Students' Perceptions of Science, Technology, Engineering And Mathematics (STEM) Fields

Syafiza Saila Samsudin (syafi915@uitm.edu.my)
Faculty of Computer Science and Mathematics, Universiti Teknologi Mara, Kedah Branch, Sungai Petani Campus, Malaysia

Norliana Mohd Najib (liananajib@uitm.edu.my)
Faculty of Computer Science and Mathematics, Universiti Teknologi Mara, Kedah Branch, Sungai Petani Campus, Malaysia

Afida Ahmad (afidaahmad@uitm.edu.my)
Faculty of Computer Science and Mathematics, Universiti Teknologi Mara, Kedah Branch, Sungai Petani Campus, Malaysia

Kamarul Ariffin Mansor[1] (ariff118@uitm.edu.my)
Faculty of Computer Science and Mathematics, Universiti Teknologi Mara, Kedah Branch, Sungai Petani Campus, Malaysia

ABSTRACT

This study investigates secondary school students' perceptions of mathematics, science, and technology within the context of STEM education. Data were collected from 121 students through a survey conducted during a special STEM program involving four schools in Sungai Petani, Kedah. The survey utilized a 5-point Likert scale to assess students' attitudes toward mathematics, science, engineering, and technology fields. A factor analysis was performed to examine the underlying structure of students' attitudes toward Science, Technology, Engineering, and Mathematics (STEM). Principal Component Analysis (PCA) with Varimax rotation was employed to extract distinct constructs within the dataset. The results revealed that only 5.8% of respondents identified mathematics as their weakest subject, while 33.1% considered themselves proficient in science. However, only 9.1% of the respondents expressed confidence in their ability to succeed in engineering. The study concludes that mathematics is not widely perceived as a weak subject among students, with only a small percentage identifying it as such. While a significant portion of students feel confident in their science abilities, relatively few believe they can achieve success in engineer-

1. Corresponding Author

ing. This finding highlights a potential gap in students' confidence or interest in pursuing engineering-related fields within STEM.
Keywords: *STEM perception, Students' confidence, Attitude towards Science and Mathematics, Secondary school students.*
JEL classification: I210, I230, I240, I240, I260

1. INTRODUCTION

The global demand for professionals in Science, Technology, Engineering, and Mathematics (STEM) continues to grow, reflecting the increasing recognition of these disciplines' critical role in driving innovation, fostering economic growth, and addressing complex 21st-century challenges. STEM professionals are essential for advancing technological progress, enhancing economic competitiveness, and tackling global issues such as climate change and public health crises. In response to this demand, many nations, including Malaysia, have implemented significant reforms in STEM education to develop a skilled workforce capable of thriving in knowledge-based economies. However, persistent challenges, including misalignments between educational curricula and workplace requirements, as well as uneven global progress in STEM education, continue to hinder the supply of qualified professionals (Hasim et al., 2022; Kelley and Knowles, 2016). Addressing these issues is crucial to ensuring that STEM education systems remain responsive to evolving workforce needs and effectively prepare students for emerging global challenges (Widya et al., 2019).

In Malaysia, the importance of STEM education is underscored by the government's commitment to transforming the nation into a high-income, knowledge-based economy. According to the Ministry of Education Malaysia (2020), only 47% of upper secondary students were enrolled in STEM streams in 2019, falling short of the government's target of 60% by 2025. This shortfall is concerning, as STEM fields are projected to contribute significantly to Malaysia's economic growth, with the demand for STEM professionals expected to rise by 26% by 2025 (Malaysia Digital Economy Corporation, 2021). Despite these ambitions, challenges such as a lack of interest in STEM subjects, insufficient qualified teachers, and limited access to resources, particularly in rural areas, continue to impede progress (Aziz et al., 2021). Educational institutions play a pivotal role in meeting this demand by fostering interest and engagement in STEM disciplines. By introducing students to foundational STEM concepts early, schools lay the groundwork for sustained interest and skill development. Through innovative curricula, experiential learning activities, and integrated STEM programs, educational institutions provide opportunities to spark curiosity and cultivate essential competencies for the modern workforce. Effective STEM pedagogy often employs interdisciplinary approaches, project-based learning, and collaborations with industry professionals, enabling students to connect theoretical knowledge with real-world applications (Watters and Diezmann, 2013). Furthermore, early exposure to STEM through inquiry-driven learning has been shown to enhance students' attitudes toward these disciplines and elevate their career aspirations in related fields (Dabney et al., 2012). By prioritizing high-quality instruction, ongoing professional development for educators, and the integration of STEM principles into core curricula, schools serve as catalysts for developing a motivated and skilled STEM workforce (Kennedy and Odell, 2014).

Despite these efforts, significant disparities in student engagement and interest in STEM persist. In Malaysia, socioeconomic factors exacerbate these disparities by limiting access to quality STEM resources and extracurricular opportunities, particularly in rural and underserved communities. For instance, a 2021 study by the Malaysian Institute of Economic Research revealed that only 35% of rural schools had adequate STEM facilities, compared to 72% of urban schools (MIER, 2021). Additionally, the lack of visible role models in STEM careers reduces motivation, particularly among female students and underrepresented minority groups, who often struggle to envision themselves in these roles (Stoet and Geary, 2018). Traditional teaching methods, which frequently emphasize rote memorization over experiential, inquiry-based learning, fail to engage students meaningfully, contributing to declining interest as they advance through their education (Theobald et al., 2020). Addressing these disparities requires targeted interventions, including inclusive pedagogical practices, early exposure to STEM career pathways, and equitable access to enriching STEM experiences.

While numerous studies have explored strategies to promote STEM education and improve student engagement, a critical gap remains in understanding how students perceive and engage with STEM disciplines, particularly mathematics, science, and technology. Much of the existing literature focuses on systemic interventions or workforce outcomes, often overlooking the nuanced perspectives of students. These perceptions, however, are crucial in shaping attitudes, motivations, and long-term career aspirations. Without a deeper understanding of students' experiences, efforts to refine STEM pedagogy and curricula risk misalignment with learners' needs and interests. Therefore, this study aims to bridge this gap by exploring student perceptions and engagement in STEM fields, with a particular focus on mathematics, science, and technology. Building on the need for studentcentered research in STEM education, this study seeks to provide actionable insights into how students perceive and engage with STEM disciplines, identifying opportunities for educators and policymakers to enhance engagement and foster sustained interest. By capturing these perspectives, the research aims to inform improvements in STEM pedagogical practices and curriculum design, ensuring they are both relevant and impactful. Additionally, the study contributes to the existing body of knowledge by examining students' attitudes toward mathematics and science, identifying specific barriers and enablers that influence their engagement.

The remainder of this article is structured as follows: The next section provides a comprehensive literature review, contextualizing the importance of STEM education and identifying factors influencing student engagement. This is followed by a detailed description of the methodology, including data collection and analysis techniques. The results section presents key findings related to student perceptions and engagement with mathematics, science, and technology. The discussion interprets these findings within the context of existing literature, highlighting their implications for STEM education practices. Finally, the article concludes by summarizing the key insights, offering policy and pedagogical recommendations, and suggesting directions for future research.

2. OVERVIEW OF STEM ENGAGEMENT RESEARCH

Research over the past 15 years underscores the critical role of student engagement in STEM disciplines for fostering interest and long-term participation in STEM careers. Studies consistently highlight the importance of early exposure to STEM through inquiry-based learning and integrated curricula. These approaches help connect abstract concepts to real-world applications, making STEM more relatable and engaging for students (Kennedy and Odell, 2014). However, participation rates have been declining, particularly among students today, due to barriers such as a lack of relatable role models and the perceived difficulty of STEM subjects (Holmes et al., 2022). In Malaysia, for instance, only 47% of upper secondary students were enrolled in STEM streams in 2019, falling short of the government's target of 60% by 2025 (Ministry of Education Malaysia, 2020). Additionally, traditional teaching methods that focus on rote memorization rather than active, hands-on learning often fail to sustain student interest over time (Dillivan and Dillivan, 2014). This body of research strongly suggests the need for comprehensive interventions to address these barriers.

2.1 Factors Influencing STEM Perceptions

Student perceptions of STEM are shaped by multiple factors, including self-efficacy, the relevance of content, and exposure to authentic STEM experiences. High levels of self-efficacy and task value are positively correlated with STEM engagement, while low confidence and societal expectations disproportionately affect females' interest in fields such as engineering and computer science (Murphy et al., 2019). In Malaysia, studies have shown that female students often perceive STEM subjects as male-dominated and challenging, which discourages their participation (Aziz et al., 2021). Learning approaches that connect STEM subjects to students' local communities and cultures can enhance understanding and engagement (Holmes et al., 2022). For example, a study by Ismail and Hassan (2019) found that integrating local environmental issues into STEM lessons increased student interest and participation in rural Malaysian schools. Supportive learning environments, such as those with mentors and collaborative projects, can also increase engagement by fostering a sense of belonging and connection (Hernandez et al., 2013).

2.2 Gaps in Existing Research

Despite growing awareness, significant gaps remain in understanding students' perspectives on STEM engagement. Current research often emphasizes system-wide educational reforms or workforce outcomes while neglecting individual experiences and perceptions. For example, few studies have explored how intersecting identities, such as gender, race, and socio-economic status, shape attitudes toward STEM. In Malaysia, research on the impact of socio-economic disparities on STEM participation is limited, particularly in rural areas where access to resources and quality education is often lacking (Ismail et al., 2020). Further research is needed to understand the long-term impact of early interventions on students' STEM career choices (Kennedy and Odell, 2014). Another gap lies in measuring the effectiveness of informal STEM learning environments, such as STEM programs and extracurricular activities, in sustaining engagement beyond formal schooling contexts (Dillivan and Dillivan, 2014). Addressing these gaps is critical to designing more targeted and inclusive interventions.

3. FRAMEWORK OF METHODOLOGY

This study employs a quantitative research design to investigate secondary school students' perception and engagement towards STEM subjects using a structured questionnaire. There were 121 secondary students

(Form 3) from four different schools in Sungai Petani, Kedah involved in this survey. Data collection took place during a two-day STEM MATHWIZ Challenges which was held in UiTM Kedah Branch where the survey was distributed during the program. The survey was conducted to investigate their perspectives towards the STEM field and career. Table 1 shows the percentage of students' participation.

Percentage of students' participation

Table 1

	Participants	**Percentage (%)**
SMK Bandar Sungai Petani	30	24.8
SMK Amanjaya	31	25.6
SMK Bedong	30	24.8
SMK Gurun	30	24.8
TOTAL	121	100

The questionnaire was divided into several sections to assess students' attitude, interests, and perceptions related to the STEM field. Responses are given on a Likert scale ("Strongly disagree", "Disagree", "Neutral", "Agree" and "Strongly agree"). The key part sections of the questionnaire include:

(1) Mathematics: Focuses on students' attitudes towards mathematics, self-perception of competence, and future aspirations involving mathematics.

(2) Science: Assesses students' interest in science, perceived relevance of science to future careers, and self-efficacy in learning science.

(3) Engineering and Technology: Evaluates interest in engineering, creativity, problem-solving abilities, and understanding of how technology and engineering impact daily life.

A reliability analysis was conducted to assess the internal consistency of the items within the three constructs: Mathematics, Science, and Engineering and Technology. Descriptive statistics (mean, standard deviation, minimum and maximum) were used to summarize data. Statistical analysis was conducted using SPSS version 29. A factor analysis was performed to examine the underlying structure of students' perception toward STEM (Science, Technology, Engineering, and Mathematics) disciplines. The analysis utilized Principal Component Analysis (PCA) with Varimax rotation to extract distinct constructs within the dataset. A Kaiser-Meyer-Olkin (KMO) measure was conducted to assess the sampling adequacy for factor analysis. The analysis aims to evaluate students' perceptions and confidence in STEM subjects to identify strengths, challenges, and opportunities for improvement. It focuses on understanding students' enthusiasm for science, engineering, and technology, while addressing barriers in mathematics and practical engineering skills. The findings will guide educators and policymakers in implementing strategies like interactive teaching, hands-on learning, mentorship, and career counselling to enhance engagement, confidence, and alignment with career aspirations in STEM fields.

4. RESULTS AND FINDINGS

STEM (Science, Technology, Engineering, and Mathematics) education is integral to equipping students with the skills needed for the 21st century, fostering innovation, problem-solving, and critical thinking. This study investigates secondary school students' perceptions of STEM components - Mathematics, Science, Engineering, and Technology. The analysis is based on data collected from 121 students across four schools located in the central state of Kedah, focusing on their confidence, attitudes, and aspirations in these fields. Understanding these perceptions is crucial for designing effective STEM programs and fostering interest in STEM careers.

4.1 Mathematics Component

Table 2 highlight varied perceptions of mathematics among the students. For the statement, *"Math has been my worst subject,"* responses were nearly evenly distributed, with 37.2% agreeing or strongly agreeing, indicating a negative perception of math, while an equal proportion disagreed. A significant 40.5% remained neutral, reflecting ambivalence and suggesting that students may lack clarity in their attitudes toward mathematics. Regarding career aspirations, the majority (53.7%) agreed or strongly agreed with the statement, *"When I'm older, I might choose a job that uses math."* This result indicates a positive outlook on mathematics' relevance to future careers, with only 16.5% disagreeing. This optimism, however, contrasts with the responses to *"Math is hard for me,"* where 40.4% agreed, suggesting that many students perceive mathematics as challenging. Notably, this percentage was closely matched by those who disagreed (39.7%), indicating a polarized perspective.

When asked about their capability in mathematics, 57.9% of students agreed or strongly agreed with the statement, *"I am the type of student who does well in math,"* demonstrating self-confidence in their abilities. Similarly, the statement *"I can get good grades in math"* received strong positive responses, with 76% of students expressing confidence. These findings suggest that while students recognize the challenges associated with mathematics, many still believe they can perform well academically. Responses to the statement *"I can understand most subjects easily, but math is difficult for me"* reveal that 48.7% agreed or strongly agreed, suggesting that mathematics stands out as a difficult subject compared to others. Nonetheless, 63.6% of students agreed or strongly agreed with *"In the future, I could do harder math problems,"* reflecting a growth mindset and optimism about improving their mathematical skills. Finally, when asked about their overall competence in mathematics, 47.9% agreed or strongly agreed with *"I am good at math,"* further reinforcing a positive self-perception among many students.

Mathematics component in STEM

Table 2

MATHEMATICS	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Math has been my worst subject.	16 13.2%	29 24.0%	49 40.5%	20 16.5%	7 5.8%
When I'm older, I might choose a job that uses math.	8 6.6%	12 9.9%	36 29.8%	50 41.3%	15 12.4%
Math is hard for me.	19 15.7%	29 24.0%	42 34.7%	25 20.7%	6 5.0%
I am the type of student who does well in math.	1 0.8%	8 6.6%	42 34.7%	55 45.5%	15 12.4%
I can understand most subjects easily, but math is difficult for me.	23 19.0%	27 22.3%	34 28.1%	32 26.4%	5 4.1%
In the future, I could do harder math problems.	4 3.3%	8 6.6%	32 26.4%	58 47.9%	19 15.7%
I can get good grades in math.	1 0.8%	4 3.3%	24 19.8%	61 50.4%	31 25.6%
I am good at math.	2 1.7%	16 13.2%	45 37.2%	39 32.2%	19 15.7%

4.2 Science Component

Table 3 reveals the results generally positive perceptions of science among the students. For the statement, *"I feel good about myself when I do science,"* 81% of students agreed or strongly agreed, while only 4.9% expressed disagreement. This indicates a strong sense of self-efficacy and satisfaction when engaging in science-related activities. Similarly, a significant 54.5% agreed or strongly agreed with *"I might choose a career in science,"* with only 14.1% expressing disagreement. However, a considerable portion (31.4%)

remained neutral, suggesting that some students are uncertain about pursuing science careers. The statement, *"After I finish high school, I will use science often,"* received agreement or strong agreement from 54.6% of respondents, with only 18.2% disagreeing. This highlights a moderate level of perceived relevance of science in daily life. When asked if knowing science will help them earn money, 79.3% agreed or strongly agreed, reflecting a strong belief in the economic value of science knowledge. This optimism was echoed in the response to *"When I am older, I will need to understand science for my job,"* where 68.6% expressed agreement, affirming the perceived importance of science for future careers.

Confidence in science abilities was evident, with 70.2% agreeing or strongly agreeing to *"I know I can do well in science."* Similarly, 69.5% agreed or strongly agreed that *"Science will be important to me in my future career."* These results suggest a strong foundation of confidence and motivation among students regarding science. Interestingly, when presented with the statement, *"I can understand most subjects easily, but science is hard for me to understand,"* 42.9% disagreed, while 33.9% were neutral. Only 23.2% agreed, suggesting that most students do not find science particularly difficult compared to other subjects. Furthermore, 57% of students agreed or strongly agreed with *"In the future, I could do harder science work,"* indicating a growth mindset and confidence in their ability to tackle advanced scientific challenges.

Science component in STEM

Table 3

SCIENCE	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I feel good about myself when I do science.	1 0.8%	5 4.1%	17 14.0%	58 47.9%	40 33.1%
I might choose a career in science.	3 2.5%	14 11.6%	38 31.4%	39 32.2%	27 22.3%
After I finish high school, I will use science often.	3 2.5%	19 15.7%	33 27.3%	44 36.4%	22 18.2%
When I am older, knowing science will help me earn money.	1 0.8%	4 3.3%	20 16.5%	61 50.4%	35 28.9%
When I am older, I will need to understand science for my job.	1 0.8%	9 7.4%	28 23.1%	55 45.5%	28 23.1%
I know I can do well in science.	2 1.7%	10 8.3%	24 19.8%	58 47.9%	27 22.3%
Science will be important to me in my future career.	1 0.8%	11 9.1%	25 20.7%	48 39.7%	36 29.8%
I can understand most subjects easily, but science is hard for me to understand.	20 16.5%	32 26.4%	41 33.9%	18 14.9%	10 8.3%
In the future, I could do harder science work.	5 4.1%	12 9.9%	35 28.9%	50 41.3%	19 15.7%

4.3 Engineering and Technology Component

From Table 4, the results show generally positive perceptions of engineering and technology among students, with notable enthusiasm for creativity and problem-solving. For the statement, *"I like to imagine making new products,"* 63.6% of students agreed or strongly agreed, indicating an interest in innovative thinking. However, 19.8% were neutral, and 16.5% disagreed, suggesting some variability in students' imagination or exposure to product design. When asked about the relevance of engineering to improving everyday items, 69.4% of respondents agreed or strongly agreed with *"If I learn engineering, then I can improve things that people use every day,"* with no students expressing strong disagreement. This response highlights students' recognition of engineering's practical applications. Similarly, 46.3% agreed or strongly agreed with *"I am good at building or fixing things,"* though 34.7% were neutral, suggesting that hands-on skills may be underdeveloped or undervalued in some students.

Curiosity about how machines work was evident, with 67.7% agreeing or strongly agreeing to *"I am interested in what makes machines work."* The statement, *"Designing products or structures will be important in my future jobs,"* received agreement or strong agreement from 48%, showing moderate confidence in the relevance of engineering to career aspirations. Interest in electronics was strong, as 68.6% of students agreed or strongly agreed with *"I am curious about how electronics work."* This reflects a growing engagement with technology, possibly influenced by modern devices and digital tools. Creativity also emerged as a key motivator, with 77.7% agreeing or strongly agreeing with *"I want to be creative in my future jobs."* This enthusiasm underscores the appeal of engineering and technology for students who value innovation. Finally, the importance of integrating math and science was widely recognized, as 82.7% agreed or strongly agreed with *"Knowing how to use math and science together will help me to invent useful things."* However, self-efficacy in engineering was more tempered; while 48.8% agreed or strongly agreed with *"I believe I can be successful in engineering,"* a notable 38% remained neutral.

Engineering and Technology in STEM

Table 4

ENGINEERING and TECHNOLOGY	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I like to imagine making new products.	1 0.8%	19 15.7%	24 19.8%	61 50.4%	16 13.2%
If I learn engineering, then I can improve things that people use every day.	0 0.0%	11 9.1%	26 21.5%	68 56.2%	16 13.2%
I am good at building or fixing things.	4 3.3%	19 15.7%	42 34.7%	45 37.2%	11 9.1%
I am interested in what makes machines work.	5 4.1%	12 9.9%	22 18.2%	50 41.3%	32 26.4%
Designing products or structures will be important in my future jobs.	3 2.5%	18 14.9%	42 34.7%	48 39.7%	10 8.3%
I am curious about how electronics work.	7 5.8%	11 9.1%	20 16.5%	57 47.1%	26 21.5%
I want to be creative in my future jobs.	3 2.5%	8 6.6%	16 13.2%	53 43.8%	41 33.9%
Knowing how to use math and science together will help me to invent useful things.	1 0.8%	1 0.8%	19 15.7%	63 52.1%	37 30.6%
I believe I can be successful in engineering.	2 1.7%	14 11.6%	46 38.0%	48 39.7%	11 9.1%

A factor analysis was conducted to explore the structure of students' perceptions of STEM (Science, Technology, Engineering, and Mathematics). Principal Component Analysis (PCA) with Varimax rotation was used to identify distinct components. The Kaiser-Meyer-Olkin (KMO) test was applied to ensure the data was suitable for factor analysis. The KMO value was 0.845, which is considered "meritorious" (Kaiser, 1974) and indicates that the data is suitable for factor analysis. Bartlett's Test of Sphericity was also significant, $\chi^2(325) = 1831.594$, $p < .001$, indicating that the correlations between items were sufficiently large for factor analysis. The findings indicated a well-defined three-factor structure representing Mathematics, Science, and Engineering and Technology. All factors had eigenvalues exceeding 1, and together they accounted for 56.97% of the total variance, suggesting a strong representation of the underlying dimensions. The rotation process redistributed variance more evenly among the components, enhancing their interpretability.

The rotated component matrix exhibited strong item loadings within their respective categories, with minimal cross-loadings, ensuring clarity in the factor structure. Furthermore, reliability analysis demonstrated high internal consistency across the constructs, with Cronbach's Alpha values ranging from 0.855 to 0.919. These findings support the validity and reliability of the identified factors. In summary, the results provide compelling evidence for a three-factor model that captures students' distinct attitudes toward Mathematics, Science, and Engineering and Technology. However, two items were removed due to low loadings and cross-loading. This reinforces the robustness of the scales employed in the analysis. The reliability of each construct was evaluated using Cronbach's Alpha, with the results summarized below and presented in Table 5. Interpretation of Table 5:

(1) Mathematics:
- The construct retained 8 items with no items dropped during the analysis.
- The Cronbach's Alpha value was 0.855, indicating good internal consistency (Nunnally, 1978).

(2) Science:
- The construct retained 8 items, with 1 item dropped due to insufficient contribution to internal consistency.
- The Cronbach's Alpha value was 0.919, reflecting excellent internal consistency.

(3) Engineering and Technology:
- The construct retained 8 items, with 1 item dropped during the analysis.
- The Cronbach's Alpha value was 0.880, demonstrating good internal consistency.

Summary of reliability analysis

Table 5

Construct	Items Retained	Item Dropped	Cronbach's Alpha
Mathematic	8	0	0.855
Science	8	1	0.919
Engineering and Technology	8	1	0.880

Lastly, descriptive statistics, including means and standard deviations, were calculated for all individual items (refer Table 6). Average scores for each component were computed, and their overall descriptive statistics (mean, standard deviation, minimum, and maximum) were analysed. Table 6 presents the descriptive statistics for all survey items. Science items generally received higher mean scores compared to Mathematics and Engineering and Technology. For example, item Q1 for science ("I find Science enjoyable") had the highest mean score across all items (M = 4.08, SD = 0.84), while for

Mathematics item Q1 ("I am confident in solving math problems") had the lowest mean score (M = 3.22, SD = 1.06). Components were ranked based on their mean scores as shown in Table 7.

Descriptive Statistics for Survey Items Across Components

Table 6

Component	Item	Mean	Standard Deviation
Mathematics	Q1	3.22	1.06
	Q2	3.43	1.05
	Q3	3.25	1.11
	Q4	3.62	0.82
	Q5	3.26	1.17
	Q6	3.66	0.94
	Q7	3.97	0.82
	Q8	3.47	0.97
Science	Q1	4.08	0.84
	Q2	3.60	1.04
	Q3	3.52	1.04
	Q4	4.03	0.82
	Q5	3.83	0.90
	Q6	3.81	0.93
	Q7	3.88	0.97
	Q9	3.55	1.01
Engineering and Tech	Q1	3.60	0.94
	Q2	3.74	0.80
	Q3	3.33	0.96
	Q4	3.76	1.08
	Q5	3.36	0.92
	Q6	3.69	1.09
	Q7	4.00	0.98
	Q9	3.43	0.87

Table 7 summarizes the descriptive statistics for the average scores of the three components. Science (M = 3.79, SD = 0.76) emerged as the component with the highest agreement, followed by Engineering and Technology (M = 3.61, SD = 0.71) and Mathematics (M = 3.48, SD = 0.70). The range of scores indicates that all components captured diverse responses, with the widest range observed in Engineering and Technology (Range = 3.88). Based on average scores, the components were ranked as follows:

(1) Science (M = 3.79)
(2) Engineering and Technology (M = 3.61)
(3) Mathematics (M = 3.48)

These rankings suggest that respondents expressed the highest agreement with science-related items, indicating stronger positive attitudes toward this component.

Descriptive Statistics for Average Component Scores

Table 7

Component	Mean	Standard Deviation	Minimum	Maximum	Range
Science	3.79	0.76	1.38	5	3.63
Engineering and Tech	3.61	0.71	1.13	5	3.88
Mathematics	3.48	0.70	1.50	5	3.50

The results highlight significant variations in respondents' attitudes toward the three STEM components. Science achieved the highest mean score, reflecting its perceived relevance and interest among participants. Engineering and Technology followed, possibly due to its practical applications and growing prominence in education. Mathematics received the lowest mean score, suggesting a need for interventions to address potential challenges, such as confidence or enjoyment in this area. These findings align with existing literature emphasizing the importance of enhancing attitudes toward Mathematics to strengthen overall STEM engagement. Future research should explore the underlying factors influencing these attitudes and examine the role of instructional strategies in shaping perceptions of STEM components.

5. CONCLUSION

The analysis highlights students' generally positive perceptions of STEM, with enthusiasm for science, engineering, and technology's creative and practical aspects. However, challenges in mathematics and confidence in hands-on engineering skills require attention. By implementing targeted strategies, educators can build on students' strengths, address challenges, and foster sustained engagement in STEM. In summary, the findings indicate a generally favourable perception of STEM subjects among students, though variations in confidence and interest are apparent across the components. Mathematics emerged as the most challenging area for many students, reflected in the significant agreement with statements regarding its difficulty.

Nonetheless, the recognition of mathematics' importance in future careers by a considerable portion of students suggests a window for educators to intervene and address obstacles to math engagement. Implementing interactive teaching methods and contextualized learning experiences could help bridge this gap (Schoenfeld, 2014). In science, students exhibited high confidence and acknowledged its relevance to real-world applications, as evidenced by strong agreement with related statements. However, the notable proportion of neutral responses concerning science careers highlights the need for initiatives such as career counselling and exposure to scientific professions. Engaging students through mentorship programs and showcasing diverse career paths may deepen their interest and align academic efforts with career aspirations (Maltese and Tai, 2010). For engineering and technology, the results reveal robust enthusiasm for creativity and problem-solving. Students showed interest in activities such as imagining new products and exploring how electronics work. However, a notable lack of confidence in practical skills, such as building or fixing things, signals the need for more hands-on learning opportunities. Limited practical exposure in current STEM curricula may be a contributing factor. Providing maker spaces, design projects, and robotics competitions could help strengthen students' technical skills and confidence (Katehi et al., 2009). Addressing these challenges holistically will allow educators to build on students' positive perceptions of STEM while mitigating specific barriers, ensuring a well-rounded preparation for STEM-related careers.

6. RECOMMENDATIONS

To foster a robust and inclusive STEM education, the following strategies are proposed:

Strengthen Mathematics Engagement: To address students' perception of mathematics as a difficult subject, educators should incorporate interactive teaching methods, real-world problem-solving activities, and peer-supported learning environments. These approaches can help demystify math and demonstrate its practical relevance. Schoenfeld (2014) highlights that active and contextually meaningful teaching methods significantly enhance students' mathematical understanding and engagement.

Promote Science Careers: Increasing students' exposure to science-related career opportunities is crucial for aligning their academic interests with potential professional paths. Strategies such as mentorship programs, science fairs, and collaborations with STEM professionals can connect classroom learning to real-world applications and inspire students to pursue science careers. According to Maltese and Tai (2010), early exposure to science professionals and career pathways can significantly influence students' aspirations.

Enhance Engineering and Technology Education: Hands-on activities, such as robotics competitions, design challenges, and maker spaces, should be integrated into STEM curricula. These initiatives can build students' practical skills, boost confidence, and stimulate interest in engineering and technology. Katehi et al., (2009) emphasize the importance of experiential learning in engineering education to prepare students for problem-solving and innovation.

Integrate Creativity Across STEM: Creativity should be a cornerstone of STEM education. By implementing interdisciplinary projects that allow students to design, build, and test ideas integrating concepts from math, science, engineering, and technology, educators can foster innovation and critical thinking. Creative problem-solving is essential for preparing students for dynamic future careers (Honey et al., 2014).

Provide Targeted Support: Targeted interventions, such as tutoring and mentoring programs, are necessary to support students who struggle with STEM subjects. These efforts should ensure inclusivity and equity in STEM education, particularly for underrepresented groups. Research shows that personalized support and mentorship can improve academic confidence and performance (Schoenfeld, 2014).

Future Research: Further studies should explore demographic variables such as gender, socioeconomic status, and prior exposure to STEM. Understanding these factors can help identify barriers and inform the design of tailored interventions to make STEM education more effective and accessible. Katehi et al., (2009) advocate for research-driven strategies to address disparities in STEM engagement.

REFERENCES

1. Aziz, N. A., Ismail, S. S., and Hashim, S. (2021). Challenges in STEM education: A Malaysian perspective. Journal of Education and Learning, 15(3), 45-58.
2. Chachashvili-Bolotin, S., Milner-Bolotin, M., and Lissitsa, S. (2016). Examination of factors predicting secondary students' interest in tertiary STEM education. International Journal of Science Education, 38(3), 366–390. DOI:10.1080/09500693.2016.1143137
3. Dabney, K. P., Tai, R., Almarode, J. T., Miller-Friedmann, J., Sonnert, G., Sadler, P., and Hazari, Z. (2012). Out-of-school time science activities and their association with career interest in STEM. International Journal of Science Education, Part B, 2(1), 63–79. DOI:10.1080/21548455.2011.629455
4. Dillivan, D., and Dillivan, M. N. (2014). Student interest in STEM disciplines: Results from a summer day camp. Journal of Extension. DOI:10.34068/joe.52.01.18
5. Hasim, S. M., Rosli, R., Halim, L., Capraro, M. M., and Capraro, R. (2022). STEM professional development activities and their impact on teacher knowledge and instructional practices. Mathematics. DOI:10.3390/math10071109

6. Hernandez, P. R., Schultz, P. W., Estrada, M., Woodcock, A., and Chance, R. C. (2013). Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. Journal of Educational Psychology, 105(1), 89–107. https://doi.org/10.1037/a0029691
7. Holmes, K., Berger, N., Mackenzie, E., Attard, C., Johnson, P., Fitzmaurice, O., and O'Meara, N. (2022). Editorial: The impact of place-based contextualized curriculum on student engagement and motivation in STEM education. Frontiers in Education, 6. DOI:10.3389/feduc.2021.826656
8. Honey, M., Pearson, G., and Schweingruber, H. (2014). STEM integration in K–12 education: Status, prospects, and an agenda for research. National Academies Press.
9. Ismail, N., and Hassan, A. (2019). Enhancing STEM education through local context integration: A case study in rural Malaysia. Malaysian Journal of Learning and Instruction, 16(2), 123-145.
10. Ismail, N., Abdullah, M., and Yusof, Z. (2020). Socio-economic disparities in STEM education: A case study of rural and urban schools in Malaysia. International Journal of STEM Education, 7(1), 1-15.
11. Kaiser, H. F. (1974). An index of factorial simplicity. Psychometrika, 39(1), 31–36.
12. Katehi, L., Pearson, G., and Feder, M. A. (Eds.). (2009). Engineering in K-12 education: Understanding the status and improving the prospects. National Academies Press.
13. Kelley, T., and Knowles, J. (2016). A conceptual framework for integrated STEM education. International Journal of STEM Education, 3(1), 1–11. DOI:10.1186/s40594-016-0046-z
14. Kennedy, T., and Odell, M. (2014). Engaging students in STEM education. Science Education International, 25(3), 246–258.
15. Malaysia Digital Economy Corporation (MDEC). (2021). Malaysia Digital Economy Blueprint: Driving the Digital Transformation of Malaysia. Cyberjaya: MDEC.
16. Malaysian Institute of Economic Research (MIER). (2021). STEM Education in Malaysia: Challenges and Opportunities. Kuala Lumpur: MIER.
17. Maltese, A. V., and Tai, R. H. (2010). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among US students. Science Education, 95(5), 877–907. https://doi.org/10.1002/sce.20441
18. Ministry of Education Malaysia. (2020). Annual Report 2020: STEM Education in Malaysia. Putrajaya: Ministry of Education Malaysia.
19. Murphy, S., MacDonald, A., Wang, C., and Danaia, L. (2019). Towards an understanding of STEM engagement: A review of the literature on motivation and academic emotions. Canadian Journal of Science, Mathematics and Technology Education, 19(3), 304–320. DOI:10.1007/s42330-019-00054-w
20. Nunnally, J. C. (1978). Psychometric theory (2nd ed.). McGraw-Hill.
21. Schoenfeld, A. H. (2014). What makes for powerful classrooms, and how can we support teachers in creating them? Educational Researcher, 43(8), 404–412. https://doi.org/10.3102/0013189X14554439
22. Stoet, G., and Geary, D. C. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. Psychological Science, 29(4), 581–593. DOI:10.1177/0956797617741719
23. Theobald, E. J., Hill, M. J., Tran, E., Agrawal, S., Arroyo, E. N., Behling, S., Cintrón, D. L., Cooper, J. D., Dunster, G. P., Grummer, J. A., Hennessey, K., Hsiao, J., Iranon, N. N., Jones, L., Jordt, H., Keller, M., Lacey, M. E., Littlefield, C. E., Lowe, A., ... Freeman, S. (2020). Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. Proceedings of the National Academy of Sciences, 117(12), 6476–6483. https://doi.org/10.1073/pnas.1916903117

24. Watters, J., and Diezmann, C. M. (2013). Community partnerships for fostering student interest and engagement in STEM. Journal of STEM Education: Innovations and Research, 14(2), 47–55.
25. Widya, R., Rifandi, R., and Rahmi, Y. L. (2019). STEM education to fulfil the 21st century demand: A literature review. Journal of Physics: Conference Series, 1317, 1–8. DOI:10.1088/1742-6596/1317/1/012208