Journal of Engineering Research and Education
Volume 18, (Special Issue) 2026 [261-271]

Demographic Influences on Secondary School Students' Interest and Educational Intentions in STEM

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ABSTRACT

Enhancing student engagement in Science, Technology, Engineering, and Mathematics (STEM) requires understanding how demographic factors shape their perspectives and aspirations. This study examines the influence of gender, parental education, and socioeconomic status on students' interest in STEM and their intention to pursue STEM subjects at Form 4. In this context, 'interest' refers to motivation and enjoyment derived from STEM activities, while 'intention' represents a concrete commitment to advanced enrolment in upper secondary education. Using a quantitative survey and descriptive analysis, data were collected from 142 secondary school students aged 13–15 in Kuala Lumpur and Selangor. The results revealed a high level of interest in STEM (M = 3.70), but only a moderate intention to pursue STEM at Form 4 (M = 3.32), indicating a gap between interest and subject selection. While demographic factors were not significant predictors of STEM interest, household income and parental education significantly influenced students' intention to continue in STEM. These findings highlight the need for targeted educational support and interventions, particularly for students from lower socioeconomic backgrounds, to bridge the interest-intention gap and promote equitable access to STEM pathways.

Keywords: Demographic Factors, Educational Intentions, STEM Interest, STEM Stream Intentions

1. INTRODUCTION

The increasing emphasis on Science, Technology, Engineering, and Mathematics (STEM) education is a global response to evolving demands of modern economies, the pursuit of innovation, and the need to develop a future-ready workforce [1]. As nations aim to strengthen their competitiveness in the digital age, STEM education has been prioritized for its potential to drive scientific and technological advancement, economic development, and societal progress [2], [3]. This global trend has led to the integration of interdisciplinary approaches, inquiry-based learning, and technology-enhanced pedagogy in educational systems worldwide [4], [5], [6]. In Malaysia, the importance of STEM education is reflected in national strategies aimed at developing a sustainable supply of STEM talent. Guided by the Malaysia Education Blueprint 2015-2025, the country has reformed curriculum, teacher training, and co-curricular programs to promote STEM learning [7]. Initiatives such as #MyDigitalMaker and participation in STEM-related competitions further complement these efforts [8], [9]. Moreover, financial incentives including scholarships and student loans (e.g. PTPTN, MyBrainSc) have been introduced to increase student enrolment in STEM fields [10]. Despite these wide-ranging initiatives, student interest in STEM has shown a worrying decline in recent years. This suggests that existing strategies, though valuable, may need to be complemented with more context-specific and inclusive approaches. In this regard, policymakers require deeper insights into the social and

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educational factors shaping STEM interest, so that interventions can be better aligned with Malaysia's long-term workforce agenda.

Globally and locally, student interest remains a primary driver of STEM engagement. Interest acts as a driver for motivation, sustained learning, and long-term commitment to STEM pathways [11], [12]. However, a gap often exists between students' interest in STEM and their intention to pursue it at more advanced levels, such as upper secondary education. Interest is an individual's affective engagement and curiosity toward a subject or activity [13], whereas intention is a person's planned effort and commitment to perform a specific behaviour [14]. In this study, STEM interest is understood as students' affective engagement (feelings, motivation, and enjoyment) and curiosity toward STEM activities and subjects, while STEM intention refers to their planned educational choices i.e., upper secondary education. This 'interest-intention gap' presents a significant barrier to building a sustainable STEM workforce.

In addition, demographic factors such as gender, parental education level, and socioeconomic status, continue to play a significant role in influencing students' access, attitudes, and outcomes in STEM education. For instance, female students remain underrepresented in specific fields such as engineering and computer science [11] Meanwhile, students from higher-income families and those with better-educated parents often have more access to quality STEM learning resources, academic support, and career guidance. These factors can shape students' aspirations and affect their decision to pursue STEM-related subjects and careers.

A further challenge lies in the availability of consistent emotional and academic support. Research indicates that students who lack supportive learning environments, mentorship, and encouragement from teachers or parents are more likely to disengage from STEM learning, particularly during critical transitions such as the move from lower to upper secondary school [15], [16], [17]. Even when students are interested in STEM, the absence of a nurturing and inclusive environment may erode their motivation and weaken their STEM interest.

In Malaysia, three persistent issues related to STEM remain underexplored within the context of secondary education: (i) socioeconomic disparities that limit students' access to STEM opportunities, (ii) the gap between students' interest and their actual intention to pursue STEM studies, and (iii) the lack of sustained academic and emotional support to encourage persistence in STEM. Understanding how these challenges interact with students' demographic backgrounds, particularly gender, parental education and income is essential for developing targeted and equitable interventions to strengthen STEM engagement. Therefore, this study seeks to provide empirical insights into how these demographic factors, specifically influence students' interest in STEM, and their intention to pursue STEM subjects at Form 4. To achieve this, the study is guided by the following research objectives:

i. To analyse the relationships between demographic factors and students' interest in STEM, and their educational intentions to pursue the STEM stream at Form 4.
ii. To examine whether demographic factors namely parental education level, household income, and gender significantly influence students' interest in STEM, and their educational intentions to pursue the STEM stream at Form 4.

2. METHODOLOGY

2.1. Research Design and Instrumentation

This study employed a quantitative survey design to examine students' perceptions and intentions toward Science, Technology, Engineering, and Mathematics (STEM) education. A structured questionnaire was used to measure two constructs: (i) interest in STEM, (ii) intention to pursue STEM at the upper secondary level (Form 4) in relation to demographic factors such as gender, parental education, and socioeconomic status. Respondents indicated their agreement on a 5-point Likert scale (1 = *Strongly Disagree* to 5 = *Strongly Agree*). The instrument demonstrated high internal consistency, with Cronbach's alpha values of 0.896 for *Interest in STEM*, and 0.806 for *Pursuit of STEM at Form 4*, indicating strong reliability across constructs.

2.2 Sample and Data Collection

The study involved 142 secondary school students aged 13 to 15 who participated in a STEM Carnival organized by the Faculty of Engineering, International Islamic University Malaysia. Data were collected through the self-administered questionnaire and analysed using the Statistical Package for the Social Sciences (SPSS) Version 27.

To ensure data integrity, three measures were applied:

1. Anonymity and confidentiality were assured to minimize social desirability bias.
2. Clear instructions were provided to promote accurate self-reporting.
3. Voluntary participation was emphasized, assuring students there were no right or wrong answers.

These procedures fostered a non-threatening environment and encouraged honest responses.

2.3 Data Analysis

Data were analysed using descriptive and inferential statistics in line with the study objectives. For the first objective—profiling students' responses across demographic variables—cross-tabulation (crosstab) analysis was employed. This technique effectively organizes categorical data, allowing descriptive comparisons by gender, parental income, and education level. As the purpose was exploratory rather than confirmatory, no inferential tests (e.g., chi-square) were conducted at this stage. Crosstab analysis is widely recognized in educational and social research for identifying patterns and subgroup differences.

To examine predictive relationships, Multiple Regression Analysis (MRA) was performed. Three demographic variables—gender, parental education, and income—served as predictors, while two dependent variables (STEM interest and intention to pursue STEM at Form 4) were modelled independently. Data were screened for completeness, outliers, and compliance with regression assumptions, including linearity, normality, homoscedasticity, and absence of multicollinearity.

All analyses were conducted using SPSS Version 27, with significance assessed at $p < 0.05$. Regression outputs included R, R^2, Adjusted R^2, Standard Error, and F-statistics to evaluate model fit and explanatory power. Standardized beta coefficients (β) were examined to determine the relative contribution of each demographic factor. These analyses provided insight into how gender, parental education, and income predict students' STEM interest and educational intentions.

3. RESULTS AND DISCUSSION

3.1 Demographic Profile

Table 1 presents the distribution of participants by background characteristics. A total of 142 students participated in the study. The sample consisted of 100 female and 42 male students, resulting in a female-majority sample (70.4%). Meanwhile, the majority of respondents (82.4%) are Form 2 students, with much smaller representation from Form 1 (4.2%) and Form 3 (13.4%). In addition, a large portion of parents (33.8%) hold certificate-level qualifications, followed by diploma (21.1%) and bachelor's degrees (19.0%). Only a small proportion of respondents' parents have postgraduate degrees (master's: 4.9%, PhD: 2.1%).

Table 1 Demographic profile (N = 142)

Background Characteristics	**N**	**%**
Form		
Form 1	6	4.2
Form 2	117	82.4
Form 3	19	13.4
Gender		
Male	42	29.6
Female	100	70.4
Parental Education Level		
Certificate	48	33.8
Diploma	30	21.1
Bachelor's Degree	27	19.0
Master's Degree	7	4.9
PhD	3	2.1
Others	27	19.0
Parental Income		
Below RM 3000	49	34.5
RM 3001 - RM 5000	27	19.0
RM 5001 - RM 10000	49	34.5
RM 10001 - RM 15000	10	7.0
Above RM 15000	7	4.9

In addition, the income is concentrated in two groups namely below RM 3000 and RM 5001 - RM 10000, each comprising 34.5% of the sample. The remaining students come from middle - to high - income households (31%), suggesting moderate income diversity. This distribution provides a balanced socioeconomic representation, but with a slight skew toward lower- to middle-income families, which may influence access to STEM resources like technology, tutoring, and extracurricular programs.

3.2 Gender-Based Analysis of STEM Interest and Intention to Pursue STEM Stream

In addressing the first objective of the study, cross tabulation analysis was conducted on Students' STEM interest and intention to pursues STEM stream according to gender, parental education and income. For this analysis, the dependent variables are categorized into three levels based on their mean scores as, (i) Low (1.00-2.33), (ii) Moderate (2.34-3.66), and (iii) High (3.67-5.00) [18].

3.2.1 Gender Based Analysis of Students' STEM Interest

The results of the cross-tabulation analysis between male and female students and their level of interest in STEM activities are presented in Table 2. Both male (100%) and female (99%) students demonstrated high levels of moderate-to-high STEM interest, indicating minimal gender difference. The table shows that interest in STEM across the entire sample is generally high, with a combined 99.3% of students reporting either moderate (52.8%) or high (46.5%) levels of interest. Only 0.7% of students reported low interest in STEM. The findings reveal that both male and female students exhibit high levels of interest in STEM, with negligible levels of disinterest (0.0% for males and 1.0% for females). These patterns suggest that interest in STEM is consistently strong among both male and female students.

Table 2 STEM interest based on gender

Gender	Low Interest	Moderate Interest	High Interest	Total %
Male (n=42)	0.0%	52.4%	47.6%	100.0%
Female (n=100)	1.0%	53.0%	46.0%	100.0%
Total (n=142)	0.7%	52.8%	46.5%	100.0%

3.2.2 Gender Based Analysis of Students' Intention to Pursue STEM Stream

Table 3 presents students' intention to pursue STEM at form 4 according to gender. More than half of the students (57.7%) reported a moderate intention to pursue STEM subjects at Form 4, followed by 34.5% with high intention, and only 7.8% with low intention. This suggests that overall, students are positively inclined toward continuing in the STEM stream, though many may still be undecided or exploring their options. Among male students, 40.5% reported high intention to pursue STEM at Form 4, 47.6% moderate intention, and 11.9% low intention. In comparison, female students reported slightly lower high intention (32.0%) but higher moderate intention (62.0%), and a smaller percentage of low intention (6.0%). These results indicate that while male students are more likely to express firm commitment toward STEM pathways at Form 4, female students are more concentrated in the moderate category, suggesting interest with some degree of uncertainty.

Table 3 Educational intentions to pursue the STEM stream based on gender

Gender	Low Intention	Moderate Intention	High Intention	Total (%)
Male (n=42)	11.9%	47.6%	40.5%	100.0%
Female (n=100)	6.0%	62.0%	32.0%	100.0%
Total (n=142)	7.8%	57.7%	34.5%	100.0%

3.3 Students' Parental Education Analysis of STEM Interest and Intention to Pursue STEM Stream

3.3.1 Parental Education and Students' STEM Interest

The results of the cross-tabulation analysis between parental education level and students' level of interest in STEM activities are presented in Figure 1. The data indicate that none of the students reported low interest in STEM across any category of parental education, suggesting a generally positive orientation toward STEM regardless of parental background.

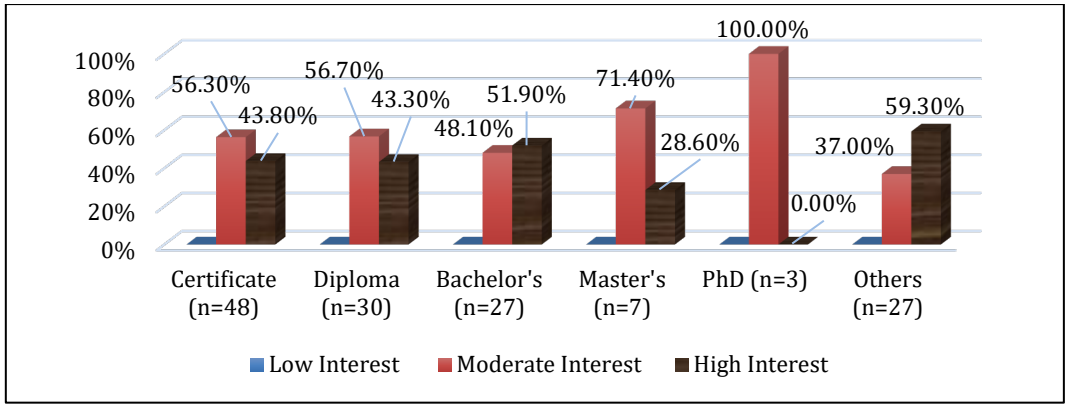

Figure 1 STEM interest based on parental education level.

Overall, 52.8% of the sample expressed moderate interest in STEM, while 46.5% reported high interest. A closer examination reveals significant variation across educational levels. Students whose parents had other education levels reported the highest proportion of high interest (59.3%), followed by those whose parents held a **bachelor's degree** (51.9%), **Certificate** (43.8%), and **Diploma** qualifications (43.3%). Interestingly, students whose parents had attained a **master's** or **PhD** qualification showed a higher tendency toward moderate interest, with **71.4%** and **100.0%,** respectively, compared to those reporting high interest.

3.3.2 Students' Parental Education and Intention to Pursue STEM Stream

Figure 2 examines the relationship between parents' educational background and students' intention to pursue the STEM stream at Form 4. The results of the cross-tabulation analysis are presented in Figure 2. The findings show that students' intention to pursue the STEM stream at Form 4 varies across different parental education backgrounds. Overall, 34.5% of students reported high intention, 57.7% moderate intention, and only 7.7% low intention. Students whose parents hold a diploma reported the highest proportion of high intention (43.3%), followed closely by those with bachelor's degrees (40.7%) and certificate qualifications (39.6%). These groups also show relatively balanced distributions between moderate and high intention, with low levels of disinterest.

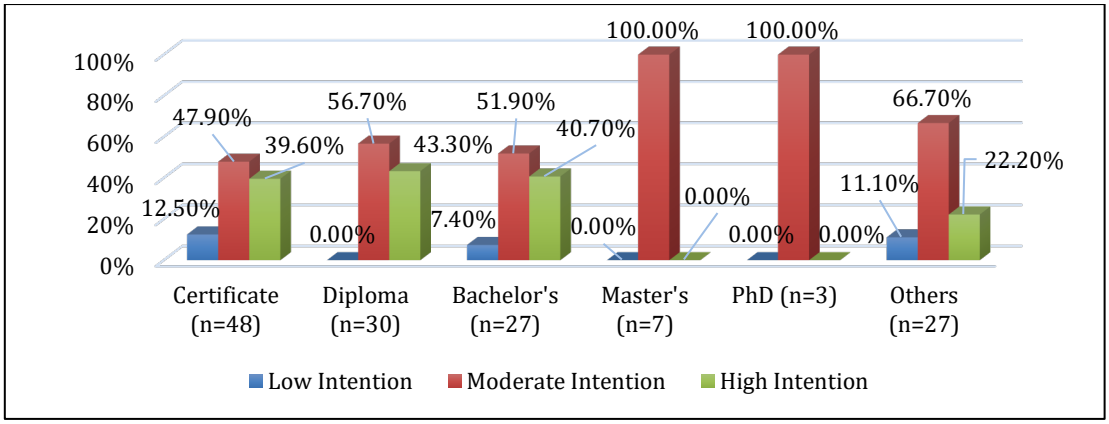

Figure 2 Educational intentions to pursue the STEM stream based on parental education level.

Besides, students whose parents had "other" education backgrounds reported the lowest proportion of high intention (22.2%) and a relatively higher percentage of moderate intention (66.7%) and low intention (11.1%). These results suggest that students from families with tertiary-level qualifications (diploma or bachelor's degrees) tend to report stronger aspirations to enter the STEM stream. Parental educational exposure may influence students' academic planning and awareness of the long-term value of STEM pathways. However, the high percentage of moderate intention across nearly all groups also points to a degree of uncertainty or the need for further guidance when making subject selections for upper secondary education.

3.4 Students' Parental Income Analysis of STEM Interest and Intention to Pursue STEM Stream

3.4.1 Parental Income and Students' STEM Interest

The results of the cross-tabulation analysis between students' level of interest in STEM and their parents' household income are presented in Table 4. The table shows that interest in STEM is generally high across all income groups, with only 0.7% of the total sample reporting low interest. Most students fall into the **moderate interest** (52.8%) and **high interest** (46.5%) categories. Among students from households with **income below RM 3,000**, the majority (65.3%) reported moderate interest in STEM, while 34.7% expressed high interest. No low-interest responses were recorded in this group. In contrast, students from the **RM 5,001 - RM 10,000** income bracket reported the **highest proportion of high interest** (55.1%), followed closely by those in the **RM 3,001 - RM 5,000** group (51.9%) and the **RM 10,001 - RM 15,000** group (50.0%). Interestingly, the only recorded low interest (3.7%) came from students in the **RM 3,001 - RM 5,000** income group, although the proportion remains small. Students from households earning **above RM 15,000** showed a majority of moderate interest (57.1%) and 42.9% high interest. Although this group reflects relatively strong STEM engagement, the proportion of high-interest students is slightly lower compared to middle-income groups.

Table 4 STEM interest based on parental income level

Parents' Income	Low Interest	Moderate Interest	High Interest	Total (%)
Below RM 3,000 (n=49)	0.0%	65.3%	34.7%	100.0%
RM 3,001 - RM 5,000 (n=27)	3.7%	44.4%	51.9%	100.0%
RM 5,001 - RM 10,000 (n=49)	0.0%	44.9%	55.1%	100.0%
RM 10,001 - RM 15,000 (n=10)	0.0%	50.0%	50.0%	100.0%

Above RM 15,000 (n=7)	0.0%	57.1%	42.9%	100.0%
Total (n=142)	0.7%	52.8%	46.5%	100.0%

These findings suggest that **middle-income households (RM 5,001 - RM 10,000)** may be associated with **higher levels of student enthusiasm toward STEM,** while students from both lower- and higher-income brackets tend to report **greater moderate interest.** Nonetheless, interest in STEM remains strong across all income categories, with virtually no disinterest reported.

3.4.2 Parental Income and Students' Educational Intentions to Pursue STEM Stream

Table 5 shows that students' intention to pursue STEM at Form 4 varies across different household income levels. Overall, 34.5% of students reported high intention, 57.8% moderate intention, and 7.7% low intention. Students from higher-income households (above RM 15,000) reported the highest percentage of high intention (71.4%) and the lowest percentage of moderate intention (28.6%), with no students in this group indicating low intention. Similarly, the RM 10,001 - RM 15,000 group reported a strong inclination toward STEM, with half of the students indicating high intention and none reporting low intention.

Table 5 Educational intentions to pursue the STEM stream based on parental income level

Parents' Income	Low Intention	Moderate Intention	High Intention	Total (%)
Below RM 3,000 (n=49)	12.2%	61.3%	26.5%	100.0%
RM 3,001 - RM 5,000 (n=27)	11.1%	55.6%	33.3%	100.0%
RM 5,001 - RM 10,000 (n=49)	4.1%	61.2%	34.7%	100.0%
RM 10,001 - RM 15,000 (n=10)	0.0%	50.0%	50.0%	100.0%
Above RM 15,000 (n=7)	0.0%	28.6%	71.4%	100.0%
Total (n=142)	7.7%	57.8%	34.5%	100.0%

In contrast, students from lower-income groups, especially those earning below RM 3,000 and RM 3,001 - RM 5,000, reported the highest proportions of low intention (12.2% and 11.1% respectively), and lower proportions of high intention (26.5% and 33.3%). The majority of students in these groups fell into the moderate category. Students from the middle-income group (RM 5,001 - RM 10,000) showed a relatively balanced distribution, with 34.7% high intention, 61.3% moderate, and only 4.1% low. These findings suggest that household income may play a role in shaping students' educational planning and confidence in pursuing the STEM stream.

3.5 Influence of Demographic Factors

This study employed multiple regression analysis (MRA) to assess the influence of parental income, parental education level, and gender on students' interest in STEM. Table 6 shows that the model was not statistically significant, $F(3, 138) = 0.712$, $p = 0.547$, indicating that the influences did not explain a significant amount of variance in STEM interest. The R^2 was 0.015, suggesting that only 1.5% of the variance in STEM interest could be accounted for by the combination of the three variables. The Adjusted R^2 was -0.006, indicating negligible explanatory power.

Table 6 Summary of multiple regression analyses

Dependent Variable	R	R^2	Adjusted R^2	F	df1	df2	p-value	Sig.
STEM Interest	0.123	0.015	-0.006	0.712	3	138	0.547	Not Significant
Pursue STEM at Form 4	0.299	0.089	0.069	4.504	3	138	0.005	Significant

Note: DV = Dependent Variable; R^2 = R Square; Adj. R^2 = Adjusted R Square; $p < 0.05$ considered significant.

Finally, an analysis was conducted to examine the influence of parents' income, parents' education, and gender on students' intention to pursue STEM at Form 4. The model was statistically significant, $F(3, 138) = 4.504$, $p = 0.005$, and accounted for approximately 8.9% of the variance in the dependent variable ($R^2 = 0.089$, Adjusted $R^2 = 0.069$). These findings suggest that students' demographic backgrounds are significantly associated with their STEM pathway choices at the upper secondary level, although additional factors are likely to play a more substantial role. Although this R^2 value represents a modest proportion of explained variance, the statistical significance highlights that factors such as gender and parental background play a notable role in shaping immediate educational choices, particularly during critical academic transitions. Prior studies similarly report heightened demographic effects on short-term decision-making at such junctures, reinforcing the need for strategic support for students as they select their upper secondary pathways.

Table 7 shows that for interest in STEM, the overall regression model was not significant, $F(3, 138) = 0.712$, $p = 0.547$, with $R^2 = 0.015$. It shows that none of the predictors significantly contributed to the model. Gender ($\beta = 0.063$, $p = 0.458$), parents' education ($\beta = -0.070$, $p = 0.409$), and parents' income ($\beta = 0.090$, $p = 0.289$) were all non-significant. These findings suggest that students' interest in STEM is not meaningfully explained by these demographic factors.

In contrast, the regression model for intention to pursue STEM at Form 4 was statistically significant, $F(3, 138) = 4.504$, $p = 0.005$, $R^2 = 0.089$. Parents' income ($\beta = 0.248$, $p = 0.003$) and parents' education ($\beta = -0.174$, $p = 0.034$) were significant predictors of students' intention to pursue the STEM stream at Form 4, while gender was not ($\beta = -0.022$, $p = 0.792$). These findings indicate that while demographic factors do not significantly influence students' interest in STEM, they do significantly predict students' intentions to pursue STEM pathways in upper secondary school.

Table 7 Multiple regression coefficients for predicting STEM

DV / Predictor	B	SE B	β	t	p	Tolerance	VIF
Interest in STEM							
(Constant)	3.467	0.236	—	14.662	0.000	—	—
Gender	0.085	0.114	0.063	0.744	0.458	0.992	1.008
Parental Education	-0.023	0.028	- 0.070	-0.829	0.409	0.992	1.008
Parental Income	0.048	0.045	0.090	1.065	0.289	0.995	1.005
Pursue STEM at Form 4							
(Constant)	3.217	0.273	—	11.792	0.000	—	—
Gender	- 0.035	0.131	- 0.022	-0.264	0.792	0.992	1.008
Parental Education	- 0.070	0.033	- 0.174	-2.138	0.034	0.992	1.008
Parental Income	0.157	0.052	0.248	3.040	0.003	0.995	1.005

Note: DV = Dependent Variable; **B** = Unstandardized Coefficient; **SE B** = Standard Error of B; **β** = Standardized Beta Coefficient; **t** = t-value; **p** = significance level; **Tolerance** = measure of multicollinearity; **VIF** = Variance Inflation Factor.

4. CONCLUSION

This study has provided empirical insights into how gender, parental education level, and household income influence secondary school students' interest and intention to pursue STEM stream. While students generally demonstrate positive attitudes toward STEM, disparities remain in terms of intention to pursue STEM in upper secondary school, particularly among female students and those from low-income households. These findings emphasize the need for differentiated and inclusive approaches to support students through critical decision-making stages in their academic journey. It should be noted that the sample was drawn from participants of a STEM Carnival, which may have attracted students with a pre-existing interest in STEM, potentially limiting the generalisability of the findings. For policymakers, the study highlights that beyond STEM promotion campaigns, policies must prioritize equitable resource distribution, parental engagement, and tailored interventions. These efforts are needed to close the gap between students' STEM interest and their educational decisions. This positions the study as a timely contribution to Malaysia's STEM workforce agenda by showing how national strategies can be recalibrated to ensure resources are not only distributed widely but also targeted effectively.

ACKNOWLEDGEMENTS

The authors would like to express their deepest appreciation to the Islamic World Educational, Scientific and Cultural Organization, ICESCO Chair in Sustainable Engineering, IIUM, for the financial and institutional support provided to this research. This study was conducted under the STEM Capacity Building Project initiated by the IIUM-ICESCO Chair in Sustainable Engineering, aimed at advancing education and research in sustainable development.

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