

Investigating STEM Interest and Its Relationship with Academic Success among Urban Secondary School Students

Nur Nazirah Mohd Farid¹, Zarith Sofiah Othman^{2*}

¹Faculty of Education, Universiti Teknologi MARA, Cawangan Selangor, Kampus Puncak Alam, 42300 Puncak Alam, Selangor, Malaysia

²Centre of Foundation Studies, Universiti Teknologi MARA Cawangan Selangor, Kampus Dengkil, Selangor, Malaysia

Authors' Email Address: ¹nzrhfarid01@gmail.com, ^{2*}zarithsofiah@uitm.edu.my

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*Corresponding Author

ABSTRACT

In today's rapidly evolving technological landscape, fostering interest in Science, Technology, Engineering, and Mathematics (STEM) among secondary school students has become increasingly critical. STEM-related careers are projected to lead future job markets, yet many students exhibit low confidence or limited motivation to pursue these fields, especially in secondary education. Although previous studies have explored general attitudes toward STEM, there is limited research focusing on how students' demographic factors and interest levels correlate with academic performance, particularly in urban school locations. The study aims to determine students' interest level in STEM courses against demographic profiles, such as gender and grades in STEM subjects, and to explore the relationship between their interest and academic performance. A questionnaire was distributed to 53 secondary school students from urban schools in Selangor, Malaysia. Key opinion indicators are on a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Descriptive analysis and correlation analysis were performed using SPSS software. The results show that most respondents preferred STEM, believed studying the field is essential for the future, and will succeed in learning it. The results also indicate that instructional methods, real-world examples, and parental support helped students become more interested in STEM. The study implies that curriculum interest was significant to the respondents but had a statistically insignificant correlation to their performance. The study suggests additional support is needed to sustain students' confidence and interest in STEM classes.

Keywords: academic performance, secondary school student, STEM education.

INTRODUCTION

Background of Studies

In the current era of globalization and rapid technological innovation, fostering children's interest and proficiency in science, technology, engineering, and mathematics (STEM) explicitly analyzes information, thinking, and enhancing problem-solving abilities (Choi, 2024). STEM education is important as a foundation for tackling 21st-century problems, as highlighted in the Malaysia

Education Blueprint 2013 to 2025 (Othman et al., 2020). The century has witnessed the development of diverse technologies ranging from artificial intelligence to renewable energy sources rooted in STEM principles and knowledge. STEM education has also gained recognition for improving student learning outcomes, increasing employability in STEM-related fields, and contributing to national economic competitiveness (Othman et al., 2024; Idris et al., 2023). However, despite the growing emphasis on STEM, challenges remain in ensuring equitable participation among secondary students, particularly in urban areas.

Many factors and complications determine students' motivation, interests, and aspirations. Those include STEM instruction quality, peer and family encouragement, their relation to STEM in daily life, and the availability and visibility of STEM mentors (Honey et al., 2014). Othman et al. (2021) discovered that early intervention and creative approaches foster students' interest in STEM. Integrating STEM elements promotes learning engagement and is relevant for students. Hence, it is crucial to nurture STEM engagement early to sustain interest at a higher level. Urban areas, known as centers for commerce, technology, and innovation, present unique opportunities for STEM education due to their advanced infrastructure and diverse populations. However, these same environments often expose students to disparities in access to resources, mentorship, and quality instruction (Vasquez Heilig et al., 2012). In Malaysia, urban secondary schools face similar challenges where, despite proximity to resources, gaps persist in student engagement, interest, and enrollment in STEM-related subjects.

Chuan et al. (2021) examined the factors influencing the enrollment of 389 Form Four students in Additional Mathematics across four urban national secondary schools. The study identified self-efficacy, teacher influence, parental influence, and peer influence as the key educational disciplines significantly impacting students' decisions to enroll in the subject. However, Riduan and Othman (2024) pointed out that even in urban areas, STEM education is ineffective due to issues like a lack of STEM role models, a lack of opportunities for experiential learning, and uneven parental involvement. These challenges can demotivate students and discourage them from pursuing STEM pathways, even in urban settings with abundant resources.

In addition, how well students do in STEM subjects is still a key indicator of their engagement, skill development, and future STEM-related career options. Studies have shown that students who are more interested and motivated tend to do better in STEM subjects (Wang & Degol, 2013; Chen et al., 2023). But in Malaysia's urban secondary schools, there is a gap between how interested students are in school and how well they do in school. This could hurt the country's efforts to build a competitive, technology-driven workforce. Therefore, this study aims to explore the factors that facilitate effective STEM learning among urban secondary school students, which is crucial to addressing these gaps. By understanding the specific influences on students' STEM engagement within urban contexts, educators and policymakers can craft precise lessons and support that keep students curious and active in labs, codes, and careers in STEM fields. Without such interventions, urban schools will waste their assets and fall short of giving Malaysia the skilled graduates needed to push technological and economic advancement.

There are three research questions for this study, which are:

1. How interested are urban students in STEM subjects?
2. What are the factors that affect students' interest towards STEM in urban areas?
3. What is the relationship between STEM interest and academic performance of students in urban areas?

There are three research objectives of this study as follows:

1. To investigate the students' interest towards STEM in urban areas.
2. To examine the factors affecting students' interest towards STEM in urban areas.
3. To analyze the relationship between STEM interest and academic performance of students in urban areas.

Conceptual Framework

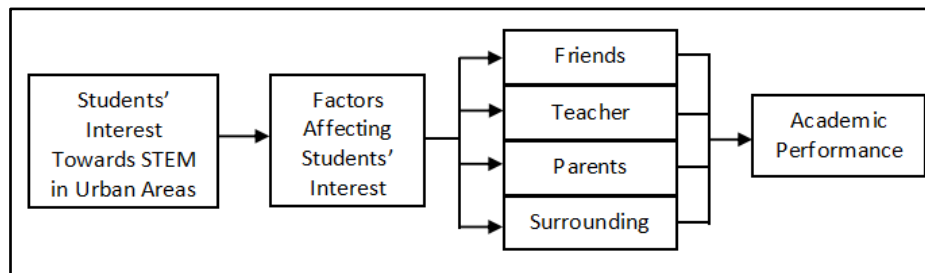


Figure 1: Conceptual Framework for Students' Interest Towards STEM in Urban Areas
(Adapted from Archer et al., 2014; Chuan et al., 2021)

The conceptual foundation for this research is illustrated in Figure 1. The framework explores urban secondary school students' interest in STEM by examining whether they enjoy studying STEM at school. Four factors influencing learning interest were identified in prior research (Archer et al., 2014; Chuan et al., 2021) and adopted in the study to examine the relationship between students' academic achievement and their interest level. These factors include exploring classroom experiences, the role of mentors and role models, the influence of families, and socioeconomic conditions. They may enhance or impede the cultivation of STEM interest among students in urban settings, as determined by understanding the complexities surrounding STEM interest in urban areas.

Factors Influencing STEM Interest

The increasing demand for STEM-related professions has made the field a priority for educators, policymakers, and researchers. STEM disciplines are recognized as dynamic and steadily evolving, offering promising career opportunities. Understanding the factors influencing students' decisions to pursue STEM professions is essential to prepare them for future challenges. Many studies have identified various influences on students' STEM interests, including academic experiences, family dynamics, teacher or faculty support, peer interactions, and media representation. Eccles and Wigfield (2002) highlighted that parental, peer, and teacher aspirations shape students' expectations of their abilities and the perceived value of STEM subjects. Furthermore, hands-on engagement with STEM tools enhances students' connection to and interest in these subjects. Media and popular culture also play pivotal roles in shaping perceptions of STEM. Negative portrayals often portray STEM as monotonous and lacking creativity, deterring students from exploring the field (Chen et al., 2023). Conversely, showcasing successful STEM professionals and innovations through positive media representation can inspire students to pursue STEM careers (Chen et al., 2023).

Teachers, particularly those instructing Mathematics and Science, are critical in influencing students' interest in STEM. Effective teaching of the subjects can positively affect post-secondary students' decisions to pursue STEM disciplines (Zhao & Perez-Felkner, 2022). Those who develop a strong interest in Mathematics and Science will likely opt for STEM-related careers. Additionally, awareness campaigns and seminars are crucial in promoting STEM education and inspiring students to engage in these fields. Khan et al. (2024) highlighted the importance of such initiatives in raising awareness and interest in STEM. Parental influence and support from community members are also vital. Encouraging participation, funding, and inspiration from these sources can significantly impact students' willingness to pursue STEM fields (Nguyen et al., 2024).

RESEARCH METHODOLOGY

This study identified the factors that minimize or enhance students' interest in STEM and the correlation of interest with academic performance, focusing on those from urban areas. It employed a quantitative and inferential statistical approach, as a survey instrument is useful and effective for gathering data. It enables the collection of responses from a sizable sample, which facilitates the investigation of correlations, trends, and/or the interactions between variables (Babbie, 2021).

A systematic sampling method ensured diversity in gender, ethnic background, and academic achievement. The study included 53 students who were 16 years old from an urban secondary school in Malaysia. This school was chosen for its diverse student population, which reflects typical urban educational settings. All students aged 16 and enrolled in STEM-related subjects (physics, chemistry, mathematics, additional mathematics) were selected. The systematic sampling involved selecting students from class lists based on a fixed interval, ensuring representation from different genders, ethnic groups, and academic performance bands. This approach minimizes selection bias and enhances the generalizability of the findings. The final sample size of 53 students aligns with Krejcie and Morgan's (1970) recommendations for determining sufficient sample sizes to yield statistically relevant results for social science research, based on the school's total student population. The structured questionnaire consists of four sections:

1. Part A: Demographic Profile – incorporates basic demographic data about the participants with an emphasis on gender and grade for STEM subjects such as physics, chemistry, mathematics, and additional mathematics,
2. Part B: Interest in STEM – measures students' interest level, belief, and self-efficacy on STEM subjects using a Likert scale (1 for strongly disagree to 5 for strongly agree). The section includes ten (10) items to evaluate students' enjoyment and expectations in STEM education.
3. Part C: Factors Influencing STEM Interest – explores the factors affecting students' interests, such as teaching strategies, parental encouragement, extracurricular activities, and role models. The section includes ten (10) items to examine relevant factors.
4. Part D: Relationship between STEM Interest and Academic Performance – investigates the correlation between interest in STEM and academic performance. The section comprises ten (10) items and one (1) open-ended question to gauge additional insight into STEM's influence on grades.

The survey is based on established research in STEM motivation and performance (Archer et al., 2014; Chuan et al., 2021), providing structured data to support the study's goals. A pilot test was conducted to ensure reliability and validity (mathematics, chemistry, physics, and additional mathematics). The instrument's reliability was assessed using Cronbach's alpha, which provided a measure of internal consistency for the sections, as shown in Table 1.

Table 1: Reliability Statistics

Sections	Cronbach's Alpha	Number of Items
All (Part B, C, and D)	0.940	30
Part B: Student's interest in STEM	0.869	10
Part C: Factors Influencing STEM Interest	0.815	10
Part D: Relationship between STEM Interest and Academic Performance	0.804	10

The results indicate strong reliability: Part B (STEM Interest) scores 0.869, Part C (Factors Affecting Interest) scores 0.815, and Part D (Relationship with Performance) scores 0.804. The values suggest acceptable reliability, making the questionnaire a robust tool for the study. The study followed standard ethical guidelines for research with students below 18 years old. Respondents were completely voluntary, and researchers promised that each student's identity would remain confidential. Before

taking part, students will ask permission from their parents or guardians to sign the approval form. All collected data were stored securely and used exclusively for academic research purposes.

RESULTS AND DISCUSSION

Demographic Profile

Table 2: Demographic Distribution of Students by Gender

Demographic Variable	Category	Percentage
Gender	Male	41.5%
	Female	58.5%

Table 2 shows the distribution of respondents' gender. Based on the data collected, the number of female respondents is larger than that of males. A total of 31 (58.5%) of the respondents are female. Meanwhile, another 22 (41.5%) of the respondents are male.

Table 3: Demographic Distribution of Students by Grades in STEM Subjects

Subjects	A	B	C	D	E	G
Physics	5.7%	18.9%	22.6%	11.3%	13.2%	28.3%
Chemistry	17.0%	17.0%	22.6%	15.1%	5.7%	22.6%
Mathematics	26.4%	26.4%	20.8%	15.1%	11.3%	0.0%
Additional Mathematics	1.9%	11.3%	13.2%	18.9%	22.6%	32.1%

Table 3 shows the demographic distribution for STEM grades in Physics, Chemistry, Mathematics, and Additional Mathematics. The first is for Physics, with the highest grades being C and G for 12 (22.6%) students, and the lowest is A with 3 (5.7%) students. Meanwhile, other grades are G with 15 (28.3%) students, B with 10 (18.9%) students, E with 7 (13.2%) students and D with 6 (11.3%) students. The second is for Chemistry, with the highest grades being C and G with 12 (22.6%) students, and the lowest is E with 3 (5.7%) students. Meanwhile, other grades are A and B, with 9 (17%) students, and D, with 8 (15.1%) students. Third, the highest grades gained in Mathematics are A and B for 14 (26.4%) students, which means students are excellent in Mathematics, and a large percentage performed well. This is followed by grade C with 11 (20.8%) students, which gives the impression of an average performance. The next grade is D with 8 (15.1%) students, which shows poor performance but still not a failing grade. Lastly, the lowest grade in the distribution is for 6 (11.3%) students. Finally, only 1 (1.9%) student attained an A in Additional Mathematics, which signifies a high level of learning. Following this, 6 (11.3%) students obtained a B, 7 (13.2%) students gained a C, and 10 (18.9%) students got a D. A total of 12 (22.6%) students scored an E for the subject. As expected, the highest frequency is for grade G, with 17 (32.1%) students.

Specifically, most students scored lower in Chemistry and Physics. The grades for Mathematics are distributed relatively between A and E, but the highest frequency is at A. Additional Mathematics has a relatively high pass rate, with many students not performing well, resulting in G. The results provide knowledge about the average grade of each subject and possible problems students experienced or improvements in the curriculum.

Student's Interest in STEM

Table 4 tabulates the responses of ten items from Part B related to interest in STEM subjects according to mean and standard deviation.

Table 4: Students Interest in STEM Subject

Items	Mean	Std. Deviation
I like to learn subjects in STEM at school.	3.66	0.831
I feel excited to study STEM subjects.	3.66	0.807
I enjoy exploring topics related to STEM outside the classroom.	3.75	0.998
I find STEM subjects interesting and fun to learn.	3.91	0.791
I am confident in my abilities to excel in STEM subjects.	3.30	0.845
I think my interest in STEM subjects has grown over the past year.	3.49	0.973
I think STEM is important for my future.	4.09	0.883
I think that understanding STEM is important in today's world.	4.15	0.907
I think my school really encourages me to like STEM.	3.64	0.879
I like participating in STEM-related extracurricular activities.	3.45	1.066

The results show the highest mean is 4.15 for the item "I think that understanding STEM is important today", showing students' agreement with the statement. The second highest mean score is 4.09 for the item, "I think STEM is important for my future", indicating acceptable perceived relevance of STEM to their future careers. Meanwhile, the lowest mean score is 3.30 for "I'm confident in my abilities to excel in STEM subjects", demonstrating that students lack confidence regardless of STEM significance. The results of middle-ranked items are slightly below the mean that students' interest is moderate but not overtly enthusiastic: "I think my interest in STEM subjects has grown over the past year" and "I like participating in STEM-related extracurricular activities", with an average mean of 3.45. Standard deviations for the items vary from 0.791 to 1.066, with the highest response variability for extracurricular activities (SD = 1.066) and the lowest for "I find STEM subjects interesting and fun to learn" (SD = 0.791).

Students' attitudes towards STEM are significant because most advanced jobs and societal development require STEM education. As evident from the high mean scores, students appreciate the role of STEM today and its applicability to their lives. However, the moderate enjoyment computed for the STEM topics outside the classroom indicates constraints. They include eliminating resources or STEM activities to improve the learning experience (Beede et al., 2011). Although students appreciate STEM, they may not feel prepared to perform well academically. Mentoring initiatives, practical assignments, and rewards that enhance student confidence are the tactics effective in promoting sustained engagement in STEM fields. However, presenting relevant role models and examples of STEM success stories is applicable for boosting self-belief.

It is essential to design effective learning environments due to students' low-level interaction and limited exploration of STEM-related extracurricular activities. Schools should liaise with organizations and institutions in the local society to ensure that students get practical experience and internships in STEM-related fields. The exposure enhances students' interest and confidence in STEM learning activities. Despite the positive attitude among students from the urban areas towards STEM, it is unanimous, in the given context, that self-efficacy needs to be improved, and optimum learning environments with adequate resources should also be provided. Thus, addressing the issues heightens interest and success in STEM disciplines in the long run, thereby improving the strength of the STEM workforce.

Factors Influencing STEM Interest

Table 5 highlights the students' responses in Part C regarding the factors affecting students' interest in STEM in urban areas.

Table 5: Factors Affecting Students' Interest in STEM in Urban Areas

Items	Mean	Std. Deviation
I feel that the teaching method in my STEM class influenced my interest in the subject.	3.98	0.888
I find my STEM classes engaging.	3.68	0.803
I would rate my STEM teachers as:	3.83	0.700
Extracurricular activities play a role in my interest level in STEM.	3.81	1.001
There are real-life role models in STEM who inspire me.	3.94	0.842
My parents support my interests in STEM.	4.30	0.822
I receive enough support from my school in pursuing STEM interests.	3.70	0.868
I think gender stereotyping impacted my interest in STEM.	2.48	1.321
The availability of STEM resources is important to my interest.	3.75	0.806
I think the encouragement of my peers has fostered my interest in STEM.	3.64	0.1076

The results show that the highest mean score is 4.30 for "My parents support my interests in STEM", highlighting the crucial role of parental support. The second highest mean value is 3.98 for "I feel that the teaching method in my STEM class influenced my interest in the subject", proving that teaching methods are influential. Meanwhile, the lowest mean score is 2.48 for "I think gender stereotyping impacted my interest in STEM", showing that most do not feel gender stereotyping influences their interest level in STEM. The other responses are "I receive enough support from my school in pursuing STEM interests" with a mean value of 3.70, and "Extracurricular activities play a role in my interest level in STEM" with a mean value of 3.81. The results indicate a moderate level of extracurricular activities' influence. The standard deviations vary from 0.700 to 1.321, with the highest for gender stereotyping (SD = 1.321), indicating differing opinions, and the lowest for STEM teachers (SD = 0.700), demonstrating a more uniform perception of their teachers.

Parental support affects the interest in Science and Mathematics, confirming that family encouragement has a substantial influence on students' choices and subsequent career paths (Wang & Degol, 2013). Consequently, parents should be provided with resources to nurture children's interest in STEM. Those resources can include workshops, training, and information-sharing sessions for parents about STEM education, its importance, and values. Effective teaching approaches and exciting classroom environments are also essential, establishing teacher preparation and pedagogy reformation within the umbrella of STEM education (Zhu, 2020). Teachers who could develop an interest in and relate the subject with STEM could considerably influence students' attitudes toward the subject areas. At this level, professional development in active learning with information technology and project-based learning experiences may help.

The perceived low impact on gender stereotyping may elucidate the emergent improvement toward gender equality, but ongoing efforts should be promoted to advance equity in STEM sectors (Master et al., 2017). Although the mean score is relatively low, the student's responses imply that they do not experience gender stereotypes as life-altering in daily interactions, yet it should be fostered proactively. Other measures, such as female role models and prejudice in STEM, can expand gender equality in STEM education. In summary, despite the importance of parental encouragement and practical instruction in promoting interest in STEM subjects, continuous gender inclusiveness, and real-life mentors are needed to maintain healthy competition between boys and girls in schools. A comprehensive look at the issues should enhance the involvement and enthusiasm among students studying STEM subjects.

Relationship Between STEM Interest and Academic Performance Students in Urban Areas

The Pearson correlation coefficient analysis test is appropriate for determining STEM interest and academic performance because it measures the extent of the linear relationship between two metric

variables (Gravetter & Wallnau, 2017). The method has been used often in educational research to understand the nexus of core academic variables (Sedgwick, 2012).

Table 6: Pearson Correlation Between Students' Interest in STEM (Mean Value Part B) and Academic Performance (Mean All Grades)

		Mean Part B	Mean All Grades
Mean Part B	Pearson Correlation	1	-.080
	Sig. (2-tailed)		0.568
	N	53	53
Mean All Grades	Pearson Correlation	-.080	1
	Sig. (2-tailed)	0.568	
	N	53	53

Table 6 shows the Pearson correlation between students' interest in STEM (Mean Value Part B) and academic performance (Mean All Grades) is -0.080, revealing a weak negative relationship. The p-value (Sig. 2-tailed) is 0.568, more significant than the typical significance level of 0.05. This indicates that the relationship is not statistically substantial. The weak correlation between STEM interest and academic results is in accord with research findings that show that even though interest plays a critical role in motivation and participation, it does not always reflect academic achievement (Renninger & Hidi, 2015). Such a difference indicates that students can be motivated towards STEM education but lack academic achievement in the relevant subjects, proving that academic performance is complex. Thus, characteristics such as quality of teaching, learning, and learning assessment may significantly impact performance.

It shows that while interest is imperative to learning, it may not portray a complete picture of academic achievement. Aside from the students, teaching and other factors influence student learning, including teacher quality, classroom environment, students' background characteristics, and educational opportunities (Wentzel & Miele, 2016). Schools must serve resources for those purposes, and provide efficient support systems to learners with learning disabilities. However, students' learning outcomes imply that introducing interventions that address academic achievement deficits should target various aspects of students' functioning. It involves sparking curiosity in each subject, helping students acquire the necessary knowledge and skills, proactively supplying them with the necessary tools, and ensuring their emotional well-being. Programs incorporating social and emotional learning with the academic curriculum may foster resilience and improve academic performance.

As these factors are complex, it is only possible to develop an approach that can positively impact student learning and extra-curricular development. Some of the programs developed in the schools include an academic support program, a mentoring program, and a program on student counselling. Working with families and communities provides care for learners, which can positively impact academic performance. Thus, as critical as students' interest in STEM is, it is not the only factor determining student performance. A comprehensive strategy aiming at several factors affecting performance is obligatory to ascertain students' potential in STEM.

CONCLUSION

This study investigated the interest of urban secondary school students in Science, Technology, Engineering, and Mathematics (STEM), the factors influencing their interest, and the relationship between that interest and academic performance. The findings indicate that students generally have a positive perception of STEM and recognize its importance for the future. Key factors such as effective instructional strategies, parental encouragement, and exposure to real-world applications were found to enhance their interest. However, the study also indicated that there is a weak and statistically non-significant association between students' school performance and their interest in STEM. That means

interest alone is not always sufficient for better academic achievements. The significance of this study lies in its contribution to understanding the dynamics of STEM engagement among urban students. It provides valuable insights for educators, school administrators, and policymakers to design more targeted and effective strategies that foster sustained interest and participation in STEM fields, especially within urban educational contexts where resource disparities and varying support systems exist.

This study contributes to understanding how urban students engage with STEM and offers practical insights for improving STEM education in schools facing resource disparities. The following recommendations should be taken into consideration to improve the results of the study for future research. First, the number of participants and the range of participants should be expanded to provide a better understanding of the extent of students' inclination toward STEM. The enrolment of students from various settings, including urban, suburban, and rural areas, can explain geographical and socioeconomic diversity peculiarities. Second, the quantitative method can complement the qualitative methods, such as interviews or focus groups, to receive more extensive data. It enables future researchers to probe into students' thoughts and feelings about STEM, and their level of interest in the subject matter. By following the recommendations, future studies will provide more insightful and accurate results to develop strategies to increase students' interest and achievements in STEM.

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Mohd Farid, N. N. conceived and planned the experiments and carried out the experiments and carried out the simulations. Othman, Z. S. contributed to the interpretation of the results and took the lead in writing the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript.

CONFLICT OF INTEREST DECLARATION

I/We certify that the article is the Authors' and Co-Authors' original work. The article has not received prior publication and is not under consideration for publication elsewhere. This research/manuscript has not been submitted for publication, nor has it been published in whole or in part elsewhere. We testify to the fact that all Authors have contributed significantly to the work, validity and legitimacy of the data and its interpretation for submission to Jurnal Intelek.

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