Journal of Sustainability Science and Management
Volume 20 Number 9, September 2025: 1836-1847
eISSN: 2672-7226

IMPACT OF TERENGGANU PEERS STEM COACHING PROGRAMME ON IMPROVING QUALITY OF EDUCATION

LAILI CHE ROSE[1], SHARIFAH WAJIHAH WAFA SYED SAADUN TAREK WAFA[2,3]*, NURUL SYAHIDA ABU BAKAR[1], NURHAKIMAH AB. RAHMAN[1], NURULHUDA MOHAMMAD YUSOFF[3] AND SITI MAISARAH ABDUL AZIZ[3]

[1]STEM Foundation Centre, Universiti Malaysia Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia. [2]Faculty of Health Sciences, Universiti Sultan Zainal Abidin, 21300 Kuala Nerus, Terengganu, Malaysia. [3]UniSZA Science and Medicine Foundation Centre, Universiti Sultan Zainal Abidin, 21300 Kuala Nerus, Terengganu, Malaysia.

**Corresponding author: sharifahwajihah@unisza.edu.my*
http://doi.org/10.46754/jssm.2025.09.006
Submitted: 3 September 2024 Revised: 11 February 2025 Accepted: 3 March 2025 Published: 15 September 2025

Abstract: The declining number of students pursuing STEM disciplines over the past decade indicates the need for urgent intervention. This study aims to increase STEM-related knowledge and attitudes among secondary school students in Terengganu through the Terengganu Peers STEM Coaching (TPSC) programme. A quasi-experimental pre-test/post-test design was employed, involving 1,758 secondary school students. The study was conducted in three phases: (1) Module development; (2) STEM knowledge transfer from university foundation students (mentors) to elite secondary school students (mentees); and (3) STEM knowledge transfer from elite secondary school students (mentors) to daily secondary school students (mentees). A paired t-test was used to analyse the pre-test and post-test surveys on students' knowledge and attitudes towards STEM. The analysis showed significant improvements in student knowledge and attitude towards STEM following participation in the TPSC programme. The findings demonstrate the programme's effectiveness in enhancing students' understanding, appreciation, and attitudes towards STEM. Ultimately, STEM education supports a more sustainable future by equipping students with the knowledge and skills necessary to address challenges outlined in the Sustainable Development Goals.

Keywords: Stem, mentor, secondary school students, peer coaching, quality education.

Introduction

STEM education refers to an instructional integrating science, technology, engineering, and mathematics (Gonzalez & Kuenzi, 2012), typically involving teaching and learning activities across all grade levels and in both formal and informal settings. In recent years, there has been a growing recognition of the critical role that STEM education plays in preparing students for the challenges of the modern world. STEM fields have driven innovation, economic growth, and societal development. Consequently, researchers and policymakers worldwide are increasingly concerned with ensuring student persistence and success in STEM (Skinner *et al*., 2017) and preparing students for a labour market that prioritises STEM competencies (World Economic Forum, 2017). Empowering school students in STEM has become a crucial aspect of education, as it not only equips them with essential knowledge, but also fosters problem-solving skills, critical thinking, and creativity.

However, many education systems today are based on educational models introduced over a century ago and do not engage students effectively. STEM education in primary and secondary schools focuses primarily on theory instead of application and experiential learning, reinforcing the separation between different STEM disciplines (Nadelson & Seifert, 2017; World Economic Forum, 2017). In Malaysia, low-level thinking continues to dominate over higher-level thinking in teaching and learning (Abdul Aziz @ Ahmad, 2017). Over the past decade, the number of students selecting

STEM disciplines has declined in favour of arts subjects, signalling the need for urgent intervention (Wen, 2023). This decline is partly attributed to a lack of student interest (Kaleva *et al*., 2019), which leads them to pursue non-STEM subjects instead.

In Malaysia, the number of students pursuing STEM education has shown a steady decline in recent years. Currently, only 15.2% of middle school students in the country opted for STEM fields in the 2023/2024 academic year (Ministry of Education Malaysia [MOE], 2023). In addition, more than 100,000 students failed science and mathematics in the most recent Sijil Pelajaran Malaysia (SPM) examination (MOE, 2023).

These trends raise concerns about the education system's ability to produce an adequate number of STEM graduates to meet economic demands. The National Council for Scientific Research and Development projected that Malaysia would require 493,830 scientists and engineers by 2020 (MOE, 2013). At the current trajectory, the Ministry of Science, Technology, and Innovation (2012) predicts a shortfall of 236,000 professionals in STEM-related fields. This shortage indicates that the demand for STEM-qualified workers significantly exceeds the number of trained candidates available. To address these gaps in the STEM workforce, Malaysia needs to encourage more students to enter these fields, as the nation's economic future relies on a well-prepared STEM-capable workforce. These statistics underscore the need for the Malaysian government to engage and motivate those who may be indifferent or disinterested in STEM (Idris *et al*., 2023).

The Sustainable Development Goals (SDGs) provide a roadmap for creating a more sustainable and improved future, aiming to eradicate poverty, safeguard the environment, and ensure peace and prosperity for all. To ensure that Malaysian students are engaged in STEM subjects, the Malaysian Education Blueprint 2013-2025 was developed as part of the government's strategy to strengthen STEM to compete with other countries in the developed world. The blueprint focuses on enhancing the quality and relevance of the STEM curriculum in schools to reflect the latest developments in science and technology, ensuring students receive a well-rounded and up-to-date education. While there have been significant efforts to improve STEM education, there are still several gaps and challenges that need to be addressed. Thus, exploring innovative and effective pedagogical approaches such as inquiry-based learning, project-based learning, and hands-on activities should be implemented to enhance student interest and understanding in STEM. Moreover, making STEM subjects more relevant to real-world contexts is crucial to sustain engagement and demonstrate the practical applications. Achieving inclusive and high-quality education reinforces the belief that education is the most potent and established catalysts for sustainable development.

Mentoring also plays a very important role in encouraging students to pursue STEM. Research indicates that effective mentoring relationships are characterised by trust, responsiveness, career, and psychosocial support, regardless of the form of the relationship (Hund *et al*., 2018). Pairing students with mentors from various backgrounds can address representation gaps and foster a more inclusive STEM community.

By sharing their experiences with mentees and providing them with real-world applications of STEM concepts, mentors make the subject matter more relevant and engaging for students as their mentees. As a result of this exposure, students can better appreciate the practical applications of STEM in various fields and professions. Previous studies have shown that a well-structured and effective mentoring programme can have a profound impact on students' academic and personal growth, especially in STEM education (Shahali *et al*., 2018). In addition, it has been shown that university-run high school summer programmes have a positive impact on the STEM career aspirations of students (Kitchen, 2018).

To promote STEM among secondary school students in Terengganu, a mentor outreach programme, known as Terengganu Peers STEM Coaching (TPSC) programme was developed. This mentor-mentee initiative aims to improve secondary school students' knowledge and attitudes towards STEM subjects. TPSC is a knowledge transfer programme from university students and agencies to elite school students and daily school students through a mentor-mentee approach, in line with SDG 4, which promotes quality education. Terengganu has demonstrated a strong commitment to enhancing STEM education, as evidenced by its consistently strong SPM performance. In 2023, the state achieved a Grade Point Average (GPA) of 4.41, outperforming the national average of 4.60, marking an improvement from the previous year's GPA of 4.59 (Terengganu State Education Department, 2023). Despite this, Terengganu has yet to reach Malaysia's national target of a 60:40 science-to-arts student ratio.

Therefore, this study aims to evaluate the improvement of students' knowledge and attitudes towards STEM among secondary school students in Terengganu through the TPSC programme. It is hoped that such initiatives will guide students towards educational sustainability.

Materials and Methods

Research Design

This study employed a quasi-experimental design with a pre-test/post-test format. Of the 122 secondary schools in Terengganu, 75 agreed to participate in the TPSC programme. The study population comprised Form Three students from 15 elite secondary schools and 60 daily secondary schools. In Malaysia, Form Three students often make subject selections that will shape their upper secondary school curriculum. By engaging them with STEM topics prior to this decision-making stage, the programme aims to foster greater interest in STEM fields, potentially encouraging them to choose science and technical subjects for upper secondary education, thereby supporting the national goal of increasing STEM enrolment. The TPSC programme was conducted from March 1, 2022 until September 10, 2022.

Context

The TPSC programme is a comprehensive initiative designed to equip secondary school students with the necessary skills and knowledge in the fields of STEM through various themes such as ocean, health, robotics, creativity and innovation, and outreach. Through a structured module and hands-on coaching, the programme could empower students to excel in these crucial disciplines.

The programme is a collaborative effort between five organisations: Universiti Malaysia Terengganu (UMT), Universiti Sultan Zainal Abidin (UniSZA), Sekolah Menengah Sains Sultan Mahmud (SESMA), Terengganu Science and Creativity Centre (PSKT), and Jazro Robotic Academy. It seeks to bridge the gap in STEM education by providing targeted coaching to secondary school students in Terengganu. Through a blend of foundational concepts and practical application, the TPSC programme cultivates a deep understanding of STEM, fostering interest in the subjects, develop critical thinking and problem-solving abilities through hands-on activities, and encourage collaborative teamwork between university students and secondary school students.

The TPSC programme was conducted in three phases: Phase (1) module development; Phase (2) STEM knowledge transfer from university foundation students (mentors) to elite secondary school students (mentees); and Phase (3) STEM knowledge transfer from elite secondary school students (mentors) to daily secondary school students (mentees) (Figure 1).

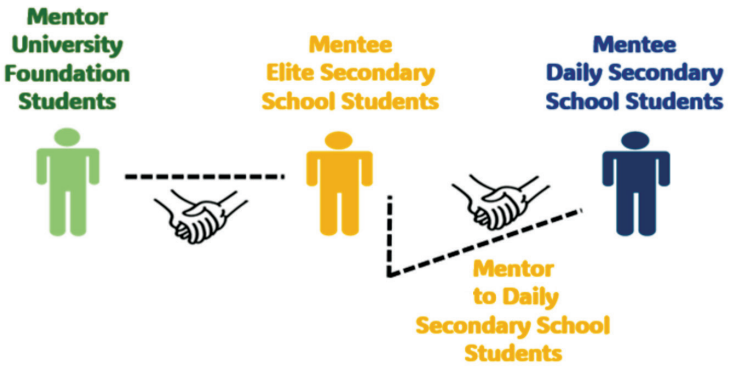

Figure 1: Process of STEM knowledge transfer

Phase 1

In phase 1, STEM modules were developed by the experts and professionals from five agencies: UMT, UniSZA, SESMA, PSKT, and Jazro Robotic Academy. The TPSC programme comprises five modules, each focusing on a specific STEM discipline, which are STEM for Ocean, STEM for Health, STEM for Robotics, STEM Outreach, and STEM Innovation and Creativity (Table 1).

The content of each module was carefully designed to provide a well-rounded understanding of each discipline, incorporating foundational concepts, practical experiments, and real-world applications. The modules were developed with a strong focus on hands-on STEM activities rather than traditional content-based instruction, aiming to engage students actively in practical and inquiry-based learning experiences. Although formal content validity testing was not conducted, the modules were meticulously crafted and reviewed by a team of STEM experts from collaborating institutions. This expert review process ensured that each module aligned with the intended learning outcomes and promoted critical thinking, provided relevant, real-world applications to enhance student engagement and understanding. As a result, the modules focused on skill development, creativity, and problem-solving, rather than theoretical content alone, aligning with the active learning goals of the TPSC programme.

Phase 2

57 university students were chosen from two foundation centres, which are the UMT STEM Foundation (40 students) and UniSZA Science and Medicine Foundation (17 students), to serve as mentors for the programme. Prior to the programme's commencement, these university mentors received extensive training from facilitators at the agencies responsible for developing the STEM modules. Each student was required to demonstrate proficiency in all assigned activities before being allowed to mentor at the elite secondary schools in Terengganu.

Invitations to participate in the programme were sent to all elite secondary schools in Terengganu through the Terengganu State Education Department. 15 elite schools agreed to participate, with a total of 375 students assigned as mentees. Each university mentor was paired with five elite secondary school students (mentor-to mentee ratio of 1:5).

The TPSC programme was conducted weekly over two weeks at UMT and UniSZA. During this phase, university mentors engaged their mentees in hands-on projects, experiments, and activities, with one activity from each module implemented. This phase focused on transferring STEM knowledge from university mentors to elite school mentees.

Table 1: Content of the modules

STEM Modules	Topics
STEM Ocean	Mathematical model in the life cycle of turtles
STEM Health	"DIY" heart model Disinfectant formulation Magnetic resonance imaging exploration in human health Exploration of mystical science 'I don't sweat, I sparkle!' Healthy muffins
STEM Innovation and Creativity	Creative Video - InShot Invention
STEM Exploration	Hungry! Polyhedron challenge Fruit battery
STEM Robotics	Introduction to MBlock 5 MBlock 5 software and programming RGB line follower

Phase 3

After completing all five modules, the elite mentees were upgraded to mentors and tasked with transferring the knowledge gained in Phase 2 to students from daily secondary schools. Through the Terengganu State Education Department, invitations were extended to all daily secondary schools in the state. A total of 64 daily secondary schools in Terengganu agreed to participate in the programme, with 1,383 students assigned as mentees.

This phase was implemented through the TPSC Boot Camp, during which all participating students stayed at UMT for two days, from September 9 to 10, 2022, to complete all the modules. In each module, the elite mentors worked with daily mentees on hands-on projects, experiments, or activities. In total, 375 elite students served as mentors to 1,383 daily school students, maintaining an approximate mentor-to-mentee ratio of 1:4.

Data Collection

A self-developed survey was used to measure students' knowledge and attitudes towards STEM. To assess the knowledge, 52 items were constructed based on the activities conducted within the five modules. Responses were recorded on a 5-point Likert-scale (1 = strongly disagree to 5 = strongly agree), yielding a total score range of 52 to 28. Attitudes towards STEM were measured using 9 items, with total scores ranging from 9 to 45.

Validation of the questionnaire was conducted to ensure appropriateness of the items, the validity, and reliability of the survey structure. The validation process involved two steps: Content validation and face validation. Content validation was conducted by two STEM experts using the Content Validity Index (CVI) while a face validation test was conducted with 30 UniSZA Science and Medicine Foundation students using the Face Validity Index (FVI) to determine the relevance of all the items. A CVI of 93% or 0.93 was obtained, which exceeds the recommended cut-off of 0.80. The I-FVI values for all subscale items (understandability and clarity) were greater than 0.95, indicating a high degree of agreement among students. The Cronbach's alpha coefficient for internal consistency reliability for the whole scale was 0.90, indicating high reliability (Bland & Altman, 1997).

The survey was administered on the first morning the TPSC programme and again on the final day, after the completion of all the STEM modules. Students were also asked to select their preferred TPSC modules among the five, which are STEM for Oceans, STEM for Health, STEM for Robotics, STEM Outreach, and STEM Innovation and Creativity.

Statistical Analysis

Survey data were analysed using a paired samples t-test to assess differences in students' knowledge and attitudes towards STEM before and after they attended the TPSC programme. The null hypothesis (H_0) posited that there would be no significant difference in student knowledge and attitudes towards STEM between the pre-test and post-test measurements. A p-value < 0.05 is considered significant.

Results and Discussion

Change in Student Knowledge of STEM

The results revealed a significant difference between participants' pre-test scores (M = 188.78, SD = 23.35) and post-test scores (M = 214.71, SD = 24.11) before and after attending the TPSC programme. The 95% confidence interval for the difference was −27.92 to −23.95. After completion of the TPSC programme, participants scored significantly higher in the post-test [t(1034) = −25.59, p =0.000], indicating a positive impact of the programme on students' knowledge of the STEM modules (Table 2). These findings suggest that the TPSC programme had a significant effect on increasing students' knowledge in various STEM fields and that the TPSC programme is an effective tool for increasing student knowledge in STEM.

The eta-square coefficient ($\eta^2 = 0.07$) was calculated to investigate the degree of change in student knowledge across time. Pre-test and post-test scores were used in this investigation. An eta-square coefficient (η^2) value between 0 and 1 shows the proportion of variance in the dependent variable can be attributed to the independent variable. The value of "0.01" is generally considered low, "0.06" medium, and "0.14" high impact (Cohen & Cohen, 1988). The result indicates that the TPSC programme was effective in boosting student knowledge in STEM. It was also evident that the programme had a lasting effect on student knowledge, as there was a statistically significant difference between the pre-test and post-test scores.

The analysis revealed there were significant gains in knowledge for all modules, which suggests that the TPSC programme is a meaningful way to support students in developing their STEM knowledge and skills in various fields.

Change in Student Attitudes towards STEM

A paired sample t-test was conducted to compare the pre-test and post-test student score means. The results showed a significant difference in participants' pre-test scores (M = 38.33, SD = 4.90) and post-test scores (M = 36.59, SD = 4.01). After completion of the TPSC programme, participants scored significantly higher in the post-test [t(1034) = −10.04, p < 0.05], revealing a positive impact of the programme on attitudes towards STEM (Table 3). This indicates that the TPSC programme was successful in improving students' attitudes towards STEM. It also suggests that similar interventions could help to increase student interest in STEM.

The eta-square coefficient ($\eta^2 = 0.07$) was also calculated to investigate the degree of change in student attitudes across time. Accordingly, it was concluded that the TPSC programme had a medium effect on increasing students' positive attitudes according to their pre-test and post-test scores.

Analysis of individual survey items revealed significant improvements across most attitude items, with the exception of item 7: "*I plan to pursue a career in STEM in the future*", which showed a significant decline after the programme. The decrease in student attitudes for item number 7 may be attributed to the fact that this programme was targeted towards lower-level secondary school students, who may lack awareness of STEM-related career pathways. It

Table 2: Pre-test and post-test results on knowledge of STEM

	Time	Mean	SD	t	SD	*p*	η^2
Total Score of Knowledge	Pre	188.78	23.35	-25.59	32.62	$p < 0.05$	0.388
	Post	214.71	24.11				
STEM for Ocean Knowledge	Pre	38.31	4.35	-27.86	6.03	$p < 0.05$	0.429
	Post	43.53	4.38				
STEM for Health Knowledge	Pre	37.01	5.22	-18.22	7.47	$p < 0.05$	0.243
	Post	41.24	5.51				
STEM for Outreach Knowledge	Pre	43.29	6.76	-17.25	9.33	$p < 0.05$	0.223
	Post	48.29	6.69				
STEM for Creativity Knowledge	Pre	33.84	6.46	-21.90	8.98	$p < 0.05$	0.317
	Post	39.95	6.51				
STEM for Robotics Knowledge	Pre	36.33	4.83	-25.69	6.74	$p < 0.05$	0.389
	Post	41.71	4.72				

is also possible that the two-day duration of the programme was insufficient to influence long-term career aspirations.

Students' Preferences for the TPSC Modules

Analysis of student preferences revealed that the STEM for Robotics module was the most favoured among participants (Figure 2). A total of 29.6% of students selected this module as their top choice, followed by STEM for Innovation and Creativity (26.0%), STEM for Health (24.20%), and STEM for Ocean (14.2%). The STEM for Outreach module was the least preferred, chosen by only 6.0% of students.

When asked which module best matched their interest in STEM and offered the most benefits, 29.0% of students selected STEM for Health, followed by STEM for Robotics (24.5%), STEM for Innovation and Creativity (24.2%), STEM for Ocean (14.8%), and STEM for Outreach (7.5%).

In terms of perceived benefits gained during the programme, STEM for Health was also rated highest, with 39.8% of students indicating it provided them with the most value. This was followed by STEM for Ocean (23.8%), STEM for Innovation and Creativity (15.3%), STEM for Robotics (12.7%), and STEM for Outreach (8.6%).

Discussions

STEM education is designed to help students develop knowledge and attitudes that relate to real-life contexts, their understanding of STEM disciplines, and how these disciplines connect to the environment (Bybee, 2013). The TPSC programme focused on providing students with the opportunity to develop problem-solving and critical thinking skills through hands-on activities and projects. Providing students with opportunities to engage in hands-on activities and inquiry-based learning experiences can enhance their understanding and interest in STEM subjects. This approach allows students to actively explore concepts, conduct experiments, and solve real-world problems, fostering critical thinking and problem-solving skills, which are related to natural resources.

Findings from this study revealed significant changes in knowledge across all STEM modules in the TPSC programme, as evidenced by the increase in post-test scores. This suggests that

Table 3: Pre-test and post-test results on attitudes towards STEM

	Time	Mean	*SD*	*t*	*SD*	P	η2
Total score attitudes towards STEM	Pre	36.59	4.01	-10.04	6.37	< 0.05	0.070
	Post	38.33	4.90				
I get a clearer picture of how things work (concepts and theories) when I participate in Terengganu Peers STEM Coaching	Pre	3.96	0.64	-17.18	0.94	< 0.05	0.180
	Post	4.40	0.68				
Learning STEM is fun	Pre	4.27	0.65	-9.27	0.92	< 0.05	0.060
	Post	4.50	0.64				
STEM courses will be more interesting to me if the method of teaching is fun	Pre	4.17	0.70	-6.70	0.97	< 0.05	0.032
	Post	4.35	0.68				
I am interested in taking more STEM courses	Pre	3.91	0.72	-10.35	1.05	< 0.05	0.074
	Post	4.21	0.75				
I am considering choosing a STEM package when I continue upper-level secondary	Pre	3.90	0.72	-3.28	1.07	< 0.05	0.008
	Post	4.00	0.81				
I am confident that I can apply STEM knowledge in my daily life	Pre	3.95	0.70	-12.48	0.97	< 0.05	0.104
	Post	4.28	0.69				
I plan to pursue a career in STEM in the future	Pre	4.02	0.74	2.01	1.11	< 0.05	0.003
	Post	3.96	0.82				
By utilising STEM knowledge, I will be able to create something useful	Pre	4.21	0.63	-3.55	0.91	< 0.05	0.009
	Post	4.30	0.66				
It is my goal to use my creativity and innovation to learn STEM subjects	Pre	4.18	0.66	-5.79	0.93	< 0.05	0.024
	Post	4.33	0.66				

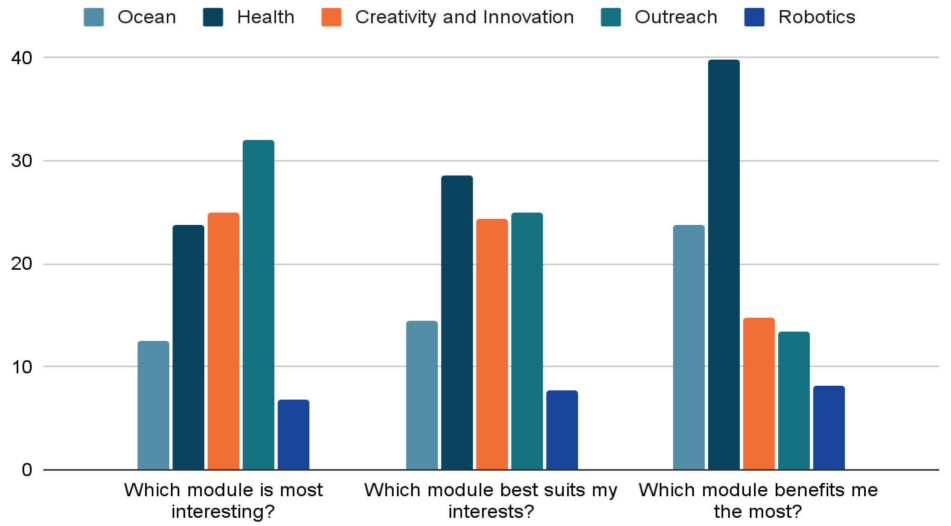

Figure 2: Students' preferences for the TPSC modules

the TPSC programme successfully improved students' understanding of STEM concepts and principles. The programme has also been effective in improving students' critical thinking skills and problem-solving skills. This is likely because TPSC provides students with the opportunity to apply the concepts and principles they learn in the TPSC programme to real-world scenarios, which provides students with a framework by which they can engage in 21st-century learning, encouraging a more positive attitude towards STEM careers (Williams & Mangan, 2016). Developing knowledge and engaging in real-world problem-solving create the foundation for self-regulation, collaboration, and communication among students (Stehle & Peters-Burton, 2019). It should be noted that the inclusion of real-world problems and authentic tools has contributed to the creation of an authentic and meaningful presentation of STEM disciplines in the STEM education programme (Ghadiri Khanaposhtani *et al*., 2018).

The results revealed significant changes in student attitudes toward STEM. After being exposed to the TPSC programme, students showed a positive attitude towards STEM activities, with high scores in the post-test indicating that students had developed a strong interest and appreciation for STEM disciplines. The programme has been successful in helping students gain a better understanding of STEM concepts and theories, as well as in improving students' interest in STEM disciplines. This also shows that one of the SDG for quality education (SDG4) has been achieved. The students reported that learning STEM was more engaging and that they were more confident in their ability to learn and apply STEM concepts, with many expressing a more positive outlook on STEM disciplines.

The students reported that they were more likely to include STEM activities in the classroom and would choose a STEM package during upper secondary education. Similar to research findings in the present study, other investigations have noted significant increases in student attitudes towards STEM after attending STEM education programmes (Baran *et al*., 2019). This suggests that STEM activities have the potential to increase student engagement in STEM-related topics and activities. Therefore, it is important to ensure that students have access to quality STEM education programmes and activities.

However, while this study showed a significant increase in student attitudes toward STEM, there was a significant decline in student attitudes towards STEM for their future

career. This suggests that although students may be receptive to STEM activities, they may not have the same level of enthusiasm for pursuing STEM-related careers. Therefore, it is important to provide students with positive role models and experiences that encourage them to consider STEM for their careers. This can be done through mentorship programmes, teaching students about successful STEM professionals, and exposing them to the opportunities available in STEM. These efforts should be implemented at an early age, as students are more likely to develop an interest in a career path when they are exposed to it early on. Additionally, providing students with adequate resources and support to pursue STEM-related careers is essential.

Recent data shows that only about 51% of students are enrolled in STEM streams in 2024. Although this is the highest percentage in the decade, it still falls short of the government's target of a 60:40 ratio, where 60% of students are expected to major in STEM (Onn, 2024). There is a growing awareness of the critical importance of STEM education among policymakers, educators, and stakeholders, who recognise that STEM education can propel the nation forward. This has resulted in increased investment in STEM education, with the 2024 Budget allocating additional funds to fostering the development of STEM knowledge and skills among young people. STEM education is seen as critical for the future success of a nation and many countries are investing in it to ensure a brighter future. The TPSC programme contributes to this national agenda by developing a new generation of students who are more equipped to contribute to innovation and economic growth.

In the present study, the STEM for Robotics module emerged as the most preferred among students. This is unsurprising, given that robotics integrates engineering, mathematics, and computer science to create complex systems that can accomplish a variety of tasks. This makes robotics an attractive field for students who are looking to combine their interests and gain valuable skills that can be applied to many different industries. Additionally, robotics can provide students with hands-on learning experiences that can be both fun and engaging. As such, it is no surprise that students are drawn to the STEM for Robotics module, as it offers an exciting way to explore the world of STEM.

According to students, STEM for Health offers the most benefits and fits their interest in STEM. STEM for Health combines elements from biology, medicine, and chemistry to explore the human body and develop new treatments and cures. This appeals to students who are interested in the medical field, as it offers a way to gain knowledge and skills that can be applied to the real world. Additionally, the field of health is constantly evolving and presents opportunities for students to explore new topics and gain experience in the latest technologies (Nilsen *et al*., 2020). This makes STEM for Health an attractive option for students who are looking for an engaging and rewarding learning experience.

Conclusions

The TPSC programme has proven effective in enhancing students' understanding and appreciation of STEM disciplines, developing their critical thinking skills, and improving attitudes towards STEM activities. The programme successfully increased student interest in STEM disciplines and encouraged them to consider STEM-related pathways in upper secondary education. It represents a meaningful step towards Malaysia's goal of increasing the number of students pursuing STEM fields.

A strong driver for accomplishing the Sustainable Development Goals, STEM education is becoming more and more important in a society, where problems are becoming more complex and interlinked. It empowers people with the know-how to tackle global concerns, encourages creativity, and advances diversity. Governments, corporations, public society, and educators must work together to emphasise STEM education and build a sustainable and prosperous future.

Acknowledgements

The authors wish to sincerely thank the local authorities, teachers, and students from all secondary schools in Terengganu, Malaysia, who participated in or supported this study. This research has been funded by the Terengganu State Government.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

References

Abdul Aziz @Ahmad, A., Ismail, F., Ibrahim, N. M., & Samat, N. A. (2017). Investigating the implementation of higher order thinking skills in Malaysian classrooms: Insights from L2 teaching practices. *Sains Humanika*, *9*(4-2). https://doi.org/10.11113/sh.v9n4-2.1361

Baran, E., Canbazoglu Bilici, S., Mesutoglu, C., & Ocak, C. (2019). The impact of an out-of-school STEM education program on students' attitudes toward STEM and STEM careers. *School Science and Mathematics*, *119*(4), 223-235. https://doi.org/10.1111/ssm.12330

Bland, J. M., & Altman, D. G. (1997). Statistics notes: Cronbach's alpha. *BMJ*, *314*(7080), 572-572. https://doi.org/10.1136/bmj.314.7080.572

Bybee, R. W. (2013). *The case for STEM education: Challenges and opportunities*. National Science Teachers Association.

Ghadiri Khanaposhtani, M., Liu, C. J., Gottesman, B. L., Shepardson, D., & Pijanowski, B. (2018). Evidence that an informal environmental summer camp can contribute to the construction of the conceptual understanding and situational interest of STEM in middle-school youth. *International Journal of Science Education, Part B*, *8*(3), 227-249. https://doi.org/10.1080/21548455.2018.1451665

Gonzalez, H. B., & Kuenzi, J. J. (2012). Science, technology, engineering, and mathematics (STEM) education: A primer. *Congressional Research Service: A Primer*. https://fas.org/sgp/crs/misc/R42642.pdf

Hund, A. K., Churchill, A. C., Faist, A. M., Havrilla, C. A., Love Stowell, S. M., McCreery, H. F., Ng, J., Pinzone, C. A., & Scordato, E. S. C. (2018). Transforming mentorship in STEM by training scientists to be better leaders. *Ecology and Evolution*, *8*(20), 9962-9974. https://doi.org/10.1002/ece3.4527

Idris, R., Govindasamy, P., & Nachiappan, S. (2023). Challenges and obstacles of STEM education in Malaysia. *International Journal of Academic Research in Business and Social Sciences*, *13*(4), 820-828. https://doi.org/10.6007/IJARBSS/v13-i4/16676

Jabatan Pendidikan Negeri Terengganu. (2023). *Pencapaian STEM 2023*. Terengganu: JPNT.

Kaleva, S., Pursiainen, J., Hakola, M., Rusanen, J., & Muukkonen, H. (2019). Students' reasons for STEM choices and the relationship of mathematics choice to university admission. *International Journal of STEM Education*, *6*(1). https://doi.org/10.1186/s40594-019-0196-x

Kitchen, J. A., Sonnert, G., & Sadler, P. M. (2018). The impact of college- and university-run high school summer programs on students' end of high school STEM career aspirations. *Science Education*, *102*(3), 529-547. https://doi.org/10.1002/sce.21332

Ministry of Education Malaysia (MOE). (2023). *Malaysia Education Blueprint 2013-2025: Annual Report 2023*. Putrajaya: MOE.

Ministry of Education Malaysia (MOE). (2013). *Malaysia Education Blueprint 2013-2025*. Putrajaya: MOE.

Ministry of Science, Technology and Innovation (MOSTI). (2012). *Science and Technology Human Capital Roadmap: Towards*

2020. Putrajaya: Malaysian Science and Technology Information Centre.

Nadelson, L. S., & Seifert, A. L. (2017). Integrated STEM defined: Contexts, challenges, and the future. *The Journal of Educational Research*, *110*(3), 221-223. https://doi.org/10.1080/00220671.2017.1289775

Nilsen, P., Seing, I., Ericsson, C., Birken, S. A., & Schildmeijer, K. (2020). Characteristics of successful changes in health care organisations: An interview study with physicians, registered nurses and assistant nurses. *BMC Health Services Research*, *20*(147), 1-8. https://doi.org/10.1186/s12913-020-4999-8

Onn, H. W. (2024). *Rethinking STEM education for Malaysia's future*. https://international.astroawani.com/malaysia-news/columnist-rethinking-stem-education-malaysias-future-485131

Skinner, E., Saxton, E., Currie, C., & Shusterman, G. (2017). A motivational account of the undergraduate experience in science: Brief measures of students' self-system appraisals, engagement in coursework, and identity as a scientist. *International Journal of Science Education*, *39*(17), 2433-2459. https://doi.org/10.1080/09500693.2017.1387946

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). https://doi.org/10.1186/s40594-019-0192-1

Shahali, E. H. M., Halim, L., Rasul, M. S., Osman, K., & Arsad, N. M. (2018). Students' interest towards STEM: A longitudinal study. *Research in Science & Technological Education*. https://doi.org/10.1080/02635143.2018.1489789

Wen, H. J. (2023). *STEM-ming the decline*. https://www.thestar.com.my/news/education/2023/06/18/stem-ming-the-decline

Williams, P. J., & Mangan, J. (2016). The effectiveness of using young professionals to influence STEM career choices of secondary school students. *Journal of Research in STEM Education*, *2*(1), 2-18. https://doi.org/10.51355/jstem.2016.19

World Economic Forum. (2017). *The World Economic Forum. World Economic Forum*. https://www.weforum.org/