their perceptions of STEM activities?

Four themes emerged from the open-ended interview with the in-service teachers. Figure 1 displays the themes: time constraints, space constraints, technical challenges and environmental safety challenges

Figure 1: Thematic Map Demonstrating Four Themes of Challenges faced by the in-service teachers



Time Constraint

Some researchers indicated that teachers have limited time to plan and carry out STEM teaching due to the high volume of tasks (Rahimah Jamaluddin et al., 2023).

The interview with in-service teachers revealed that time was a challenge. The teachers quoted the following phrases:

“I think this activity was one where there’s a lot of time needed for the experiment itself.” (T4)

“We had many groups, so they were all in pairs. So, actually going and checking on every group takes a lot of time.” (T5)

Space Constraint

In this study, space constraints are a lack of facilities and inadequate activity areas. This is similar to the research by Baskaran & Abdullah (2023), who faced the challenge of insufficient facilities to conduct STEM education.

The teachers quoted the following phrases:

“So, I mean that’s one of our restricted areas where there is another open space that we had, but not that conducive, as next to it is a housing area.” (T7)

Technical Challenges

Technical Challenges mainly refer to the limitations of STEM materials, the integration of STEM components, and limited digital skills. Teachers stated that financial assistance is needed to purchase STEM resources, such as materials and equipment, to conduct STEM activities (Rahimah Jamaluddin et al., 2023).

Knowledge of STEM is important in identifying whether teachers face difficulties during the implementation of STEM activities. Integration of the STEM components: science, technology, engineering and mathematics was identified by the teachers as being a little blurred when it comes to having all components implemented together. As a result, some teachers did not embed all components into the implementation of the STEM activities. The teachers quoted the following phrases:

“We have to prepare many items” (T2)

“Sourcing the materials was challenging as in before this I was only referring to YouTube video”. (T7)

“The mathematics integration should have done more precisely” (T3)

“I do integrate, I mean or at least I used to think that I integrated stem into my lessons. But, I think now I realise it’s really maybe the S and the M part just the signs I don’t really include the engineering part, it’s not all four elements.” (T5)

“Also, there was a digital skills gap, some students who didn’t know how to use Google Sheets, Google Docs, Microsoft and all because it’s something that they can translate into their work life later. So I think that was a problem.” (T4)

Environmental Safety Challenges

Environmental safety challenges could lead to the risk of accidents during the STEM activities, as some groups did the rocket activities, which show a low level of safety for students

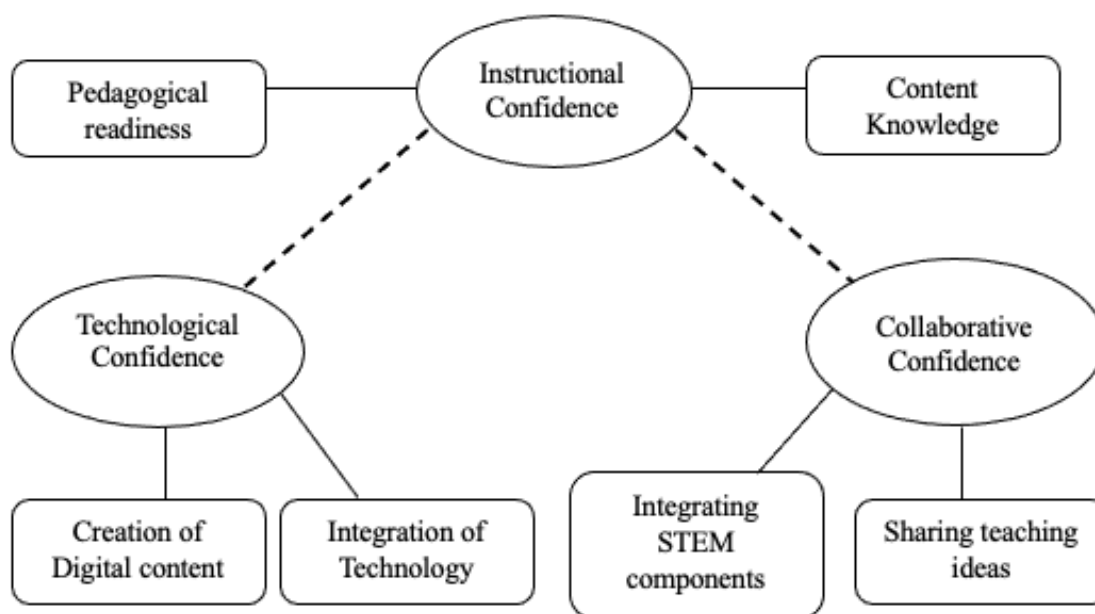
“Lucky the rockets that flew did not destroy the roof.” (T7)

The results for question four are below:

How do in-service teachers describe their self-efficacy experience related to roles, knowledge and confidence in implementing STEM teaching?

Figure 2 displays three themes: instructional confidence, technological confidence and collaborative confidence. These themes emerged from the focus group interview with the in-service teachers.

Figure 2: Thematic Map Demonstrating Three Themes of the in-service teachers' self-efficacy experience



According to Syafrizal (2024), confidence is an individual's conviction and awareness about his or her own adequate competencies in performing a task.

Instructional Confidence

Instructional confidence is related to the pedagogical approach and methods used to ensure the students understand what is delivered to them. In this study, the in-service teachers engaged students during STEM teaching with inquiry-based learning, project and problem-based learning approaches (Papagiannopoulou & Vaiopoulou (2024).

Information quoted from teachers:

“For me, I think I gained a lot of confidence teaching three-year-olds.” (T1)

“I really enjoy teaching maths and science and naturally also I’m very activity based. So all my classes have a lot of resources and activities just to make the kids understand better.” (T4)

“I feel more confident to do STEM activities with my students now.” (T8)

“So, I felt that as an educator, carrying out STEM has improved my teaching skills and approaches.” (T6)

Technological Confidence

In this era, the incorporation of technology is inseparable from the education system, with a crucial change in the traditional teaching approaches, improving the teaching and learning experiences (Ika Liana Khalid et al., 2025). Technological confidence in this study is supported by Zhao et al. (2022), who described that the rapid growth of technology-based learning impacted techno-pedagogical competency.

Information quoted from the teachers:

“I am confident in using the digital tools in the STEM activities.” (T8)

Collaborative Confidence

Collaboration is the ability to work effectively in groups, exchange information, and integrate a broad spectrum of views to tackle complex issues in everyday practical environments (Ramachandran, 2025). In line with this, Shelley & Kiray (2018) indicate that collaboration is the ability to work diligently and professionally with another team in a learning space or working life.

Some phrases quoted from the teachers during the interview are:

“ I felt very confident in group work. I felt very comfortable with my group, I felt very good, biggest success, what I take pride was really planning the entire activity with my group members” (T1)

“Students for this activity were quite engaged and participative, especially during the building part.” (T6)

“Work in groups, students got an opportunity to become more critical in their thinking and better problem solvers.” (T9)

“Students should learn how to collaborate with others, when we put them into groups , we can see that all of them can actually do together although one group found it hard to work together collaboratively.” (T10)

INTERPRETATION OF RESULTS

The quantitative results of the first research question revealed the positive insight of the in-service teachers, which then disclosed the hindrances encountered through the continuous qualitative research question 3. The in-service teachers concluded that the STEM activities were transformative and empowering. Despite that, they also experienced limitations of time, space, equipment and an appropriate workroom with facilities.

Results in research question 2 prove that the in-service teachers contribute substantially towards STEM teaching and acquire competence and self-assurance. It is well supported by research question 4 on teachers' self-efficacy. Qualitatively, it was confirmed by the teachers that they obtained teaching and learning, technological and collaborative confidence.

DISCUSSION

Quantitatively, the first research question indicated that in-service teachers had positive perceptions of the implementation of STEM activities in the classrooms. Firstly, teachers consented that STEM activities are interesting and experiential for the students. This is aligned with a study in Indonesia, which found that 92% of students expressed interest in STEM (Nurulsaidah Abdul Rahim & Suzaliza Mustafar, 2024). Additionally, the same study supported experiential learning, showing that interactive, practical strategies enhanced students' connections to and awareness of STEM through real-world applications. Contrarily, a study found that students did not demonstrate any enthusiasm in science since they were incapable of connecting their learning with a physical existence state (Gülhan& Sahin, 2018).

Furthermore, the in-service teachers explicitly shared that STEM activities encouraged creativity among the students. This is supported by a study by Sirajudin et al. (2021) that presented STEM education indeed inspired the students' competencies in developing their creative thinking skills.

Additionally, the findings from the first research question revealed that most teachers believed their students enjoyed the STEM activities. This is supported by Margot and Kettler (2019), who stated that, in their study, teachers included STEM in the curriculum due to students' excitement, which led to engagement. On the other hand, in any condition, if the educators applied conventional, teacher-centred and one-way presentation, it would not practically encourage the students to embrace vibrant activities like STEM (Marzuki et al., 2024).

Teachers stated that they were satisfied with STEM activities, which they carried out mainly by employing technology in the STEM lesson, clearly showing that the students' needs were fulfilled; students demonstrated the sentiment of contentment (Zhao et al., 2022)

Qualitatively, the third research question discusses the challenges teachers faced during the implementation of STEM activities. Teachers stated that they face some barriers in terms of less space for conducting the STEM activities, difficulties in managing the time well during the STEM activities, a lack of safety in the environment during the implementation of the STEM activities, a lack of funding for materials and the absence of integration of all the STEM elements in the activities. All these challenges are summarised as space constraints, time constraints, technical challenges and environmental safety. These findings are in agreement with a study in Pakistan by Abdul Nasir Kiazai et al (2020), which revealed that various issues were noticed, such as STEM activities needing space for activities, and time management was identified as another challenge in implementing STEM activities by the teachers. Additionally, Ismail et al. (2019) stated in their discussion that teachers admitted they have issues with limited time and a tight schedule to cover the syllabus. Technical challenges, such as the capabilities of the teachers in integrating the STEM subject while focusing only on science, and insufficient material supply, were spotted in the same study supporting the findings of the current research. No sign of a properly equipped classroom or laboratory for STEM activities was observed, which is another factor contributing to the hazardous conduct of STEM activities in the environment (Abdul Nasir Kiazai et al., 2020). Teachers will be demotivated if they have ideas but are unable to carry them out, as they are burdened with many tasks which hinder them from performing creative activities like STEM. STEM activities require a generous amount of time to complete them productively and fruitfully.

Quantitatively, every in-service teacher acknowledged that they play a significant role in delivering STEM education. This signifies the teachers' self-assurance that they are ready to instruct and guide students through STEM education and activities. These findings are aligned with Papagiannopoulou & Vaiopoulou (2024), who declared that teachers with a ready mindset, inclination towards teaching and possessing STEM comprehension are determined because of their self-efficacy in STEM teaching.

Additionally, the in-service teachers reported that they gained knowledge and confidence through the STEM activities they implemented with their students. This finding is supported by Papagiannopoulou & Vaiopoulou (2024), who reported that teachers exhibiting intellectual competence have greater confidence in teaching STEM.

Qualitatively, the teachers described their experiences in terms of roles, knowledge, and confidence. The themes are summarised into instructional confidence, technological confidence, and collaborative confidence. The teachers had instructional confidence, which portrayed that they were able to teach and implement STEM in the classroom after going through the science & mathematic master's course for 6

weeks. Buechel et al. (2024) explained this in their study; teachers with prior STEM knowledge or who had attended STEM training were capable of teaching integrated STEM. This shows that in-service teachers recognise and understand that their roles in teaching STEM are essential. Contrarily, a previous study revealed that teachers faced a lack of confidence because of inadequate foundational STEM understanding (Bullo et al., 2023). In the current study, most of the in-service teachers gained pedagogical confidence as they had sufficient content knowledge of STEM education (Akiha et. al, 2017),

In-service teachers in this study were mainly from private international schools doing a master's level program in teaching and learning, and they affirmed their confidence in technology. This has similarities with a previous study that revealed private school teachers and teachers with higher educational qualifications exhibit better self-efficacy in teaching STEM (Sellami et al., 2025). On the other hand, a previous study, contrarily, revealed that technology was teachers' major hurdle (El-Deghaidy and Mansour, 2015). Teachers asked for digital skills enhancement training to manage technological tools and materials (Wardrip & Brahms, 2016).

Collaborative confidence referred to the collective partnership among the in-service teachers in planning STEM teaching and implementing integrated STEM activities. In line with this, Moore et al. (2020) described integrated STEM as a source of investigation, prototyping a design by encouraging students into joint efforts or collaboratively working in groups. Similarly, teamwork was observed among the students during the implementation of the STEM activities. According to Ramachandran (2025), STEM is related to the physical world application, and it cannot be conducted single-handedly or individually. In STEM, collaboration plays an important role in conducting interdisciplinary tasks in groups (Ramachandran, 2025). In this study, the in-service teachers reflected on their efficacy by attaining collaborative confidence during STEM teaching and activities with their students, as they planned them deliberately by ensuring cooperative learning environments catering to the practical coordination among everyone. This is in agreement with Ramachandran (2025), who stated that teachers could cultivate a pedagogical setting focusing on teamwork, reflecting on actual practical discipline. There are numerous skills that the students captured during the STEM activities through collaborative practices, such as overcoming conflicts, polishing their communication and building relationships among peers. It was stated that the secondary level teachers might have higher content knowledge compared to teachers at the primary or early years level (Liu et al., 2025)

Implications

The in-service teachers have the impression that STEM activities performed with students were interesting, practical and engaging. The challenges encountered by teachers enable others to understand them better. Positively, it encouraged the teachers to carry out STEM activities in the future as they gained confidence in teaching and learning, confidence in using technology tools and enhanced collaboration among teachers and students during planning and execution.

Recommendation and Conclusion

Future research should explore ways to promote STEM activities at all levels, from preschool to high school. Teachers should be allowed to attend more professional development programmes as emphasised by Zhou et al. (2023).

Acknowledgment

Publication of this work was supported by HELP University, Malaysia

Declaration of Interest Statement

The author declares that there is no conflict of interest.

References

- Abbas, Q., Parveen, K., Rehman, M., Tabassum, S., & Ahmed, D. (2023). Teachers' perspectives on the benefits and role of stem education in the solution of complex global challenges. *Journal of Education and Social Studies*, 4(1), 183-191. <https://doi.org/10.52223/jess.20234118>
- Abdul Nasir Kiazai, Naila Siddiqua, & Zarina Waheed. (2020). Challenges in implementing STEM education and role of teacher education programs in mitigating these challenges. *International Journal of Distance Education and E-Learning*, 5(2), 123-137. <https://doi.org/10.36261/ijdeel.v5i2.1047>
- Akiha, K., Brigham, E., Couch, B. A., Lewin, J., Stains, M., Stetzer, M. R., ... & Smith, M. K. (2018, January). What types of instructional shifts do students experience? Investigating active learning in science, technology, engineering, and math classes across key transition points from middle school to the university level. In *Frontiers in Education* (Vol. 2, p. 68). Frontiers Media SA.
- Allen, M., Webb, A. W., & Matthews, C. E. (2016). Adaptive teaching in STEM: Characteristics for effectiveness. *Theory Into Practice*, 55(3), 217-224. <https://doi.org/10.1080/00405841.2016.1173994>
- Bandura, A. (1997). *Self-efficacy: the exercise of control*. W. H. Freeman.
- Buechel, C., Daugherty, M. K., Carter, V., & Sahin Topalcengiz, E. (2024). Elementary teachers' self-efficacy and its role in STEM implementation. *Turkish Journal of Education*, 13(3), 217-238. <https://doi.org/10.19128/turje.1267839>
- Bullo, M. M., Leuterio, J. B., Atiga, K. L., Reyes, B. Y., Veloso, J. M. L., Dalimocon, J. C., Dayday, A. K. O., Bersales, K. G., Inhog, J. C. C., Dagohoy, A. J. P., Son, C. T., & Orcales, J. C. (2023). A study of teachers' perceptions of the factors affecting STEM teaching. *Zenodo (CERN European Organization for Nuclear Research)*. <https://doi.org/10.5281/zenodo.8345044>

- Calkins, L., Wiens, P., Parker, J., & Tschinkel, R. (2024). Teacher motivation and self-efficacy: How do specific motivations for entering teaching relate to teacher self-efficacy? *Journal of Education*, 204(2), 427-438. <https://doi.org/10.1177/00220574221142>
- Dare, E. A., Keratithamkul, K., Hiwatig, B. M., & Li, F. (2021). Beyond content: The role of STEM disciplines, real-world problems, 21st century skills, and STEM careers within science teachers' conceptions of integrated STEM education. *Education Sciences*, 11(11), 737. <https://doi.org/10.3390/educsci11110737>
- El-Deghaidy, H., and N. Mansour. 2015. Science Teachers' Perceptions of STEM Education Possibilities and Challenges. *International Journal of Learning and Teaching* 1 (1): 51–54.
- Gülhan, F., & Şahin, F., (2018). A comparative investigation of middle school 5th and 7th grade students of perceptions on engineers and scientists. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education*, 12(1), 309-338.
- Huang, X., Erduran, S., Luo, K., Zhang, P., & Zheng, M. (2022). Investigating in-service teachers' STEM literacy: The role of subject background and gender. *Research in Science & Technological Education*, 42(3), 867-887. <https://doi.org/10.1080/02635143.2022.2153243>
- Ika Liana Khalid, Mohd Nor Syahrir Abdullah, & Hidayah Fadzil. (2025). A Systematic Review: Digital Learning in STEM Education. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, 52(2), 48-62.
- Ismail, M. H., Hidayah, M. F., Furkan, M. S. M., Rohaida, M. S., Kurniawan, C., & Hariyono, E. (2024). Investigating Science Teachers' Instructional Practices: A Need Analysis for Preparing Integrated STEM Practices through Scientist-Teacher-Student Partnership (STSP). *Asian Journal of University Education*, 20(3), 630–644. <https://doi.org/10.24191/ajue.v20i3.27858>
- Ismail, M. H., Salleh, M. F., & Nasir, N. A. (2019). The issues and challenges in empowering STEM on science teachers in Malaysian secondary schools. *International Journal of Academic Research in Business and Social Sciences*, 9(13). <https://doi.org/10.6007/ijarbss/v9-i13/6869>

- Jerrim, J., Sims, S., & Oliver, M. (2023). Teacher self-efficacy and pupil achievement: much ado about nothing? International evidence from TIMSS. *Teachers and Teaching*, 29(2), 220-240. <https://doi.org/10.1080/13540602.2022.2159365>
- Kavak, Ş. (2023). The evolution and global significance of STEM education in the 21st century. *The Journal of International Scientific Researches*, 8(3), 410–415. <https://doi.org/10.23834/isrjournal.1342255>
- Lavi, R., Tal, M., & Dori, Y. J. (2021). Perceptions of STEM alumni and students on developing 21st century skills through methods of teaching and learning. *Studies in Educational Evaluation*, 70, 101002. <https://doi.org/10.1016/j.stueduc.2021.101002>
- Liu, J., Wang, K., & Pan, Z. (2025). The effectiveness of professional development in the self-efficacy of in-service teachers in STEM education: A meta-analysis. *Behavioral Sciences*, 15(10), 1364. <https://doi.org/10.3390/bs15101364>
- Malaysia, Kementerian Pendidikan. *Pelan pembangunan pendidikan Malaysia 2013-2025*. (2013).
- Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: a systematic literature review. *International Journal of STEM Education*, 6(1). <https://doi.org/10.1186/s40594-018-0151->
- Marzuki, O. F., Lih, E. T., Zainol @ Abdullah, W. N., Khairuddin, N., Inai, N. H., Md Saad, J. B., & Abdul Aziz, M. H. (2024). Innovating education: A comprehensive review of STEM education approaches. *International Journal of Academic Research in Progressive Education and Development*, 13(1). <https://doi.org/10.6007/ijarped/v13-i1/20490>
- Moore, T.J., Johnston, A.C., & Glancy, A.W. (2020). STEM integration: A synthesis of conceptual frameworks and definitions. In Johnson, C.C., Mohr-Schroeder, M. J., Moore, T.J., & English, L.D. (Eds.), *Handbook of research on STEM education*. (3–16) Routledge, <https://doi.org/10.4324/9780429021381-2>.
- Nipyrakis, A., Stavrou, D., & Avraamidou, L. (2024). In-service teachers' views about STEM integration. *Research in Integrated STEM Education*, 2(2), 85-119. <https://doi.org/10.1163/27726673-bja00021>

- Rezaull Karim, M., Ahmed Masud, N., Nesa Subarna, M. T., Billah, M. M., & Wienaah, P. (2021). Self-efficacy: A key components of teacher effectiveness. *Asian Journal of Education and Social Studies*, 24-34. <https://doi.org/10.9734/ajess/2021/v25i130590>
- Roehrig, G. H., Dare, E. A., Ellis, J. A., & Ring-Whalen, E. (2021). Beyond the basics: A detailed conceptual framework of integrated STEM. *Disciplinary and Interdisciplinary Science Education Research*, 3(1). <https://doi.org/10.1186/s43031-021-00041-y>
- Sellami, A., Santhosh, M. E., Michaleczek, I., Alazaizeh, M., & Madad, J. (2024). Unveiling teachers' instructional self-efficacy in science, mathematics, and technology: Personal and contextual influences. *Canadian Journal of Science, Mathematics and Technology Education*, 24(3-4), 418-438. <https://doi.org/10.1007/s42330-025-00359-z>
- Shelley, M., & Kiray, S. A. (2018). *RESEARCH HIGHLIGHTS IN STEM EDUCATION*. ISRES Publishing.
- Sirajudin, N., Suratno, J., & Pamuti. (2021). Developing creativity through STEM education. *Journal of Physics: Conference Series*, 1806(1), 012211. <https://doi.org/10.1088/1742-6596/1806/1/012211>
- Srikoom, W., Hanuscin, D. L., & Faikhamta, C. (2017). Perceptions of In-Service Teachers toward Teaching STEM in Thailand. *Asia-Pacific Forum on Science Learning and Teaching*, 18(2). <https://eric.ed.gov/?id=EJ1179211>
- Stehle, S. M., & Peters-Burton, E. E. (2019). Developing student 21st century skills in selected exemplary inclusive STEM high schools. *International Journal of STEM Education*, 6(1), 6. <https://doi.org/10.1186/s40594-019-0192-1>.
- Stretch, E. J., & Roehrig, G. H. (2021). Framing failure: Leveraging uncertainty to launch creativity in STEM education. *International Journal of Learning and Teaching*, 7(2), 123–133. <https://doi.org/10.18178/ijlt.7.2.123-133>.
- Syafrizal. (2024). The influence of teachers confidence on teaching and learning process in

school. *JOLADU: Journal of Language Education*, 2(3), 150-159. <https://doi.org/10.58738/joladu.v2i3.369>

Zhao, J., Wijaya, T. T., Mailizar, M., & Habibi, A. (2022). Factors Influencing Student Satisfaction toward STEM Education: Exploratory Study Using Structural Equation Modeling. *Applied Sciences*, 12(19), 9717. <https://doi.org/10.3390/app12199717>

Zhou, X., Shu, L., Xu, Z., & Padrón, Y. (2023). The effect of professional development on in-service STEM teachers' self-efficacy: A meta-analysis of experimental studies. *International Journal of STEM Education*, 10(1). <https://doi.org/10.1186/s40594-023-00422-x>