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The Relationship between Malaysian Students' Socio-Economic Status and their Academic Achievement in STEM education

Saras Krishnan*
INTI International University, Negeri Sembilan, Malaysia

Enriqueta Reston
University of San Carlos, Cebu City, The Philippines

Sheila Devi Sukumaran
SEGI University, Selangor, Malaysia

Abstract. Although there is proliferating literature on STEM (science, technology, engineering and mathematics) education, studies on the impact of socio-economic status (SES) on STEM education are limited in developing countries. Studies on STEM education in Malaysia has largely involved the teaching and learning aspect while there are limited studies in other areas. This study investigates the possible relationships between socio-economic factors and Malaysian students' academic achievement in STEM subjects. Data was collected from students in the higher learning institutions located in five different regions in Malaysia using a survey questionnaire. Cross-tabulations were made between the construct of SES and students' academic achievement, and analyses for Chi-Square tests for associations were carried out using the Statistical Package for Social Sciences (SPSS). Results of this study show that there are statistically significant positive associations between students' grades in engineering and their fathers' education, between students' grades in science and their mothers' education, and between students' grades in science and their parents' combined income. Moreover, there are statistically significant and positive associations between students' grades in mathematics and parents' education, occupation and combined income. Future studies can identify the reasons for these associations and how Malaysian students' declining academic performance in international assessments can be improved by improving STEM education.

Keywords: higher learning; parents' education; parents' income; parents' occupation; sustainable development

* Corresponding author: *Saras Krishnan, saras.krishnan@newinti.edu.my*

1. Introduction

The idea of STEM (science, technology, engineering and mathematics) was conceived by the National Science Foundation (NSF) in the United States back in the late 1990s to meet the country's challenge in becoming a leader in the field of science and technology. Initially identified with the acronym SMET (science, mathematics, engineering and technology) in the 1990s, it was later changed to METS (mathematics, engineering, technology and science) and eventually to STEM in 2001 (Blackley & Howell, 2015). Although over time STEM has become increasingly important across nations, the differences in policies and practices are broadly influenced by the economic regions (Freeman et al., 2019). The different approaches to STEM are distinctly characterized by the four main geo-social separations: (1) English speaking countries, (2) Western European countries, (3) Asian countries, and (4) developing countries (Blackley & Howell, 2015) and thus variations in STEM policies reflect the different economic, cultural and social settings.

The focus of STEM especially in the developing countries has been on improving STEM education (Blackley & Howell, 2015). STEM education merges the four disciplines science, technology, engineering and mathematics into a cohesive system with the objective to prepare students for the 21st-century job market. STEM education provides skills that govern the way students think and behave including critical thinking, problem-solving, and the ability to adapt and work collaboratively. The advancement of STEM education in developing countries is in alignment with the goal for quality education as indicated by the Sustainable Development Goals of the United Nations (Vuong et al., 2020). Vuong et al. (2020) further contends that it is crucial to have more studies on STEM education in developing countries as current scientific literature is mostly concerned with developed countries.

STEM education consists of meta-disciplines that combine the skills and knowledge from the fields of mathematics, engineering, science, and technology (Ali et al., 2021). In Malaysia, the acronym STEM is used in three different contexts that are STEM field, STEM education and STEM stream related to science, technology, engineering and mathematics (Chong, 2019). Realizing the importance of STEM education, the Ministry of Education (MOE) Malaysia, under the National Education Blueprint 2013-2025, transformed the existing curriculum to the Standard Secondary School Curriculum by strengthening and introducing STEM in the education system of Malaysia as one of the pillars in the new curriculum (Razali et al., 2020). This is to prepare the country to meet the challenges and demands of a STEM-driven economy.

2. Literature Review

STEM education offers a well-rounded education encompassing a range of soft skills that renders the graduates more employable and prepared to meet the demands of the current employment. According to (Freeman et al., 2019), emerging research priorities have focused on STEM education compared to other priorities of STEM. A systematic review of research and trends in STEM education between year 2000 and year 2018 by Li et al. (2020a) revealed the categories of journal publications with the highest number of papers published in the category "goals and policy, curriculum, evaluation, and assessment" (375 publications) while the least popular category is "post-secondary teacher and teaching" (18 publications). The other categories include: (1) K-12 education, (2) culture, social and gender issues, (3) post-secondary STEM education, and (4) history, philosophy, epistemology, and nature of STEM education (see Table 1).

Table 1. Categories of journal publications in STEM education

Category	Ranking	Number of publications
Goals and policy, curriculum, evaluation, and assessment (including literature review)	1	375
K-12 teaching, teacher and teacher education	2	103
K-12 STEM learner, learning, and learning environment	3	97
Culture, social, and gender issues	4	78
Post-secondary STEM learner, learning, and learning environments	5	76
History, philosophy, epistemology, and nature of STEM and STEM education	6	51
Post-secondary teacher and teaching	7	18

Further, a review of the number of publicly funded projects in STEM education for different groups of participants from year 2003 to year 2019 by Li et al. (2020b) revealed that most projects involved grade five to grade eight learners. On the other hand, (Chomphuphra et al., 2019) found that the three popular topics among STEM papers were: (1) innovation for STEM learning, (2) professional development, and (3) gender gap and career in STEM. In addition, researchers found that the top three countries in terms of publication of STEM papers were the United States, Australia and Canada (Chomphuphra et al., 2019; Li et al., 2020a) suggesting the need for more publications from the developing countries as pointed out by Vuong et al. (2020).

In the Malaysian context in particular, the review of STEM education research conducted by Jayarajah et al. (2014) showed that the two highest research areas are: (1) teaching tool, and (2) teaching and learning. The third place is shared by two categories that are 'learning strategies' and 'gender'. The review which included articles from year 1999 to year 2013 intended to summarize the trend of literature across the STEM disciplines. In addition to the research areas, Jayarajah et al. (2014) also revealed that most studies involved university graduates whereas studies at the school level were scarce. Taking a cue from these findings, the trend in STEM research shifted to more studies involving school children as opposed to studies involving post-secondary students, from year 2010 to year 2020 (Saat & Fadzil, 2021). According to Freeman et al. (2019), past studies have generally found considerable variability within countries and territories in terms of demographics specifically gender, ethnicity, socio-economic status (SES), religion and distribution. However, certain areas have been given less importance and thus the need for future studies to consider these aspects of research in STEM education. For instance, Vuong et al. (2020) urged for an examination of the impact of demographic factors on students' performance in STEM domains because they believe this will shed light on the intertwining relationship between SES and academic achievement.

SES is one of the most studied and consistent predictors of students' academic achievement (Dixson et al., 2018) because SES explained most of the differences in students' academic achievement (Liu et al., 2020). Numerous studies showed significant relationships and positive correlations between SES and students' academic performance (Broer et al., 2019). However, there are lesser studies on the relationship between SES and STEM education. Although, initial studies focused on Western countries and only after the late 1970s, studies included developing countries (Kim et al., 2019). These studies showed that SES had a greater impact on the academic achievement of students from developing countries than that of those in the developed countries (Kim et al., 2019). Moreover, SES and its' relationship with students' academic achievement is one of the prevalent issues in educational research (Thomson, 2018). However, there is lack of documented studies relating SES and STEM (Li et al., 2020a; Li et al., 2020b), particularly in Malaysia (Jayarajah et al., 2014; Saat & Fadzil, 2021).

3. Study Design

3.1. Study objective

This study used the quantitative non-experimental cross-sectional explanatory design to investigate the association between SES and academic achievement in STEM subjects among the Malaysian undergraduate students from both the public and private education sectors. Kim et al. (2019) argued that the construct of SES is multidimensional because it reflects the social system and so it is a challenge to accurately measure SES. The commonly used definition of SES includes characteristics of family background while other definitions include assets and home resources. In this study, the definition of SES includes family income (Xie et al., 2015), education level (Kendler et al., 2015; Noble et al., 2015) and employment of the adults in the families (Hotz & Pantano, 2015).

3.2. Study questions

This study focused on investigating the relationship between students' academic achievement and the SES constructs related to their parents. As such the three research questions are:

(1) Are there associations between parents' education level and students' academic achievement in STEM subjects?
(2) Are there associations between parents' occupations and students' academic achievement in STEM subjects?
(3) Are there associations between parents' income and students' academic achievement in STEM subjects?

3.3. Study variables

As shown in Figure 1, the independent variables for this study are parents' education, parents' occupations and parents' income, and the dependent variable is students' academic achievement in the STEM subjects.

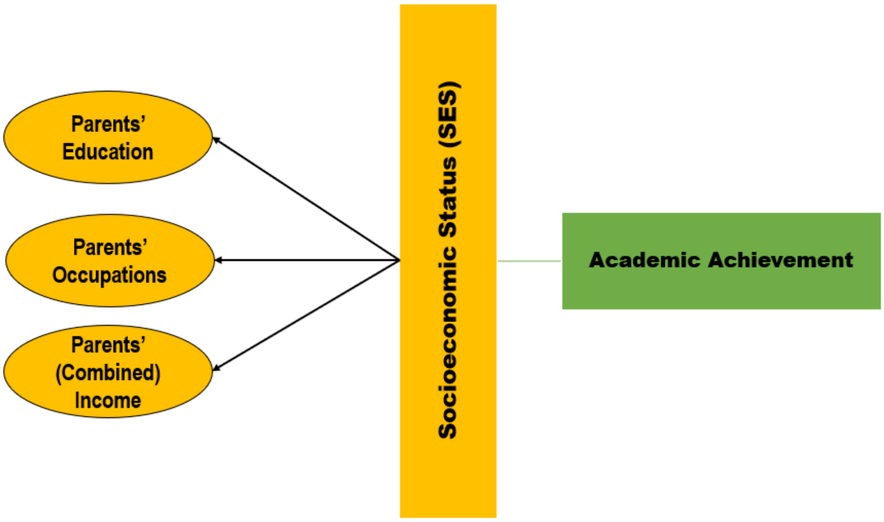

Figure 1: Study variables

3.4. Sample of study

This study has gathered 300 responses from undergraduate students in different higher learning education institutions, in all the different regions in Malaysia namely: (1) Central region (Selangor, Putrajaya and the federal territories of Kuala Lumpur), (2) Southern region (Negeri Sembilan, Melaka and Johor), (3) Northern region (Perlis, Kedah, Penang and Perak), (4) East Coast region (Kelantan, Pahang and Terengganu), and (5) West Coast region (Sabah and Sarawak).

3.5. Instrument and data collection

The instrument used for this study is a survey questionnaire of ten items (see Appendix 1). The reliability of the instrument was analyzed using Cronbach's alpha as a measure of the internal consistency of the items. The results show a Cronbach alpha value for the ten items is 0.78 which is greater than the reliability standard threshold of 0.70. Thus, the questionnaire is reliable. Data was collected physically and virtually. In physical data collection, students provided responses on hardcopy of the questionnaire while virtual data collection used google forms. In both formats of data collection, students were first required to give their consent for their responses to be used by the researchers (see Appendix 1).

4. Results and Discussion

Table 2 shows the distribution of the students in the major school examinations that they sat for prior to their university entries. Most students sat for the Malaysian Certificate of Education examination (65.3%), followed by Malaysian Higher School Certificate examination (15.0%) and the Unified Examination Certificate examination (1.0%). The Malaysian Certificate of Education is a national examination taken by form five (equivalent to year eleven in K-12 American education system) secondary school students in Malaysia. The

Malaysian Higher School Certificate is the last secondary school level public examination and is one of the options after completing year eleven and before pursuing a university degree. Meanwhile, the Unified Examination Certificate is a standardized examination under the Malaysian Independent Chinese Secondary Schools system taken by students who have completed six years of primary education at a Chinese primary school prior to their secondary level education.

Table 2. Students' highest school qualification

Highest school qualification	Number of students (%)
Malaysian Certificate of Education	196 (65.3%)
United Examination Certificate	3 (1.0%)
Malaysian Higher School Certificate	45 (15.0%)
Others/missing data	56 (18.7%)

4.1. Parents' education and students' academic achievement

Table 3 displays the distribution of parents' highest academic qualification whereby most of the parents' highest academic qualification is only at the school level that is 46.3% for the fathers and 47.7% for the mothers. A smaller percentage has attained postgraduate education, that is 10.0% for the fathers and 7.7% for the mothers. The school level category comprises primary and secondary schooling, the tertiary education category comprises the diploma and degree levels, and the postgraduate education category comprises master's degree and doctorate degree.

Table 3. Parents' highest academic qualification

Academic qualification	Father	Mother
Not educated	4 (1.3%)	4 (1.3%)
School level	139 (46.3%)	143 (47.7%)
Tertiary education	120 (40.0%)	121 (40.3%)
Postgraduate education	30 (10.0%)	23 (7.7%)
Others/missing data	7 (2.3%)	9 (3.0%)

Table 4 shows that there is no statistically significant association between students' achievement in science and their fathers' education level ($\chi^2(28, 300) = 32.82, p = 0.243$). There is also no statistically significant association between students' achievement in technology-based subjects and their fathers' education level ($\chi^2(35, 300) = 34.06, p = 0.513$). However, there is a statistically significant association between students' achievement in engineering and their fathers' education level ($\chi^2(35, 300) = 55.64, p = 0.015$). There is also a statistically significant association between students' achievement in mathematics and their fathers' education level ($\chi^2(42, 300) = 79.74, p = 0.000$).

Table 4. Association between fathers' education and academic achievement

	Pearson Chi-Square	df	p-value
Science	32.817	28	0.243
Technology	34.063	35	0.513

Engineering	55.642	35	0.015
Mathematics	79.744	42	0.000

Table 5 shows the cross-tabulation analysis between fathers' highest academic qualification and students' achievement in engineering for grades A, B, C and D. Meanwhile, Table 6 shows the cross-tabulation analysis between fathers' highest academic qualification and students' achievement in mathematics for grades A to D. Table 5 shows that the highest percentage of students who got grade A (10.1%) have fathers whose highest academic qualification is school level. Similarly, the students with grade A in engineering mostly have fathers whose highest academic qualifications is school level (73.7%). Those students whose fathers are not educated were not able to get grade A or grade B. Likewise, of the students who got grade A and grade B in engineering, no one has fathers who are not educated. This shows that students whose fathers have higher academic qualifications have higher grades in engineering.

Table 5. Cross-tabulation between fathers' education and students' grades in engineering

Father's education	Percent	A	B	C	D
Not educated	% within fathers	0.0%	0.0%	0.0%	25.0%
	% within engineering	0.0%	0.0%	0.0%	25.0%
School	% within fathers	10.1%	8.6%	5.0%	2.2%
	% within engineering	73.7%	54.5%	58.3%	75.0%
Tertiary	% within fathers	2.5%	5.0%	3.3%	0.0%
	% within engineering	15.8%	27.3%	33.3%	0.0%
Postgraduate	% within fathers	3.3%	13.3%	3.3%	0.0%
	% within engineering	5.3%	18.2%	8.3%	0.0%

Table 6 shows that 25.0% of the students whose fathers are not and 63.3% of the students whose fathers are school leavers have grade A in mathematics. Meanwhile, 82.5% of the students whose fathers have tertiary qualifications and 90.0% of the students whose fathers have postgraduate qualifications have grade A. In addition, 12.4% of the students who got grade A in mathematics have fathers who are postgraduates compared to 4.5% of the students who got grade C. Conversely, 0.5% of the students who got grade A have fathers who are not educated but 4.5% of the students who got grade C have fathers who are not educated. This shows that students whose fathers have higher academic qualifications have higher grades in mathematics.

Table 6. Cross-tabulation between fathers' education and students' grades in mathematics

Father's education	Percent	A	B	C	D
Not educated	% within fathers	25.0%	0.0%	25.0%	0.0%
	% within mathematics	0.5%	0.0%	4.5%	0.0%
School	% within fathers	63.3%	15.8%	9.4%	2.9%
	% within mathematics	40.4%	56.4%	59.1%	80.0%

Tertiary	% within fathers	82.5%	10.8%	5.8%	0.8%
	% within mathematics	45.4%	33.3%	31.8%	20.0%
Postgraduate	% within fathers	90.0%	3.3%	3.3%	0.0%
	% within mathematics	12.4%	2.6%	4.5%	0.0%

Table 7 shows that there is no statistically significant association between students' achievement in technology and their mothers' education level ($\chi^2(35, 300) = 38.82, p = 0.302$). There is also no statistically significant association between students' achievement in engineering and their mothers' education ($\chi^2(35, 300) = 39.34, p = 0.282$). However, there are statistically significant associations between students' achievement in science and their mothers' education ($\chi^2(28, 300) = 48.99, p = 0.008$), and between students' achievement in mathematics and their mothers' education ($\chi^2(42, 300) = 59.89, p = 0.036$).

Table 7. Association between mothers' education and academic achievement

	Pearson Chi-Square	df	p-value
Science	48.985	28	0.008
Technology	38.816	35	0.302
Engineering	39.337	35	0.282
Mathematics	59.891	42	0.036

Table 8 shows the cross-tabulation analysis between mothers' academic qualification and students' achievement in science for grades A, B and C (no responses for grade D in Science). Table 9 shows the cross-tabulation analysis between mothers' academic qualification and students' achievement in mathematics for grades A, B, C and D. Table 8 shows that the percentages of students who obtained grade A in science increased when the academic qualification of their mothers increases. For instance, 25.0% of the students whose mothers are not educated obtained grade A while 60.9% of the students whose mothers have postgraduate qualifications obtained grade A. In addition, 0.8% of the students who got grade A have mothers who are not educated while 10.0% of the students who got grade C have mothers who are not educated. Further, 11.4% of the students who got grade A have mothers who are postgraduates while 3.3% of the students who got grade C have mothers who are postgraduates. This shows that students whose mothers have higher academic qualifications obtained better grades in science.

Table 8. Cross-tabulation between mothers' education and students' grades in science

Mother's education	Percent	A	B	C
Not educated	% within mothers	25.0%	0.0%	75.0%
	% within science	0.8%	0.0%	10.0%
School	% within mothers	34.3%	37.8%	14.0%
	% within science	39.8%	50.5%	66.7%
Tertiary	% within mothers	46.3%	35.5%	5.0%
	% within science	45.5%	40.2%	20.0%

Postgraduate	% within mothers	60.9%	26.1%	4.3%
	% within science	11.4%	5.6%	3.3%

Table 9 shows that the percentages of students who obtained grade A in mathematics increased when the academic qualification of the mothers increases. For instance, 25.0% of the students whose mothers are not educated and 65.7% of the students whose mothers' highest qualification is school level have grade A in mathematics. Meanwhile, 80.2% of the students whose mothers have tertiary education and 82.6% of the students whose mothers are postgraduates obtained grade A. In addition, 0.5% of the students who got grade A in mathematics have mothers who are not educated while 8.7% of the students who got grade A have mothers who are postgraduates. This shows that students whose mothers have higher academic qualifications obtained higher grades in mathematics.

Table 9. Cross-tabulation between mothers' education and students' grades in mathematics

Mother's education	Percent	A	B	C	D
Not educated	% within mothers	25.0%	50.0%	0.0%	0.0%
	% within mathematics	0.5%	5.1%	0.0%	0.0%
School	% within mothers	65.7%	13.3%	10.5%	2.1%
	% within mathematics	43.1%	48.7%	68.2%	60.0%
Tertiary	% within mothers	80.2%	12.4%	5.0%	1.7%
	% within mathematics	44.5%	38.5%	27.3%	40.0%
Postgraduate	% within mothers	82.6%	8.7%	4.3%	0.0%
	% within mathematics	8.7%	5.1%	4.5%	0.0%

4.2. Parents' occupations and students' academic achievement

Table 10 displays the distribution of parents' occupations which has been classified according to the International Standard Classification of Occupations (ISCO) of the United Nations. Most parents of the students in this study are professionals, that is 22.0% of the fathers and 28.3% of the mothers. However, many of the students were unsure in which category their parents' occupations are. These students either chose the wrong category or chose the option 'others'. Hence, the incorrect job categorization could have possibly affected the results of the analysis.

Table 10. Distribution of parents' occupations

Occupations	Father	Mother
Managers	44 (14.7%)	22 (7.3%)
Professionals	66 (22.0%)	85 (28.3%)
Technicians and associate professionals	31 (10.3%)	5 (1.7%)
Clerical support workers	10 (3.3%)	20 (6.7%)
Service and sales workers	21 (7.0%)	18 (6.0%)
Skilled agricultural, forestry and fishery workers	13 (4.3%)	2 (0.7%)

Craft related trades workers	22 (7.3%)	7 (2.3%)
Plant and machine operators, and assemblers	11 (3.7%)	6 (2.0%)
Elementary occupations	15 (5.0%)	7 (2.3%)
Armed forces occupations	14 (4.7%)	3 (1.0%)
Others/missing data/never worked	53 (17.7%)	125 (41.7%)

Table 11 shows that there is a statistically significant association between students' achievement in mathematics and their fathers' occupations ($\chi^2(66, 300) = 100.69, p = 0.004$). However, there are no statistically significant associations between students' achievement in science and their fathers' occupations ($\chi^2(44, 300) = 57.39, p = 0.085$), between students' achievement in technology-based subjects and their fathers' occupations ($\chi^2(55, 300) = 57.71, p = 0.375$), and between students' achievement in engineering and their fathers' occupations ($\chi^2(55, 300) = 48.97, p = 0.703$).

Table 11. Association between fathers' occupations and academic achievement

	Pearson Chi-Square	df	p-value
Science	57.394	44	0.085
Technology	57.711	55	0.375
Engineering	48.970	55	0.703
Mathematics	100.685	66	0.004

Table 12 shows the cross-tabulation analysis between fathers' occupations and students' achievement in mathematics for grades A, B, C and D. The table shows that within a job category, the percentages of students generally decreased from grade A to grade D. For instance, 77.3% of students whose fathers are managers got grade A, 13.6% got grade B and 9.1% got grade C. Further, 54.5% of students whose fathers are in the category 'plant and machine operators, and assemblers' have grade A while 18.2% of students whose fathers are in the same category have grades B and C.

For the 'service and sales workers' group, the percentages of students who got grade C is higher than percentages of students who got grade B but it is not substantially higher. Likewise, with the 'elementary occupations' and 'armed forces occupations' categories. For the three top job categories, the percentages of students with grade A whose fathers are in these categories are higher than 10% while for the other categories, the percentages of students with grade A whose fathers are in these categories are lower than 10%. This shows that students whose fathers hold better jobs have higher grades in mathematics.

Table 12. Cross-tabulation between fathers' occupations and students' grades in mathematics

Father's occupation	Percent	A	B	C	D
Managers	% within fathers	77.3%	13.6%	9.1%	0.0%
	% within mathematics	15.6%	15.4%	18.2%	0.0%
Professionals	% within fathers	92.4%	4.5%	1.5%	1.5%

	% within mathematics	28.0%	7.7%	4.5%	20.0%
Technicians and associate professionals	% within fathers	77.4%	12.9%	9.7%	0.0%
	% within mathematics	11.0%	10.3%	13.6%	0.0%
Clerical support workers	% within fathers	50.0%	20.0%	10.0%	0.0%
	% within mathematics	2.3%	5.1%	4.5%	0.0%
Service and sales workers	% within fathers	61.9%	14.3%	19.0%	0.0%
	% within mathematics	6.0%	7.7%	18.2%	0.0%
Skilled agricultural, forestry and fishery workers	% within fathers	53.8%	15.4%	7.7%	7.7%
	% within mathematics	3.2%	5.1%	4.5%	20.0%
Craft related trades workers	% within fathers	63.6%	27.3%	4.5%	4.5%
	% within mathematics	6.4%	15.4%	4.5%	20.0%
Plant and machine operators, and assemblers	% within fathers	54.5%	18.2%	18.2%	0.0%
	% within mathematics	2.8%	5.1%	9.1%	0.0%
Elementary occupations	% within fathers	66.7%	13.3%	13.3%	0.0%
	% within mathematics	4.6%	5.1%	9.1%	0.0%
Armed forces occupations	% within fathers	71.4%	7.1%	14.3%	7.1%
	% within mathematics	4.6%	2.6%	9.1%	20.0%

Table 13 shows that there is a statistically significant association between students' achievement in mathematics and their mothers' occupations ($\chi^2(66, 300) = 133.46, p = 0.000$). There are no statistically significant association between students' achievement in science and their mothers' occupations ($\chi^2(44, 300) = 50.44, p = 0.234$), between students' achievement in technology-based subjects and their mothers' occupations ($\chi^2(55, 300) = 45.99, p = 0.801$), and between students' achievement in engineering subjects and their mothers' occupations ($\chi^2(55, 300) = 45.35, p = 0.820$).

Table 13. Association between mothers' occupations and academic achievement

	Pearson Chi-Square	df	p-value
Science	50.442	44	0.234
Technology	45.986	55	0.801
Engineering	45.347	55	0.820
Mathematics	133.461	66	0.000

Table 14 shows the cross-tabulation analysis between mothers' occupations and students' achievement in mathematics for grades A, B, C and D. Within a job category of the mothers, the percentages of students generally decreased from grade A to grade D. For instance, of the students whose mothers are professionals, 84.7% got grade A, 11.8% got grade B, 2.4% got grade C and 1.2% got grade D. However, unlike the fathers' occupations, the percentages of students with grade A are lower than 10% except for the second category. Still, this shows that students whose mothers have better jobs have higher grades in mathematics.

Table 14. Cross-tabulation between mothers' occupations and students' grades in mathematics

Mother's occupation	Percent	A	B	C	D
Managers	% within mothers	77.3%	13.6%	9.1%	0.0%
	% within mathematics	7.8%	7.7%	9.1%	0.0%
Professionals	% within mothers	84.7%	11.8%	2.4%	1.2%
	% within mathematics	33.0%	25.6%	9.1%	20.0%
Technicians and associate professionals	% within mothers	40.0%	40.0%	20.0%	0.0%
	% within mathematics	0.9%	5.1%	4.5%	0.0%
Clerical support workers	% within mothers	65.0%	15.0%	10.0%	0.0%
	% within mathematics	6.0%	7.7%	9.1%	0.0%
Service and sales workers	% within mothers	61.1%	11.1%	16.7%	5.6%
	% within mathematics	5.0%	5.1%	13.6%	20.0%
Skilled agricultural, forestry and fishery workers	% within mothers	50.0%	0.0%	50.0%	0.0%
	% within mathematics	0.5%	0.0%	4.5%	0.0%
Craft related trades workers	% within mothers	28.6%	28.6%	28.6%	0.0%
	% within mathematics	0.9%	5.1%	9.1%	0.0%
Plant and machine operators, and assemblers	% within mothers	66.7%	33.3%	0.0%	0.0%
	% within mathematics	1.8%	5.1%	0.0%	0.0%
Elementary occupations	% within mothers	42.9%	0.0%	0.0%	14.3%
	% within mathematics	1.4%	0.0%	0.0%	20.0%
Armed forces occupations	% within mothers	33.3%	0.0%	33.3%	33.3%
	% within mathematics	0.5%	0.0%	4.5%	20.0%

4.3. Parents' income and students' academic achievement

Table 15 displays the distribution of parents' income while Table 16 shows the chi-square analysis between parents' income and students' academic achievement in the STEM subjects. The salary range shown in Table 15 follows the household income classification in Malaysia defined as the B40 group (≤ RM 4,850), the M40 group (RM 4,851 to RM 10,970) and the T20 group (≥ RM 10,971) whereby B40 represents the bottom 40%, M40 represents the middle 40% and T20 represents the top 20% of the Malaysian household income. As seen in the table, most of the parents of the students in this study have a combined salary in the lowest salary range, that is most of them are in the B40 group (46.3%).

Table 15. Distribution of parents' income

Income	Number of parents (%)
≤ RM 4,850	139 (46.3%)
RM 4,851 to RM 10,970	107 (35.7%)
≥ RM 10,971	54 (18.0%)

Table 16 shows that there is a statistically significant association between students' achievement in science and their parents' income ($\chi^2(8, 300) = 23.44, p = 0.003$). There is also statistically significant association between students' achievement in mathematics and their parents' income ($\chi^2(12, 300) = 27.09, p = 0.008$). However, there are no statistically significant associations between students' achievement in technology and their parents' income ($\chi^2(10, 300) = 10.74, p = 0.378$), and between students' achievement in engineering and their parents' income ($\chi^2(10, 300) = 8.95, p = 0.536$).

Table 16. Association between parents' income and academic achievement

	Pearson Chi-Square	df	p-value
Science	23.439	8	0.003
Technology	10.736	10	0.378
Engineering	8.954	10	0.536
Mathematics	27.085	12	0.008

Table 17 shows the cross-tabulation between parents' income and students' grades in science. Meanwhile, Table 18 shows the cross-tabulation analyses between parents' income and students' grades in mathematics. Table 17 shows that 29.5% of students whose parents earn less than RM 4,850 (B40 group) obtained grade A in science, 47.7% of students whose parents earn between RM 4,851 and RM 10,970 (M40 group) obtained grade B and 57.4% of students whose parents earn and more than RM 10,971 (T20 group) obtained grade C. In addition, of the students who got grade C, 63.3% have parents in the lowest B40 group while 3.3% have parents in the highest T20 group. This indicates that students obtained better grades in science when their parents' income is higher.

Table 17. Cross-tabulation between parents' income and students' grades in science

Parents' income	Percent	A	B	C
≤ RM 4,850	% within parents	29.5%	42.4%	13.7%
	% within science	33.3%	55.1%	63.3%
RM 4,851 to RM 10,970	% within parents	47.7%	28.0%	9.3%
	% within science	41.5%	28.0%	33.3%
≥ RM 10,971	% within parents	57.4%	33.3%	1.9%
	% within science	25.2%	16.8%	3.3%

Similar with the science grades, the cross-tabulation analysis in Table 18 reveals that the more the students' parents earn, the better their achievement in mathematics is, that is from 66.2% when parents' income is less than RM 4,850 (B40 group) to 90.7% when parents' income is more than RM 10,971 (T20 group) for grade A in mathematics. Also, of the students who got grade C in mathematics, 54.5% have parents in the B40 group while 4.5% have parents in the T20 group. Again, this indicates that students who obtained higher grades in mathematics have parents whose income is higher.

Table 18. Cross-tabulation between parents' income and students' grades in mathematics

Parents' income	Percent	A	B	C	D
≤ RM 4,850	% within parents	66.2%	14.4%	8.6%	1.4%
	% within mathematics	42.2%	51.3%	54.5%	40.0%
RM 4,851 to RM 10,970	% within parents	72.0%	16.8%	8.4%	0.9%
	% within mathematics	35.3%	46.2%	40.9%	20.0%

≥ RM 10,971	% within parents	90.7%	1.9%	1.9%	3.7%
	% within mathematics	22.5%	2.6%	4.5%	40.0%

5. Conclusion

This study focused on the relationships between parents' SES status in terms of their education, occupations and combined income, and the students' academic achievement in STEM as measured by their grades in the STEM subjects. These relationships are in the form of associations since parents' SES status were categorical variables and students' grades were categorical ordinal data (A, B, C, D). Results of the Chi-Square tests for association show that some of these socio-economic variables related to parents' SES were significantly associated with students' academic achievement in STEM subjects. The study shows that there is a significant association between fathers' education level and students' grades in engineering and mathematics whereby students whose fathers have higher academic qualifications have higher grades in these subjects.

As to mothers' education, this study found significant associations between students' grades in science and in mathematics whereby students whose mothers have higher academic qualifications have higher grades in these subjects. Also, there is a significant association between parents' occupations and students' grades in mathematics whereby students whose parents hold better jobs (managers and professionals) have higher grades in mathematics. As to parents' income, this study found significant associations with students' grades in science and in mathematics whereby students whose parents earn more have higher grades in these subjects.

The results of this study are in conformity with previous studies that established a positive association between SES and academic achievement (e.g., Kim et al., 2019; Jeffries et al., 2020). Literature also reveals that SES is likely to play a more important role in students' educational attainment in the developing countries (Kim et al., 2019). More importantly, research found that the strength of the association between SES and students' academic achievement increases from low-income countries to higher income countries with a widening achievement gap worldwide. In addition, the positive association between SES and students' mathematics achievement found in this study agrees with previous studies (e.g., Ersan & Rodriguez, 2020; Xuan et al., 2019).

While there may be many factors that relate to students' academic achievement in STEM subjects, such as students' intellectual ability and affective variables such as students' dispositions and motivations in STEM fields, this study has focused on socio-economic factors pertaining to parents' education, occupation and income. One limitation on the data is that they are based on students' self-reports, and no triangulation was done with other sources or related variables. Also, another limitation of the study is its generalizability since it is limited to the population of Malaysian students.

6. Implications of Study

Although there are studies on students' SES and their academic achievement in general (e.g., Eren & Mahmut, 2022; Lenkeit et al. 2022; Vadivel et al., 2023), there are limited studies on the relationships between students' SES and STEM education. As such, this study is important because it shows the associations between students' academic achievement in STEM subjects and their parents' socio-economic backgrounds. Although this study is limited to the scenario in Malaysia, it fulfils the need for more studies on STEM education in the developing countries. Moreover, instead of investigating students' academic achievement in general STEM education, this study has investigated the relationships of parents' SES status and the four STEM subjects individually.

STEM graduates have the capability to transform society with innovative ideas and creation especially since present day vocations require some amount of knowledge in these subjects. SES has been recognized as an important variable in students' academic achievement. Within the country's context, future studies can investigate the reasons certain variables of SES influence some STEM subjects but not the others. Studies can also identify other mediating variables that influence the relationship between SES and students' academic achievement in Malaysia. On a broader context, this study can be replicated in other developing countries to improve their STEM education. It is imperative to advance the quality of STEM education to achieve the objective of quality education which is one of UNESCO's sustainable development goals.

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Appendix 1

Dear Student,

We are engaged in a research project to study the relationship between **SES** (**S**ocio **E**conomic **S**tatus) and **STEM** (**S**cience, **T**echnology, **E**ngineering & **M**athematics) education in Malaysia. Please fill-out this questionnaire with the needed information. Be assured that your information will be treated confidentially and data will be presented only in summary forms.

Thank you very much for your time.

Name (optional) : ______________________________

Contact number/e-mail (optional) : ______________________________

I give permission to the researchers to use the information provided in this questionnaire.

____
Please sign here

Please tick ✓ on **(only) one** of the options.

1. Gender [ ] Male [ ] Female

2. Ethnic group [ ] Malay [ ] Chinese [ ] Indian [ ] other ethnic groups

3. State your **highest school** qualification and year of exam.

	Before 2020	After 2020
[ ] Sijil Pelajaran Malaysia (SPM)	[ ]	[ ]
[ ] Unified Examination Certificate (UEC)	[ ]	[ ]
[ ] Sijil Tinggi Pelajaran Malaysia (STPM)	[ ]	[ ]
[ ] Others (*Please state* ____________________)	[ ]	[ ]

4. With reference to ***item 4*** above, what are the grades obtained for these subjects (*where applicable*)?

Science	Technology (or Computer related)	Engineering	Mathematics
[ ] A	[ ] A	[ ] A	[ ] A
[ ] B	[ ] B	[ ] B	[ ] B
[ ] C	[ ] C	[ ] C	[ ] C
[ ] D	[ ] D	[ ] D	[ ] D
[ ] E	[ ] E	[ ] E	[ ] E
[ ] F	[ ] F	[ ] F	[ ] F
[ ] not applicable	[ ] not applicable	[ ] not applicable	[ ] not applicable

5. What are your parents' **highest** academic qualification?

	Father	Mother
Not educated	[ ]	[ ]
Primary school	[ ]	[ ]
Secondary school	[ ]	[ ]
Diploma	[ ]	[ ]
Degree	[ ]	[ ]
Masters	[ ]	[ ]
Doctorate	[ ]	[ ]
Others (*Please state* ________________)	[ ]	[ ]

6. What is your current field of study related to?

[ ] Science
[ ] Technology
[ ] Engineering
[ ] Mathematics
[ ] Others

7. With reference to ***item 7*** above, what are the grades obtained for these subjects for the most recent examination (*where applicable*)?

Science	Technology (or Computer related)	Engineering	Mathematics
[ ] A	[ ] A	[ ] A	[ ] A
[ ] B	[ ] B	[ ] B	[ ] B
[ ] C	[ ] C	[ ] C	[ ] C
[ ] D	[ ] D	[ ] D	[ ] D
[ ] E	[ ] E	[ ] E	[ ] E
[ ] F	[ ] F	[ ] F	[ ] F
[ ] not applicable	[ ] not applicable	[ ] not applicable	[ ] not applicable

8. What are your parents' occupations?

	Father	Mother
Managers	[ ]	[ ]
Professional	[ ]	[ ]
Technicians and associate professionals	[ ]	[ ]
Clerical support workers	[ ]	[ ]
Service and sales workers	[ ]	[ ]
Skilled agricultural, forestry and fishery workers	[ ]	[ ]
Craft related trades workers	[ ]	[ ]
Plant and machine operators, and assemblers	[ ]	[ ]
Elementary occupations	[ ]	[ ]
Armed forces occupations	[ ]	[ ]
Others/not sure which category	[ ]	[ ]

9. What is your family size (including parents and siblings)?

[ ] 1 – 3 people
[ ] 1 – 5 people
[ ] > 5 people

10. What is your parents' estimated combined monthly income?

[ ] At most RM 4,850 (≤ RM 4,850)
[ ] Between RM 4,851 and RM 10,970 (RM 4,851 to RM 10,970)
[ ] At least RM 10,971 (≥ RM 10,971)