Rural High School Students' Interest and Perception Towards STEM Education

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ABSTRACT

Science, Technology, Engineering, and Mathematics (STEM) education is pivotal for equipping students with skills for 21st-century industries, yet its effective implementation faces challenges such as resource limitations and varying student engagement. Understanding student perspectives is crucial for enhancing STEM initiatives. This study investigated rural high school students' perceptions towards STEM education and examined the relationship between these perceptions and their interest in STEM fields. A quantitative correlational research design was employed, with data collected from 47 rural high school students in Malaysia using a structured questionnaire assessing STEM interest and perceptions on a 5-point Likert scale. Descriptive statistics revealed generally positive student perceptions, particularly regarding the enjoyable nature of STEM (M = 4.40), the effectiveness of group discussions (M = 4.23) and group activities (M = 4.28), comprehensible teacher instruction (M = 4.19), and the relevance of STEM to daily experiences (M = 4.19) and technology/engineering concepts (M = 4.17). Pearson correlation analysis indicated a statistically significant moderate positive relationship ($r = 0.575$, $p < 0.001$) between students' interest in STEM and their perceptions of STEM education. These findings highlight the interdependence of interest and perception, suggesting that fostering positive, engaging, and relevant STEM learning experiences is key to cultivating sustained student interest and participation in STEM.

Keywords-STEM education, student perceptions, student interest, correlational study, project-based learning, educational engagement

INTRODUCTION

STEM education has gained significant prominence as a critical pathway for preparing students to navigate the complexities of interdisciplinary industries in the 21st-century workforce. The strategic integration of innovative tools and methodologies, such as robotics, Augmented Reality (AR), project-based learning (PBL), and gamification, has been shown to substantially enhance students' learning experiences, knowledge acquisition, and skill development, thereby transforming traditional pedagogy and fostering deeper student involvement [1]. Beyond conceptual understanding, STEM education cultivates essential competencies like critical thinking, creativity, scientific reasoning, and innovation, encouraging students to explore real-world problems and fortify their scientific and engineering foundations, which are vital for future career trajectories.

Despite the evident benefits and transformative potential of robust STEM activities, their widespread and equitable implementation faces several persistent challenges. Many educational institutions, particularly those in underserved or rural areas, contend with limited accessibility to advanced resources like Arduino kits, robotics, and AR technologies, which hinders the adoption of modern teaching methods. Furthermore, teacher preparedness is a significant concern, as not all educators possess the specialized skills or training necessary to effectively facilitate STEM activities, potentially impacting the quality of instruction and student outcomes [2].

Even when advanced tools are available, variations in student interest and access, especially within competitive learning environments, can further complicate efforts to achieve broad and meaningful engagement.

To ensure the comprehensive involvement of students and maximize the impact of STEM initiatives, it is crucial to understand the student perspective directly. While various efforts are underway by different stakeholders to address the aforementioned issues, a deeper insight into how students perceive STEM education and what drives their interest is essential for tailoring effective interventions and fostering sustained engagement. Therefore, this research aims to investigate students' perceptions towards STEM education and to examine the relationship between their interest in STEM fields and these perceptions, ultimately contributing to more student-centered and impactful STEM learning experiences.

LITERATURE REVIEW

STEM education integrates several subjects—Science, Mathematics, Engineering, and Technology—into a single field that is considered more relevant and practical for teaching in schools. This approach emphasizes real-world applications, allowing students to learn Science and Mathematics in meaningful and realistic contexts through the use of technology and innovation. By combining various teaching methods and STEM components, this integrated approach fosters creative and innovative thinking, encouraging more discussions among students about science and technology. One effective strategy for implementing STEM learning is project-based learning, which helps engage students in hands-on, applied learning experiences. Another way to boost students' interest in STEM is by involving them in STEM-based competitions. Events like robotics challenges and design contests motivate students to collaborate in problem-solving while fostering discussions on new ideas and research on emerging technologies, which broadens their knowledge and piques their interest.

The importance of Science, Technology, Engineering, and Mathematics (STEM) education in today's rapidly evolving world has become undeniable. As countries strive to enhance innovation and prepare students for future career opportunities, understanding students' perceptions of STEM subjects is crucial. This literature review synthesizes insights from three studies that explore students' and teachers' perceptions of STEM education in various educational contexts. Understanding students' perceptions of STEM education is essential for designing effective STEM curricula and teaching strategies. The reviewed studies emphasize that while students recognize the importance of STEM, they often face challenges in perceiving these subjects as accessible and relevant to their lives and future careers. By addressing these concerns through engaging, real-world learning experiences and providing better exposure to STEM career options, educators can help foster a more positive and sustained interest in STEM among students. Future research should continue to explore how different factors—such as age, cultural context, and exposure to role models affect students' perceptions of STEM education.

The Impact of STEM Activities on Students

The STEM project-based activities have been found to enhance students' understanding of programming after participating in a mentoring program. Additionally, STEM project-based activities significantly enhanced students' teamwork skills [3]. A study revealed that students felt STEM-based activities were fun and enjoyable, where the activities supported them to produce different ideas in their lessons [4]. The findings indicate that such activities can create a learning environment that enhances students' scientific creativity. Participants agreed that these activities helped them develop various skills. STEM learning not only educates students about science and technology but also encourages them to make thoughtful calculations, considering cost factors during projects. This focus on cost management indirectly boosts students' mathematical skills.

Students also highlighted that integrating the STEM concept provides them with insight into how scientists and engineers work, while also demonstrating how STEM principles are applied in daily life [5]. This approach promotes meaningful learning by encouraging students to engage with real-world contexts, which in turn enhances their Higher Order Thinking Skills (HOTS). The students in the study mentioned they gained greater confidence in learning scientific concepts as they see their real-life applications. Connecting STEM's core concepts to projects focused on biodiversity and ecosystem issues makes science learning more relevant and impactful.

Students' Perception of STEM: Challenges, Teacher Roles, and Career Perspectives

The study reveals that while students recognize the importance of STEM fields, they express concerns about their limited understanding of how the different disciplines within STEM are integrated. Teachers, however, stress the need to make STEM learning more relevant and engaging, noting that students often struggle with the abstract nature of scientific concepts. Both students and teachers agree that practical, hands-on learning experiences are essential for bridging the gap between theory and real-world application, helping to foster a more positive attitude toward STEM. To achieve this, effective teaching strategies—such as integrating different STEM disciplines and providing engaging, experiential learning—are vital for cultivating positive perceptions among students [6].

Perceptions of STEM vary significantly across educational stages. Younger students tend to show more enthusiasm and curiosity toward STEM subjects than the older students such as in students in universities and pre universities. As students advance through the educational system, however, they often develop negative attitudes toward STEM, driven by perceived difficulty and a lack of interest. The research highlights the crucial role that teachers and curricula play in shaping students' views, noting that ineffective STEM teaching strategies contribute to student disengagement. While students recognize the real-world applications of STEM subjects, they often find the content abstract and disconnected from their daily lives. Teachers, too, face the challenge of engaging students with practical, hands-on learning opportunities, which are known to significantly enhance motivation and comprehension [7].

Despite these challenges, students generally hold a positive view of STEM subjects, although many express concerns about career prospects in these fields. Many perceive STEM careers as highly demanding and requiring specialized skills they feel they lack. Interestingly, students who have exposure to STEM role models or participate in STEM-related extracurricular activities report a higher level of interest in pursuing careers in STEM. This suggests that practical exposure to STEM fields can play a crucial role in shaping students' perceptions and influencing their career choices [8].

METHODOLOGY

Research Design

This study employed a quantitative correlational research design to investigate the relationship between rural high school students' interest in STEM (Science, Technology, Engineering, and Mathematics) education and their perceptions of STEM learning environments. Correlational designs are appropriate for examining the strength and direction of associations between variables without manipulating them, thereby providing insights into naturally occurring relationships [9].

The study submitted the consent application to the Ethical Committee Board and the school principal to ensure confidentiality where data collected was solely for research purposes. The application was approved by the Ethical Committee of University Technology MARA (UiTM) with reference number REC/08/2024 (ST/MR/156). Additionally, approval was obtained from the District Education Office and the school principal. The participants were briefed on the purpose of data collection for the program conducted.

Participants

The study sample comprised 47 rural high school students from a selected school in Malaysia. Participants were chosen using purposive sampling, targeting students who had prior exposure to STEM-related subjects and activities. This sampling method ensures that the participants possess relevant experiences to provide meaningful responses regarding their interest and perceptions in STEM education [10].

Instrumentation

Data were collected using a structured questionnaire divided into two sections:

STEM Interest Scale (Items C1–C11): This section assessed students' interest in STEM subjects and activities.

STEM Perception Scale (Items D1–D11): This section evaluated students' perceptions of STEM education, including aspects such as relevance, engagement, and applicability.

Each item was rated on a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The use of Likert scales is common in educational research for measuring attitudes and perceptions due to their simplicity and ease of interpretation [11].

Data Collection Procedure

The questionnaires were administered during regular school hours to ensure a consistent environment for all participants. Participants were assured of the confidentiality and anonymity of their responses. The administration of the questionnaire was supervised by the researchers to address any queries and ensure completeness of responses.

Data Analysis

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 27. Descriptive statistics, including means and standard deviations, were calculated to summarize the responses for each item and overall scales.

To assess the normality of the data distributions for the STEM Interest and STEM Perception scales, the Shapiro-Wilk and Kolmogorov-Smirnov tests were employed. Both tests indicated that the data were approximately normally distributed ($p > 0.05$), justifying the use of parametric statistical analyses.

The Pearson correlation coefficient was utilized to examine the relationship between students' interest in STEM and their perceptions of STEM education. The analysis revealed a moderate positive correlation ($r = 0.575$, $p < 0.001$), suggesting that higher levels of interest in STEM are associated with more positive perceptions of STEM education.

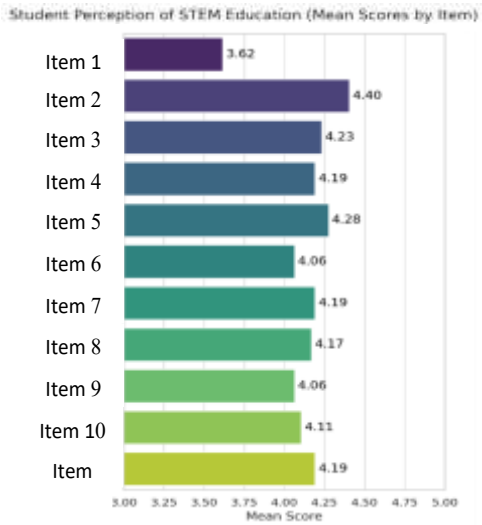
This methodological approach aligns with previous studies that have explored the interplay between students' interests and perceptions in STEM, emphasizing the importance of these factors in fostering engagement and motivation in STEM learning [12], [13].

FINDINGS

Students' Perception on STEM Education

Fig.1 shows the mean score of 11 items on student perception of STEM Education.

Fig. 1. Student Perception of STEM Education (Mean Score by Item)



Item 1: STEM courses are easy to learn.

The perception of ease in learning STEM courses yielded a moderate mean score of 3.62, with a relatively high standard deviation of 0.95. This variation suggests that while some students find STEM subjects accessible, others encounter challenges, potentially due to differences in prior knowledge, cognitive abilities, or teaching quality. As classrooms often include students with varied achievement levels and learning strategies, those with lower abilities may struggle with organizing information and applying effective learning methods[14]. To address this, shifting from traditional lectures to project-based learning can help all learners engage with STEM content more effectively.

Item 2: STEM courses are fun.

Students reported a high level of enjoyment in STEM subjects (mean = 4.40, SD = 0.77), reflecting positive engagement. Enjoyment plays a vital role in sustaining interest and motivation. Activities like coding, building prototypes, and creating products provide experiential learning that makes STEM concepts more appealing. These hands-on tasks activate multiple senses and encourage active participation, contributing to long-term retention and deeper understanding [14],[15]. This affirms the value of incorporating playful, creative, and interactive elements into STEM instruction.

Item 3: Group discussions with friends about STEM went well.

A mean score of 4.23 and a standard deviation of 0.89 show that students generally find peer discussions about STEM beneficial. These collaborative interactions support comprehension, critical thinking, and peer-to-peer learning. Group-based science projects—especially those centered on real-life problems—enhance the relevance and effectiveness of STEM education [16]. Such activities also cater to diverse learner needs, allowing students to leverage their social and communication skills in constructing knowledge together.

Item 4: The STEM course teacher's teaching is easy for me to understand.

With a mean score of 4.19 (SD = 0.71), students perceive their teachers' instruction as clear and comprehensible. This may reflect the successful implementation of effective teaching strategies that simplify complex STEM concepts. Continued professional development and training in inquiry-based, interdisciplinary pedagogies can further support teaching quality and ensure that lessons remain accessible to all students [17]. Educators are encouraged to combine traditional explanation with demonstrations, scaffolding, and questioning techniques that support diverse learning needs.

Item 5: Learning about STEM concepts is more fun through group activities.

The high mean score of 4.28 (SD = 0.88) for this item reinforces the importance of group-based learning. These activities not only make learning enjoyable but also promote essential 21st-century skills like collaboration, decision-making, and innovation. STEM learning becomes more meaningful when students work together on practical tasks that mirror real-world scenarios [17]. Group activities also allow for differentiated instruction, ensuring that learners of varying proficiency levels can contribute meaningfully based on their strengths and interests.

Item 6: STEM courses take into account my problem-solving skills.

Students perceive moderate acknowledgment of their problem-solving abilities (mean = 4.06, SD = 0.82). Incorporating real-world challenges and inquiry-based learning into the curriculum can improve this perception. Product creation and engineering tasks engage students in identifying problems, testing solutions, and iterating designs—core components of the engineering design process [15]. Emphasizing these processes more explicitly in lessons may help students recognize and develop their own problem-solving capabilities.

Item 7: STEM courses take into account my daily experiences.

A mean score of 4.19 (SD = 0.71) indicates that students find STEM content relevant to their everyday lives. Relating classroom content to familiar contexts enhances relatability and retention. Project-based learning that

utilizes materials and scenarios from students' environments fosters engagement and helps them see the real-world utility of STEM concepts [14]. Teachers should continue designing lessons that tap into students lived experiences, making abstract theories more tangible.

Item 8: STEM courses take into account concepts in technology and engineering

Students generally agree that STEM integrates concepts from technology and engineering (mean = 4.17, SD = 0.73), showing that the interdisciplinary nature of STEM education is being communicated effectively. To deepen this integration, activities should combine elements from science, mathematics, and technology within the framework of the engineering design process [15]. This approach supports students in understanding how various STEM domains work together to solve real-world problems.

Item 9: STEM courses take into account my ability to make decisions.

The mean score of 4.06 (SD = 0.84) shows that students moderately perceive decision-making opportunities in their STEM learning. Encouraging autonomy through open-ended tasks and student-led projects helps build confidence and self-regulation. Teachers must consider individual differences and provide structured choices within projects to support all learners in developing independent decision-making skills [16].

Item 10: STEM courses take into account understanding and analyzing problems logically.

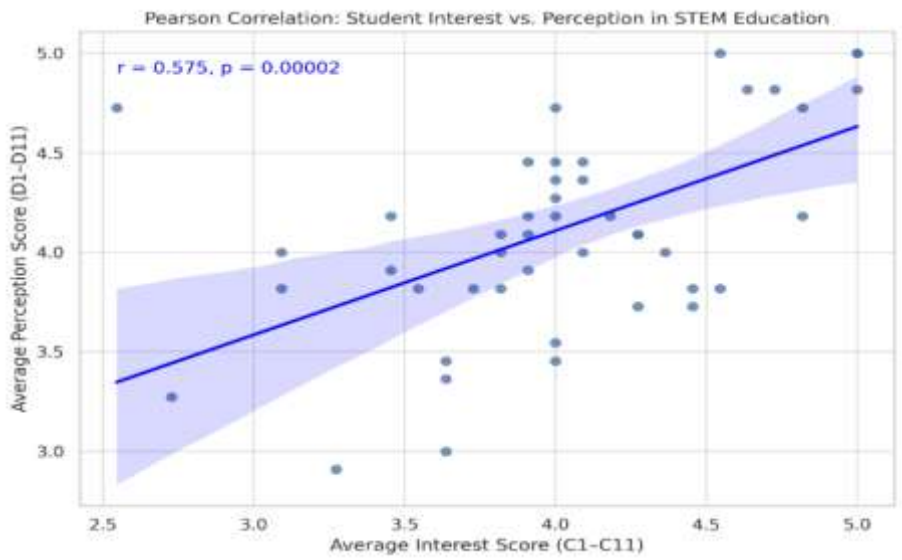
Logical reasoning is a key focus in STEM, with this item scoring a mean of 4.11 and a low standard deviation of 0.70, indicating consistent student agreement. Real-world problem-solving activities that require data analysis, pattern recognition, and hypothesis testing reinforce logical thinking. Embedding these cognitive skills into lessons not only strengthens understanding but also equips students with tools for lifelong learning in science and technology.

Item 11: STEM courses take into account the use of various media and learning resources.

A mean score of 4.19 (SD = 0.71) demonstrates positive student responses toward the use of diverse media. Videos, simulations, online platforms, and interactive tools cater to varied learning styles and make complex STEM content more accessible and engaging. Designing lesson plans that incorporate multimedia resources while aligning with pedagogical principles specific to STEM helps address students' diverse needs [15].

Relationship between Students' Interest in STEM and Their Perceptions of STEM Education

Fig. 2. Student Interest vs Perception in STEM Education



The Pearson correlation analysis conducted on the dataset revealed a statistically significant moderate positive relationship ($r \approx 0.575$, $p < 0.001$) between students' interest in STEM education (items C1–C11) and their perception of STEM education (items D1–D11) as shown in Fig.2. This finding underscores the interdependence between students' intrinsic interest and their evaluative perceptions of STEM learning environments.

Recent literature supports this association. For instance, scholars emphasized the role of academic hope and a sense of belonging in enhancing persistence among underrepresented STEM students, highlighting that positive perceptions can bolster sustained interest and engagement in STEM fields [18]. Similarly, elements such as student freedom, peer collaboration, and problem-solving opportunities within the classroom significantly influence students' perceptions of their STEM learning environment, which in turn can affect their interest and motivation [19].

Furthermore, students' perceptions of STEM professionals positively correlate with their career aspirations, suggesting that enhancing students' perceptions can lead to increased interest in pursuing STEM careers [20]. This aligns with the notion that students' interest and perception are mutually reinforcing factors in STEM education.

A critical viewpoint into STEM education context is by empirically linking the cultivation of 21st-century skills to enhanced student attitudes. When students are equipped with competencies such as critical thinking, collaboration, and creative problem-solving, their fundamental perception of STEM disciplines is transformed [21]. This moves the educational focus beyond the rote memorization of facts towards the development of practical, applicable abilities. Consequently, STEM subjects are demystified, transitioning from being perceived as abstract and difficult to being viewed as engaging and achievable.

This pedagogical approach fosters a sense of agency and confidence, which directly nurtures a more positive attitude and, subsequently, a deeper interest in pursuing STEM fields. For a nation aiming to build a technologically proficient workforce, this insight is profoundly significant. It advocates for a strategic integration of 21st-century skill development directly into STEM curricula, positioning it not as an adjunct but as a core component for fostering the next generation of innovators and problem-solvers.

Collectively, these findings highlight the importance of integrated educational strategies that simultaneously cultivate students' interest and positive perceptions of STEM. By creating supportive and engaging learning environments, educators can foster a virtuous cycle where increased interest enhances perception, which in turn further stimulates interest, leading to sustained engagement and success in STEM education.

CONCLUSION

This study aimed to investigate rural high school students' perceptions of STEM education and the relationship between these perceptions and their interest in STEM subjects. The findings revealed that students generally hold positive perceptions towards various facets of STEM education, including its enjoyable aspects, the benefits of collaborative learning through group discussions and activities, the clarity of teacher instruction, and the real-world relevance of STEM concepts. Notably, aspects perceived as moderately challenging or less acknowledged included the ease of learning STEM courses and the extent to which STEM courses considered students' problem-solving and decision-making skills.

Crucially, a significant moderate positive correlation ($r = 0.575$, $p < 0.001$) was identified between students' overall interest in STEM and their perceptions of STEM education. This finding underscores the critical interplay between how students experience and perceive their STEM learning environment and their intrinsic interest in these fields. Positive perceptions—shaped by engaging content, effective pedagogy, and connections to real-world applications—appear to be strongly associated with higher levels of student interest. This aligns with existing literature emphasizing that supportive, relevant, and collaborative learning environments enhance student motivation and engagement in STEM.

The implications of these findings are significant for educators, curriculum developers, and policymakers. To foster greater interest and participation in STEM, efforts should focus on cultivating positive perceptions by:

1. **Enhancing Engagement:** Continuing to integrate enjoyable, hands-on, and project-based activities that make learning active and fun.

2. **Promoting Collaboration:** Leveraging group work to facilitate peer learning and develop teamwork skills.

3. **Ensuring Pedagogical Clarity:** Supporting teachers in delivering comprehensible instruction that makes complex STEM concepts accessible.

4. **Highlighting Relevance:** Explicitly connecting STEM content to students' daily lives, real-world problems, and technological/engineering applications.

5. **Developing Core Skills:** More overtly integrating and acknowledging opportunities for students to develop and apply problem-solving and decision-making skills within STEM activities.

While this study provides valuable insights within a Malaysian rural high school context, future research could expand upon these findings by exploring larger and more diverse student populations, investigating the long-term impact of specific pedagogical interventions on both perceptions and interest, and examining how factors like teacher preparedness and resource availability mediate this relationship.

In summary, fostering positive perceptions through thoughtfully designed and engaging STEM education is a key strategy for nurturing student interest, which is essential for developing a future generation equipped to tackle complex interdisciplinary challenges and contribute to innovation.

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