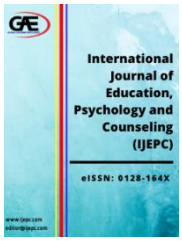
International Journal of Education, Psychology and Counseling
IJEPC
EISSN : 0128-164X
Volume 10 Issue 57 (March 2025) PP. 756-764
DOI 10.35631/IJEPC.1057049



INTERNATIONAL JOURNAL OF EDUCATION, PSYCHOLOGY AND COUNSELLING (IJEPC)
www.ijepc.com

IMPACT OF ENGAGEMENT WITH STEM PROFESSIONALS ON SECONDARY SCHOOL STUDENTS' ATTITUDES TOWARDS SCIENCE AND MATHEMATICS – A CASE STUDY IN KUALA MUDA, KEDAH

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Article Info:

Article history:
Received date: 14.01.2025
Revised date: 23.01.2025
Accepted date: 27.02.2025
Published date: 20.03.2025

To cite this document:

Nasir, I. N. M., Samsudin, S. S., Sufter, N. S. M., & Ahmad, R. (2025). Impact Of Engagement With STEM Professionals On Secondary School Students' Attitudes Towards Science And Mathematics – A Case Study In Kuala Muda, Kedah. *International Journal of Education, Psychology and Counseling, 10* (57), 756-764.

DOI: 10.35631/IJEPC.1057049

Abstract:

This study explores the impact of engagement with STEM professionals on the academic performance and students' attitudes toward science and mathematics in Kuala Muda, Kedah. Data were collected through surveys assessing academic performance, attitudes on a 5-point Likert scale, and levels of interaction with scientists, engineers, mathematicians, and technologists. Results indicate that students demonstrated more positive attitudes toward science (mean = 3.67) than mathematics (mean = 3.42). A significant proportion of students rated their academic performance in mathematics and science as "mediocre," with both subjects lagging English. Engagement with engineers positively influenced attitudes toward science ($p = 0.008$), while interactions with scientists ($p = 0.001$), mathematicians ($p = 0.035$), and technologists ($p = 0.027$) significantly enhanced attitudes toward mathematics. These findings underscore the importance of involving STEM professionals as mentors to foster positive attitudes and improve academic outcomes in STEM disciplines. Future research should investigate the long-term effects of such engagements and explore targeted strategies to maximize their impact.

Keywords:

STEM Professionals, Attitude Towards Science And Mathematics, STEM Engagement, Secondary School Students

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Introduction

STEM education encompasses Science, Technology, Engineering, and Mathematics, fostering critical thinking, problem-solving, and innovation skills crucial for addressing global challenges (National Science Foundation, 2023). Engaging students with STEM professionals provides invaluable real-world experiences, inspiring interest, and cultivating positive attitudes towards STEM disciplines (Han et al., 2021). This interaction fosters a deeper understanding of STEM careers and their societal impact, motivating students to pursue STEM-related fields and contribute to advancements in science and technology (American Association for the Advancement of Science, 2021).

Student engagement in STEM subjects, particularly mathematics and science, is a significant concern during the critical transition from primary to secondary education. Research consistently indicates that student interest, motivation, and participation in these core academic areas can decline markedly during this pivotal period, which has far-reaching implications for students' academic achievement, career aspirations, and future engagement with STEM fields. (Skilling et al., 2020). This troubling trend is especially pronounced among underrepresented groups, including women, ethnic minorities, and students from low socioeconomic backgrounds, further limiting the diversity of the STEM pipeline and workforce.

One potential approach to addressing the issue of declining student engagement in STEM subjects during the transition to secondary education is through increased engagement with STEM professionals. (Holmes et al., 2021). This strategy is based on the premise that exposure to enthusiastic and knowledgeable STEM experts can help to foster positive attitudes and inspire students to pursue further study and careers in these areas. By highlighting the relevance and excitement of STEM fields, interactions with STEM professionals can potentially counteract the decreases in self-efficacy, self-concept, and overall motivation that are often observed among students during this critical period of transition. The underlying rationale is that engaging with STEM professionals can help students better understand the practical applications and real-world significance of science, technology, engineering, and mathematics, which may in turn enhance their engagement and interest in these subjects (Hiğde & Aktamış, 2022). Additionally, STEM professionals can serve as role models, demonstrating the diverse career paths and opportunities available in these dynamic and impactful fields. By exposing students to this range of possibilities, this approach aims to broaden their perspectives and inspire them to consider STEM-related educational and professional pursuits.

Literature Review

The transition from primary to secondary education is a critical period that often coincides with declines in student engagement, self-efficacy, and motivation in key subjects such as mathematics and science (Ryan et al., 2022). This period is particularly significant because it can shape students' academic trajectories and career aspirations. Research consistently highlights the role of motivational, emotional, and social factors in influencing learning outcomes, emphasizing the need for effective interventions to counteract these declines (Skilling et al., 2020).

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Engagement with STEM professionals has emerged as a promising strategy for addressing these challenges. Studies have shown that interactions with scientists, engineers, mathematicians, and technologists can enhance students' understanding of STEM disciplines, demystify complex concepts, and inspire interest in STEM careers (Holmes et al., 2021). Such engagements allow students to see the practical applications of STEM knowledge, thereby fostering a sense of relevance and purpose in their learning. Moreover, STEM professionals can serve as role models, challenging stereotypes and broadening students' perspectives on career possibilities in these fields (Gamse et al., 2016).

The nature and frequency of these interactions play a significant role in their effectiveness. Sustained engagement, as opposed to one-off events, has been shown to yield more meaningful impacts. Repeated interactions provide students with opportunities to build connections, ask questions, and develop a nuanced understanding of STEM careers and disciplines (Hiğde & Aktamış, 2022). This approach not only enhances students' attitudes and interest in STEM but also cultivates critical thinking, problem-solving, and innovation skills, which are essential for future success in STEM fields (American Association for the Advancement of Science, 2021).

Despite these benefits, disparities in STEM engagement persist, particularly among underrepresented groups such as women, ethnic minorities, and students from low socioeconomic backgrounds. These groups are less likely to pursue STEM-related pathways, contributing to the underrepresentation of diverse talent in STEM fields (Holmes et al., 2021). Addressing these disparities requires targeted strategies that leverage the unique strengths of STEM professionals to inspire and motivate students from diverse backgrounds.

Furthermore, the impact of STEM engagement extends beyond academic achievement. A review of initiatives designed to raise interest and participation in STEM fields found that a holistic approach—including teacher professional development, hands-on learning experiences, and formative assessments—can significantly enhance student outcomes (Meester et al., 2020). Integrating STEM professionals into these initiatives can further enrich the learning experience by providing real-world context and inspiring students to explore STEM careers (Archer et al., 2021).

In conclusion, the existing literature underscores the importance of engaging students with STEM professionals as a means of fostering positive attitudes, enhancing academic performance, and inspiring interest in STEM careers. To explore the potential impact of engagement with STEM professionals on secondary school students' attitudes towards science and mathematics, this study employs a quantitative data collection and analysis.

Methodology

This study employed a quantitative approach to investigate the relationship between student engagement with STEM professionals and their attitudes towards science and mathematics. Data were collected through a survey administered to a sample of 121 secondary school students (Form 3) in Kuala Muda, Kedah using convenience sampling. The students were involved in a special program conducted under STEM program at UiTM Kedah. The study is framed as a case study specific to Kedah, not representative of all secondary students in Malaysia. The survey included questions about students' interactions with various STEM professionals (scientists, engineers, mathematicians, and technologists) and their attitudes towards science and math, measured using Likert-type scales.

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Instrument

This study employed the Student Attitudes toward STEM survey, developed by the Friday Institute for Educational Innovation (2012), to assess high school students' STEM attitudes. Specifically, the Middle/High School Student level version of the S-STEM survey, comprising six sections, was utilized. The first three sections gauge student attitudes towards mathematics, science, engineering, and technology, respectively. The fourth section assesses students' self-perceived 21st-century learning skills. The fifth section explores student interest in STEM careers across 12 different areas, utilizing a four-point Likert-type scale (1=Not at all interested to 4=Very interested). Finally, the sixth section (not described in detail in the provided text) presumably addresses additional aspects of STEM attitudes. For the first four sections, a five-point Likert-type scale, ranging from "strongly disagree" to "strongly agree," was employed. However, this study only focuses on the attitude towards Science and Mathematics and student interest in STEM careers.

Descriptive Statistics

Descriptive statistics were employed to characterize the study sample and provide a summary of the collected data. To understand the distribution of student engagement with STEM professionals, frequencies and percentages were calculated for each type of professional (scientists, engineers, mathematicians, and technologists). This analysis provided insights into the prevalence of interactions between students and various STEM fields. Furthermore, to assess student attitudes towards science and mathematics, means and standard deviations were computed. These descriptive measures offer a clear picture of the average attitudinal scores and the variability of responses within the student sample. The use of both frequencies and descriptive statistics for attitudes allows for a comprehensive understanding of the sample characteristics and the overall trends in student engagement and perceptions of STEM fields.

Test of the Independent (T-Test)

T-tests were conducted to determine the statistical significance of the relationship between engagement with STEM professionals and attitudes toward science and mathematics. Specifically, four separate t-test were performed:

1. ***Scientist Engagement and Attitudes Towards Science and Mathematics:*** This t-test tested for significant differences in attitudes between students who had engaged with scientists and those who had not.
2. ***Engineer Engagement and Attitudes Towards Science and Mathematics:*** This t-test tested for significant differences in attitudes between students who had engaged with engineer and those who had not.
3. ***Mathematician Engagement and and Attitudes Towards Science and Mathematics:*** This t-test tested for significant differences in attitudes between students who had engaged with mathematician and those who had not.
4. ***Technologist Engagement and and Attitudes Towards Science and Mathematics:*** This t-test tested for significant differences in attitudes between students who had engaged with technologist and those who had not.

The alpha level for all statistical tests was set at 0.05. All statistical analyses were performed using SPSS version 25.

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Result

This study encompassed a sample of 121 secondary school students drawn from four distinct schools within the Kuala Muda district of Kedah, Malaysia. The participating schools were Sekolah Menengah Kebangsaan Aman Jaya, Sekolah Menengah Kebangsaan Bandar Sungai Petani, Sekolah Menengah Kebangsaan Bedong, and Sekolah Menengah Kebangsaan Gurun. This selection of schools aimed to capture a representative cross-section of students from the region. The participants represented a diverse range of academic backgrounds, encompassing students with varying levels of prior achievement in science and mathematics. Furthermore, the sample included students from diverse personal backgrounds, reflecting the socioeconomic and cultural heterogeneity of the Kuala Muda district. This diversity within the sample enhances the generalizability of the study's findings to the broader secondary school population in the region. The subsequent sections will detail the results of the analyses conducted on the data collected from these 121 students.

Academic Performance

Table 1 summarizes the self-reported academic performance of students in three subjects: English, Mathematics, and Science, categorized as "weak," "mediocre," or "very good." The results indicate that a majority of students rated their performance as "mediocre" across all subjects, with 57.0% for English, 47.9% for Mathematics, and 47.9% for Science. Notably, 25.6% of students identified their performance in Mathematics and Science as "weak," compared to only 15.7% for English.

Conversely, the proportion of students rating their performance as "very good" was highest in English (27.3%), followed by Science (26.4%) and Mathematics (26.4%). These findings suggest that students generally perceive their academic performance in English to be stronger than in Mathematics and Science.

Table 1: Academic Performance

Academic Performance	English		Mathematics		Science	
	n	%	n	%	n	%
Weak	19	15.7	31	25.6	31	25.6
Mediocre	69	57.0	58	47.9	58	47.9
Very Good	33	27.3	32	26.4	32	26.4

Student Attitude Towards Sciences and Mathematics

Table 2 shows descriptive statistics for student attitudes towards science and mathematics, measured on a 5-point Likert scale (1=strongly disagree, 5=strongly agree). The table reveals that students hold generally positive attitudes towards both science and mathematics, as indicated by the mean scores of 3.669 for science and 3.421 for mathematics. The standard deviations of 0.636 for science and 0.523 for mathematics indicate moderate variability in attitudes within the sample. The ranges of 3.22 for science and 2.75 for mathematics further confirm this variability, representing the difference between the highest and lowest reported attitude scores. The skewness values of -0.535 for science and -0.023 for mathematics suggest a slightly asymmetrical distribution for science attitudes, with a tendency towards higher scores, while mathematics attitudes are more symmetrically distributed. Finally, the kurtosis values of 0.078 for science and 0.083 for mathematics indicate distributions that are neither excessively peaked nor flat.

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Table 2: Attitude Towards Sciences and Mathematics

Attitude towards	Mean	Standard Deviation	Range	Skewness	Kurtosis
Science	3.669	0.636	3.22	-0.535	0.078
Mathematics	3.421	0.523	2.75	-0.023	0.083

The descriptive statistics presented in Table 2 offer a preliminary understanding of student attitudes towards science and mathematics. The data suggest generally positive views towards both subjects, with slightly more favorable attitudes towards science.

Engagement with STEM Professionals

Table 3 reveals the distribution of student engagement with various STEM professionals. A notable disparity exists, with engineers receiving the most engagement (41.1%), followed by technologists (18.2%) and mathematicians (17.4%). Comparatively, only a small percentage of students (10.7%) reported engaging with scientists. This imbalance suggests a potential area for growth in leveraging STEM professionals to enhance student engagement. Specifically, increasing opportunities for students to interact with scientists, whether through mentorships, guest lectures, or other forms of outreach, could broaden students' exposure to diverse STEM careers and potentially foster greater interest in scientific fields. This suggests the need to use STEM professional as mentors, volunteers, role models, tutors, or guest speakers contribute to student STEM engagement.

Table 3: Engagement with STEM professionals

Professional	n	Percent (%)
Scientist	13	10.7
Engineer	51	41.1
Mathematician	21	17.4
Technologist	22	18.2

The Relationship Between Engagement with STEM Professionals with Attitude Towards Science and Mathematics

This section displays the results of t-tests examining the relationship between student engagement with STEM professionals and their attitudes towards science and mathematics. This statistic tests for a significant difference in means between two groups (students who engaged with the specific STEM professional vs. those who did not). The p-value indicates the statistical significance of the t-test. A lower p-value suggests a stronger relationship.

1. ***The Relationship Between Engagement with STEM Professionals with Attitude Towards Science***

Table 4 presents the results of t-tests examining the relationship between engagement with different types of STEM professionals (scientists, engineers, mathematicians, and technologist) and student attitudes towards science. The results reveal a statistically significant positive relationship between engagement with engineers and attitudes towards science ($t = 2.698$, $p = 0.008$). This suggests that students who reported greater engagement with engineers also tended to hold more positive attitudes towards science. Conversely, the relationships between engagement with all other STEM professionals (scientists, mathematicians, and technologist) and attitudes towards science were not statistically significant.

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Table 4: Engagement With STEM Professionals and Attitude Towards Science

Engagement with STEM professionals	Attitude towards Sciences		
	t-test	p-value	Summary
Scientist	0.444	0.658	Not Significant
Engineer	2.698	0.008	Significant
Mathematician	0.943	0.348	Not Significant
Technologist	1.637	0.104	Not Significant

The findings presented in Table 4 highlight the potential influence of specific types of STEM engagement on student attitudes towards science. While engagement with engineers appears to be positively associated with science attitudes, no such relationship was observed for scientists or mathematicians. These results underscore the importance of considering the specific nature of STEM engagement when designing interventions aimed at fostering positive attitudes towards science among students.

2. The Relationship Between Engagement with STEM Professionals with Attitude Towards Mathematics

Table 5 presents the results of t-tests examining the relationship between engagement with various STEM professionals (scientists, engineers, mathematicians, and technologists) and student attitudes towards mathematics.

Table 5: Engagement With STEM Professionals and Attitude Towards Mathematics

Engagement with STEM professionals	Attitude towards Mathematics		
	t-test	p-value	Summary
Scientist	4.068	0.001	Significant
Engineer	1.210	0.229	Not Significant
Mathematician	2.192	0.035	Significant
Technologist	2.233	0.027	Significant

The findings reveal statistically significant positive relationships between engagement with scientists ($t = 4.068$, $p = 0.001$), mathematicians ($t = 2.192$, $p = 0.035$), and technologists ($t = 2.233$, $p = 0.027$) and student attitudes towards mathematics. This suggests that students reporting higher levels of engagement with these professionals also tend to hold more positive attitudes towards mathematics. In contrast, the relationship between engagement with engineers and mathematics attitudes was not statistically significant ($t = 1.210$, $p = 0.229$), indicating no discernible association within this sample.

The results presented in Table 5 underscore the potential impact of engaging with specific STEM professionals on student attitudes towards mathematics. While interactions with scientists, mathematicians, and technologists appear to be positively linked to mathematics attitudes, no such relationship was observed for engineers.

Discussion and Conclusion

This research indicates that engaging secondary school students with STEM professionals can positively influence their attitudes and motivation toward science and mathematics. The findings revealed statistically significant positive relationships between engagement with specific STEM professionals and student attitudes. Specifically, interactions with engineers

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were positively associated with science attitudes, while engagement with scientists, mathematicians, and technologists were positively linked to mathematics attitudes. These findings suggest that exposure to real-world STEM applications and interactions with professionals in these fields can enhance students' perceptions and potentially spark greater interest in pursuing STEM-related careers. The lack of a significant relationship between engagement with engineers and mathematics attitudes, and similarly between engagement with scientists and mathematicians and science attitudes, warrants further investigation (Giofrè et al. 2020, Moore, 2020 and Ing & Nylund-Gibson, 2013). This could be due to the specific nature of the interactions, the students' prior experiences, or other contextual factors. (Attard et al., 2020 and Jansen et al., 2023). It's important to consider that the study was conducted with a specific sample of secondary school students in Kuala Muda, Kedah, and the generalizability of these findings to other populations and contexts requires further exploration.

This study contributes to the growing body of literature highlighting the importance of STEM engagement in fostering positive student attitudes and academic outcomes. The findings emphasize the potential of involving STEM professionals as mentors and role models to enhance students' interest and motivation in science and mathematics. Future research should explore the longitudinal effects of such interventions and investigate the specific types of engagement that are most effective in promoting positive STEM attitudes. Furthermore, exploring the nuances of these relationships across different STEM fields and demographic groups could provide valuable insights for designing targeted interventions to maximize the impact of STEM engagement on student learning and career aspirations.

Acknowledegment
The instrument of this study is adopted form the Friday Institute for Educational Innovation (2012). Student Attitudes toward STEM Survey- Upper Elementary School Students, Raleigh, NC: Author.

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