Teacher, parental and friend influences on STEM interest and career choice intention

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STEM subjects were officially introduced into upper secondary schools in Malaysia in 2020. Form Four students were given the opportunity to choose the STEM subjects before their enrolment in the STEM stream. According to the Malaysian Ministry of Education, this initiative prioritises students' interests to promote STEM involvement among the younger generation and to reinstate STEM components in the curriculum. This study aimed to investigate the influence of teachers, parents and friends on STEM interest and career choice intention among secondary school students in Malaysia. A total of 230 Form Four students from the central region of Peninsular Malaysia participated in a self-report survey. Data were analysed using structural equation modelling. The results showed that parents had a significant influence on both students' STEM interest and career choice intention, whereas teachers did not. Friends were only influential on students' STEM career choice intention, but not on their STEM interest. This study also revealed that students' STEM interest was a significant predictor that influenced their career choice intention in STEM. The findings could be used as the latest reference for authorities, researchers and policy makers to support the STEM initiatives, education system and STEM workforce in Malaysia.

Introduction

Jobs in science, technology, engineering and mathematics (STEM) fields are in high demand to ensure a country's sustainable development (Razali et al., 2018). However, it has been a worldwide scenario that many jobs in STEM fields remain vacant due to shortages of quality STEM professionals (Christensen et al., 2014; Murcia et al., 2020). This issue has raised concerns about the ability of education systems to improve STEM literacy among students, and to retain students to work in the STEM fields (Chachashvili-Bolotin et al., 2016; Christensen et al., 2014).

In Malaysia, eight million workers in the STEM fields will be needed by 2050 to sustain the country's growth (Academy of Sciences Malaysia, 2018). In view of this, the National Education Blueprint 2013-2025 mapped out educational plans and complementary strategies to cater to the country's demands (Ministry of Education [MoE], 2013). Despite the substantial investment and effort in refining STEM education, the composition of the STEM workforce in Malaysia has yet to meet the country's needs (Academy of Sciences Malaysia, 2018; Ali et al., 2018). This is due to the leaky pipeline in the STEM system from the educational curriculum to the workforce (Ali et al., 2018; Razali, et al., 2018; Rozek et al., 2016).

This has been recognised as one of the most urgent issues in Malaysia. Students' enrolment in science at the upper secondary level has remained undesirable since the 1970s in which the 60:40 science to non-science policy was implemented in the national curriculum (Shahali, Ismail & Halim, 2017). Previously, the Academy of Sciences Malaysia

(2018) reported that Malaysia needed one million workers in STEM by 2020. Unfortunately, the National Education Blueprint 2013-2025 was not effective in improving the situation to supply adequate STEM human capital to the labour force, and the current STEM scenario in Malaysia is likely to threaten the country's development.

Subsequently, the new national curriculum, Secondary School Standard Curriculum (*Kurikulum Standard Sekolah Menengah*, KSSM) was introduced in 2017 to reinstate STEM education in Malaysia (MoE, 2013; Shahali, Ismail & Halim, 2017). The implementation of KSSM is an important initiative taken by the MoE to prioritise STEM education based on students' interests. In KSSM, students at the upper secondary levels (Form Four and Form Five) are allowed to choose the STEM subjects they like upon their enrolment in the STEM stream at Form Four. These students are also given the opportunity to choose any one of the STEM packages with different combination of STEM subjects (MoE, 2016a, 2016b).

The major shift in the Malaysian education system is a reinforcement action to impart STEM literacy and career opportunities at school level. According to the MoE, the implementation of KSSM does not only prioritise students' interests, but is also to emphasise STEM components in the curriculum as well as to promote STEM involvement among the younger generation (MoE, 2013, 2016a; Shahali, Ismail & Halim, 2017). The change in the education system is important because adolescents begin to make career decisions at secondary school level (Tai et al., 2006; Murcia et al., 2020).

According to Mohd, Salleh and Mustapha (2010), students' career decision making can be affected by the surrounding influences as their intellectual and emotional development are still immature, thus their role models are usually within the family and school. Humayon et al. (2018) explained that career choice can be influenced by teachers, parents and friends. Similarly, Bergin (2016) also reported that students' STEM interest develops as they grow under the social influences from teachers, parents and friends. Therefore, this study aimed to investigate the influence of teachers, parents and friends on students' STEM interest and career choice intention among secondary school students in Malaysia.

Literature review

STEM refers to a combination of disciplines including science, technology, engineering and mathematics. The purpose of STEM education is to prepare STEM-talented students who are able to address and solve real-life problems, as well as to create new ideas and inventions using STEM skills (Ali et al., 2018). As more jobs are becoming available in the global STEM industries, more STEM talents are needed to fill the vacancies.

According to Kelley and Knowles (2016), many education systems and policy makers around the world have taken initiatives to reform their education systems to overcome shortages in the STEM workforce. In the effort to address the issue, reinforcement of STEM education is often done by integrating STEM elements into the education system. Kelley and Knowles (2016) mentioned that an integrated curricular approach is widely implemented to solve global challenges in the current STEM scenario. According to

English (2017), STEM integration is an approach that connects students' learning across the four STEM disciplines to the STEM knowledge they learn at school. This approach facilitates students to have knowledge and understanding of STEM in their learning, and helps enhance its relevance to solving real-world challenges. However, opinions on the implementation of STEM integration vary across the globe due to differences in curricula and contexts (English, 2017).

Among the most popular STEM integration approaches at the secondary school level are in STEM projects, courses and outreach programs. Research conducted by Vennix et al. (2018) in the United States and Netherlands reported that students are able to apply STEM skills via their learning experiences from STEM projects, courses and outreach programs. Chen and Chang (2018) suggested that robotic education has been implemented effectively in the United States, Europe, and Taiwan to promote students' interests in STEM. It was also cited in English (2017) that Australia has implemented the *Australian Design and Technologies Curriculum* to strengthen the STEM disciplines in its education system.

In Malaysia, the national curriculum has also undergone reformation to consolidate its STEM education. The old national curriculum, *Kurikulum Bersepadu Sekolah Menengah* (KBSM), has been replaced by KSSM in order to produce STEM-literate students, in which the students are given the opportunity to learn subjects beyond pure sciences. In KSSM, twelve STEM subjects are offered to the STEM stream students, namely physics, chemistry, biology, additional mathematics, additional science, technical graphic communication, basics of sustainability, agriculture, home science, invention, computer science, and sport science (MoE, 2016a, 2016b).

Despite a great emphasis placed on knowledge content, Academy of Sciences Malaysia (2018) pointed out that students lack awareness of opportunities and information related to STEM careers. It also reported that parental influence and limited encouragement to engage in STEM were among the reasons that led to low student enrolment in the STEM stream. The STEM subjects introduced via the reformation of the national curriculum aimed to ensure students are provided with adequate STEM knowledge and skills that they will be able to apply in the STEM workforce in the future (Shahali, Ismail & Halim, 2017). It was noted that too much emphasis on STEM content in the curriculum does not instil interest among students to take up STEM subjects, so eventually there could be lesser candidates enrolling in the STEM stream (Academy of Sciences Malaysia, 2018; Ali et al., 2018).

Shahali, Halim, Rasul, Osman and Zulkifeli (2017) noted that students' interests in STEM influenced their decisions to take up STEM subjects in school. Their research further revealed that STEM interest is indeed a precursor of students' career choice intention in STEM. Likewise, Tai et al. (2006) also highlighted that students who show greater interest in STEM careers are more likely to further education in the STEM fields, followed by venturing into STEM professions. Hence, STEM interest must be taken into consideration in discussion of students' STEM career choice.

Career choice is a decision made by an individual which will direct the person's future (Humayon et al., 2018); Mohd et al., 2010) Humayon et al. (2018) explained that career choice is based on a person's interest as well as external factors such as influences from parents, peers and role models. Rozek et al. (2017) also reported that there is a need to prepare students for STEM career pursuits during high school. In Malaysia, Mohd et al. (2010) emphasised that career decision is essentially important for students at the secondary school level, as they develop the ability to relate academic subjects to future applications. Previous studies have revealed that students' career choice can be influenced by teachers, parents and friends (Bergin, 2016; Humayon et al., 2018).

Mohd et al. (2010) described teachers, parents and friends as external contexts who can offer and limit opportunities that are available to students' career choices in technical areas. Their research used the *Social Cognitive Career Theory* (SCCT) by Lent et al. (1994) to examine the effect of contextual aspects upon career planning and development among students. The study focused on parents and teachers as role models whom the students considered inspiring and resourceful. Among teachers, parents and friends, Mohd et al. (2010) highlighted that parents had the greatest influence on students' career choices, because parents were the closest people who can provide the necessary information related to careers.

In Murcia et al.'s (2020) qualitative research, SCCT was used to explore the influencers of secondary school students' STEM career interests and choices by considering the importance of STEM self-efficacy. Three career counsellors together with fifteen students and their parents were involved in the interviews. Murcia et al. (2020) found that parents' career experiences and students' learning achievements can influence their career choices in STEM. The research also reported that career counsellors also play an important role in providing both parents and students the exposure to STEM awareness and resources (Murcia et al., 2020).

Wang and Degol (2013) used *Expectancy-Value Theory* by Eccles (1994) to examine gender differences in STEM educational and career choices. Their study revealed that teachers, parents and friends were key influences that enabled students to engage in STEM-related activities. Teachers are considered as students' role models and source of support. It was reported in the same study that teachers' encouragement can influence students' participation in mathematics and science. They mentioned that a student's career interests and values can also be endorsed by the home environment that parents create (Wang & Degol, 2013). Teenage students' involvement and achievement in mathematics and science were associated with peer support (Wang & Degol, 2013). In the literature, Wang and Degol (2013) noted that adolescents had a greater tendency to conform to peer norms, hence teenage students were more likely to develop career intentions that were similar to their friends.

Using the *Model of Interest Development* by Hidi and Renninger (2006), Bergin (2016) noted that students' career interests and subsequent ventures into the workforce are influenced by their surroundings. Teachers, parents and friends play the biggest part in students' social experiences, hence they develop interests and preferences in careers they are

exposed to from early stages of life at school and at home (Bergin, 2016). Teachers are an important source of students' career interests in STEM, as teachers teach the relevant content in the classroom (Bergin, 2016). Meanwhile, students grow up under constant influences and guidance from their parents, hence their interests, beliefs and behaviours are greatly affected by the familial conditions that they are exposed to (Bergin, 2016). The same study also mentioned that students are highly dependent on social belongingness. Students tend to develop similar pursuit of interests in careers that their friends intend to pursue (Bergin, 2016).

The *Theory of Planned Behavior* (TPB) is one of the most widely used theories to predict future behaviour. Subjective norms in TPB refer to an individual's perceived social pressure from significant others to perform or avoid a behaviour (Ajzen, 1991). The influence of teachers, parents and friends on students' career interests and choices have been consistently reported in previous studies. Hence, this study proposed that teachers, parents and friends are the significant others who play important roles in students' social experience and decision making. Subjective norms in the TPB are therefore used as the guiding framework of this study to develop the proposed research model and the research instrument. The present study aimed to examine the influences of teachers, parents and friends on STEM interest and career choice intention among Form Four STEM stream students in Peninsular Malaysia.

The following hypotheses were formulated based on the literature review:

H1: Teachers will have a significant influence on students' STEM interest.
H2: Parents will have a significant influence on students' STEM interest.
H3: Friends will have a significant influence on students' STEM interest.
H4: Teachers will have a significant influence on students' career choice intention.
H5: Parents will have a significant influence on students' career choice intention.
H6: Friends will have a significant influence on students' career choice intention.
H7: STEM interest will have a significant influence on students' career choice intention.

Figure 1 shows the proposed research model of this study according to the hypotheses.

Method

Research instrument

A self-report questionnaire was used in this study. Three experts in the research areas reviewed the questionnaire to establish the face and content validity of the research instrument. Revisions were subsequently made based on the experts' comments. Cognitive interviews with fifteen Form Four STEM stream students were also conducted to ensure the questionnaire was appropriate for the target sample (Beatty & Willis, 2007). The students were requested to comment on questionnaire properties such as wording clarity to ensure the items matched their level of understanding.

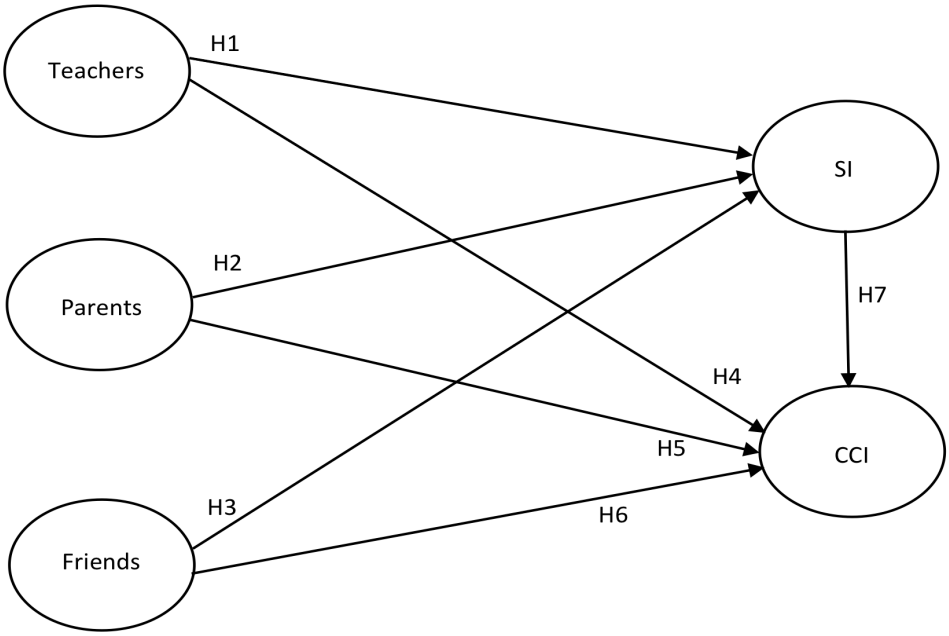

Figure 1: Proposed research model
Note: Teachers = Teacher influence; Parents = Parental influence;
Friends = Friend influence; SI = STEM interest; CCI = Career choice intention.

The final self-report questionnaire consisted of two sections. The first sought demographic information such as date of birth and name of school. The second section comprised 27 items measuring teacher influence, parental influence, friend influence, STEM interest and career choice intention, aligned with the objectives of this study. All items were measured on a seven-point Likert scale, ranging from disagree = 1 to agree =7. Items from teacher influence, parental influence, friend influence and career choice intention were adapted from Ajzen (2002). Teacher influence was measured with items such as "My teachers think that I should choose a career in STEM" and "When it comes to choosing a career, I feel the need to do what my teachers think I should do". Parental influence was measured using items such as "My parents think that I should choose a career in STEM" and "My parents encourage me to choose a career in STEM fields". Among the items that measured career choice intention were "I aim to choose a career in STEM" and "There is a high possibility that I will choose a career in STEM". On the other hand, the items from STEM interest were adapted from Kier et al. (2014). Items that measured stem interest included, for example, "I am interested in careers that use science, technology, engineering or mathematics" and "I like my science, technology, engineering or mathematics classes".

Sampling and data collection

The recommended sample size to obtain reliable results using Structural Equation Modelling (SEM) is 100–150 (Hair, Black, Babin, Anderson & Tatham, 2010; Kline, 2005). It was also reported that the critical sample size of above 200 is sufficient to

provide adequate statistical power for data analysis (Hair et al., 2010; Schmidt & Hollensen, 2006). Hence, a total of 230 useable questionnaires were collected using a stratified proportionate sampling method. The data was collected from Form Four STEM stream students who were 16 years old. The participants were from the central region of Peninsular Malaysia, namely Selangor (n = 161, 70%), Federal State of Kuala Lumpur (n = 61, 27%) and Federal State of Putrajaya (n = 8, 3%). Among the participants, 60% (n = 138) were females and 40% (n=92) were males.

Prior to the commencement of data collection, approvals were obtained from the MoE, state education departments, and the Scientific and Ethical Review Committee at the researchers' university. According to the terms granted by the MoE, this research could only collect data from Form Four students, and Form Five students were to be excluded as they were preparing for the national Malaysian Certificate of Education (SPM) exam. All participants were also informed on the purpose of the research before data collection. The researchers also sought the participants' informed consent by emphasising that the research was on a voluntary basis and all their information would be kept confidential by the research team. The participants took approximately 20 minutes to complete the questionnaire.

Data analysis

A quantitative survey research method was employed in this study. Data were analysed using SEM with *AMOS* to examine relationships between the observed and latent variables as proposed in this study.

The proposed research model was assessed for construct validity, convergent validity and discriminant validity which were assured by computing fitness indices. A two-step approach including the measurement model, and the structural model is recommended (Schumacker & Lomax, 2012). The measurement model examines how well the observed indicators measure the latent variables. Subsequently, the structural model is tested to examine the proposed relationships between the exogenous and endogenous variables.

Results

Measurement model assessment

The measurement model was assessed via confirmatory factor analysis (CFA) using *AMOS*. CFA was used to assess the measurement model fit as well as its convergent and discriminant validity (Hair et al., 2010). The model fit indices used to evaluate the measurement model were comparative fit index (CFI), Tucker-Lewis index (TLI), goodness of fit (GFI), parsimony normed fit index (PNFI), root mean square error of approximation (RMSEA), and normed chi-square (χ^2/df). According to Hair et al. (2010), a model is considered fit when the values of CFI and TLI exceeds 0.90. Besides, the values of GFI above 0.80, PNFI above 0.50, RMSEA below 0.08, and χ^2/df below 3.0 indicate a good fit (Hair et al., 2010; Kline 2005; MacCallum & Hong, 1997).

The initial measurement model offered a poor fit with CFI = 0.869, TLI = 0.853, GFI = 0.764, PNFI = 0.731, RMSEA = 0.094, and χ^2/df = 3.024. Hence, the process of improving the model was done by using modification indices and stabilising the error variances. Consequently, seven out of twenty-seven items from the initial model were dropped: two items from teacher influence (T4 and T5), two items from parental influence (P2 and P3), one item from friend influence (F5), and two items from STEM interest (SI3 and SI5).

Table 1 shows the fit indices of the revised measurement model. The values of CFI was 0.945, TLI was 0.935, GFI was 0.867, PNFI was 0.766, RMSEA was 0.078, and χ^2/df was 2.411 (χ^2 = 380.923, df = 158). Hence, the CFA results suggested that the revised measurement model had an acceptable model fit with the sample data.

Table 1: Fit indices for the measurement model

Fit indices	Recommended cut-off values (a)	Results	Fit (yes/no)
Comparative fit index (CFI)	>0.90	0.945	Yes
Tucker-Lewis index (TLI)	>0.80	0.935	Yes
Comparative fit index (GFI)	>0.80	0.867	Yes
Parsimony normed fit index (PNFI)	>0.50	0.766	Yes
Root mean square error of approximation (RMSEA)	<0.08	0.078	Yes
Normed chi-square (χ^2/df)	<3.00	2.411	Yes

a. References taken from MacCallum and Hong (1997), Hair et al. (2010) and Kline (2005)

Table 2: Results for measurement model

Constructs	Items	FL	α	CR	AVE
Teachers	3	0.682-0.812	0.732	0.773	0.534
Parents	3	0.765-0.928	0.852	0.863	0.679
Friends	4	0.668-0.726	0.707	0.817	0.528
STEM Interest (SI)	3	0.598-0.874	0.829	0.828	0.623
Career Choice Intention (CCI)	7	0.830-0.956	0.974	0.973	0.838

Notes: FL = Factor loading; α = Cronbach's alpha; CR = Composite reliability;
AVE = Average variance extracted.

According to Hair et al. (2010), the convergent validity of the data can be examined via the factor loadings, composite reliability (CR) and average variance extracted (AVE). The factor loadings of the construct items ranged from 0.598 to 0.956 (Table 2), exceeding the minimum of 0.55 required for consideration as good (Comrey & Lee, 1992). Concerning CR and AVE, Hair et al. (2010) recommended that the value of CR should be greater than 0.70, and AVE should be greater than 0.50. As shown in Table 2, these recommended threshold values are exceeded. Also, Cronbach's alpha values for all constructs were above the recommended value of 0.70 (Pallant, 2013). Hence convergent validity for the measurement model in this study was deemed adequate.

In the assessment of discriminant validity, Fornell and Larcker (1981) recommended that the values of squared root of AVE for each construct (diagonal entries) should be greater than the variance shared between any two constructs (off-diagonal entries). The results in Table 3 shows that the squared root of AVE of all constructs are greater than the shared variance between constructs. Thus, the results reflected that all constructs in this study also established desirable discriminant validity.

Table 3: Discriminant validity for the measurement model

Construct	AVE	SI	Teachers	Parents	Friends	CCI
SI	0.623	(0.79)				
Teachers	0.534	0.33	(0.73)			
Parents	0.679	0.46	0.51	(0.82)		
Friends	0.528	0.33	0.72	0.57	(0.73)	
CCI	0.838	0.76	0.39	0.57	0.46	(0.92)

Note: Diagonal in parentheses: square root of AVE by constructs; Off-diagonal: variance shared between constructs. SI = STEM interest; CCI = Career choice intention.

Structural model assessment and hypothesis testing

SEM was used in this study to examine the overall model fit and the causal strengths of each causal path in the model, using several model-fit indices (Hair et al., 2010). In the evaluation of the structural model, a set of model-fit indices, CFI, TLI, GFI, PNFI, RMSEA and χ^2/df, was used to evaluate the structural model of the study. Table 4 shows the fit indices and their level of acceptable fit for the proposed structural model. The proposed model had a good fit with CFI = 0.945, TLI = 0.933, GFI = 0.863, PNFI = 0.756, RMSEA = 0.079, and $\chi^2/df = 2.415$ ($\chi^2 = 381.508$, df = 158).

Table 4: Fit indices for the structural model

Fit indices	Recommended cut-off values (a)	Results	Fit (yes/no)
Comparative fit index (CFI)	>0.90	0.945	Yes
Tucker-Lewis index (TLI)	>0.80	0.933	Yes
Comparative fit index (GFI)	>0.80	0.863	Yes
Parsimony normed fit index (PNFI)	>0.50	0.756	Yes
Root mean square error of approximation (RMSEA)	<0.08	0.079	Yes
Normed chi-square (2/df)	<3.00	2.415	Yes

a. References taken from MacCallum and Hong (1997), Hair et al. (2010) and Kline (2005)

The tests of the structural model showed that four out of seven hypotheses proposed were supported by the results in this study. Two endogenous variables (STEM interest and career choice intention) were tested in the model. STEM interest was explained by parental influence with a R^2 of 0.613, which is accounted for 61.3% of the variance found in STEM interest. The combination of teachers, parents and friends explained 54.8% ($R^2 = 0.548$) of the variance in career choice intention. The standardised path coefficient for

H2 and H7 were significant at $p < .001$, while H5 and H6 were significant at $p < 0.01$ and $p < 0.05$ respectively. However, H1, H3 and H4 were not supported in this study. A summary of the hypotheses testing results is shown in Table 5. The final research model is displayed in Figure 2.

Table 5: Summary of hypothesis testing

	Path	Std. est.	Critical ratio	Path coeff.	Results
H1	Teacher influence à STEM interest	0.135	0.815	.120	Not supp.
H2	Parental influence à STEM interest	0.331	4.198***	.395	Supp.
H3	Friend influence à STEM interest	0.136	0.061	.009	Not supp.
H4	Teacher influence à Career choice intention	0.115	-0.847	.806	Not supp.
H5	Parental influence à Career choice intention	0.070	3.047**	.207	Supp.
H6	Friend influence à Career choice intention	0.116	1.962*	.205	Supp.
H7	STEM interest à Career choice intention	0.077	9.995***	.626	Supp.

Notes: *$p < 0.05$; **$p < .01$; *** $p < .001$. Std. est.= Standard estimate; Supp.= supported

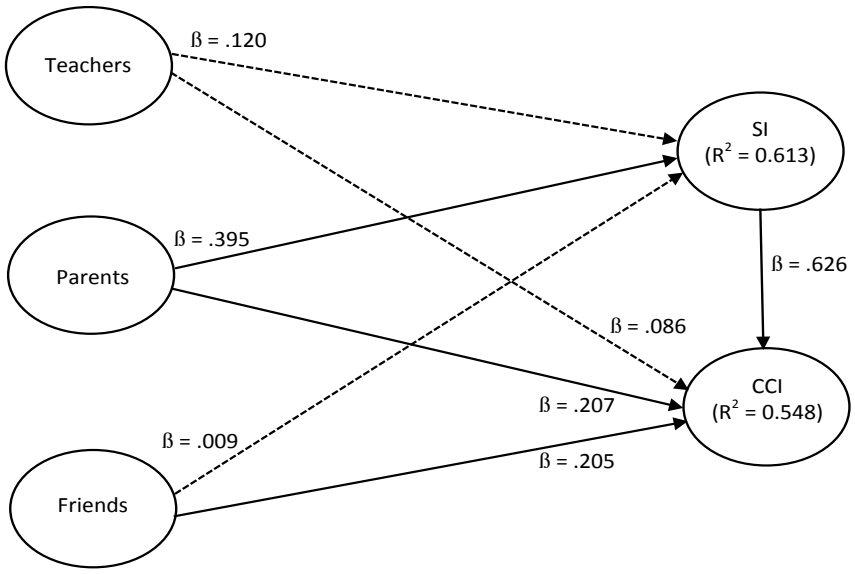

Figure 2: Final research model

Notes: Teachers = Teacher influence, Parents = Parental influence, Friends = Friend influence, SI = STEM interest, CCI = Career choice intention; ß = path coefficient; R^2 = Squared multiple correlations (variance explained).

Discussion

The objective of this study was to examine the influence of teachers, parents and friends on STEM interest and career choice intention among Form Four STEM stream students in the central region of Peninsular Malaysia. The research objective was achieved by

investigating teacher, parental and friend influences on STEM interest; teacher, parental and friend influences on career choice intention; and the influence of students' STEM interest on their intention to choose a career in STEM. The hypotheses in this study were tested using SEM.

Overall, this study found that parental influence was the only factor that showed statistical significance on students' STEM interest. Parents, friends and STEM interest had statistically significant influences on students' career choice intention. Specifically, the results revealed that parental influence showed strong statistical significance on both students' STEM interest and career choice intention. By contrast, teacher influence did not show statistical significance on both students' STEM interest and career choice intention. This study also found that friends influence had statistical significance on students' career choice intention, but not on STEM interest. Lastly, students' career choice intention was statistically influenced by their STEM interest.

In this study, parental influence had strong influence on STEM interest and career choice intention among Form Four STEM stream students in the central region of Peninsular Malaysia. This finding is consistent with a recent study conducted by Razali et al. (2018) which involved Form Four science stream students in Selangor. In their study, it was suggested that parents can influence students' interests in STEM careers, and will subsequently enable them to choose STEM-based careers. According to Humayon et al. (2018), parental influence on students' career choice is common in the Asian culture. Asian parents offer support and sponsorship to their children to meet their expectations, while Asian children have great acceptance of parental authority including career choice. This finding is also supported by Saleem, Hanan, Saleem and Shamshad (2014) who reported that parents had influence on students' career choice through their profession, knowledge, income and beliefs. Evidence from the present study confirmed that students from the central region will develop interest and career choice intention in STEM based on their parents' advice and encouragement.

On the other hand, this study found that teachers did not have a statistically significant influence on both students' STEM interest and career choice intention. This finding means that students were not likely to develop STEM interests and career choice intention based on their teachers' opinion, advice and encouragement. This finding contradicts previous studies that reported the influence of teachers on students' interests and career choice (Bergin, 2016; Mohd et al., 2010; Wang & Degol, 2013). The contradictory finding in this study may be due to the issues in the curriculum and school environment as discussed by Academy of Sciences Malaysia (2018) and Ali et al. (2018). It was reported in Ali et al. (2018) that STEM education in the curriculum heavily emphasised on STEM content knowledge, hence teachers are obligated to focus on teaching and delivery according to the syllabi. Consequently, students regard STEM learning with teachers at school as not interesting and too theoretical, because their STEM experience involving hands-on activities has become limited. This also results in students' decreasing interests towards STEM subjects which are deemed to be difficult, thus fewer students are likely to enrol in the STEM stream at school.

From the results, friends had statistical significant influence on students' career choice intention, but not on their STEM interest. The findings suggest partial importance of the role of friends on career decision making among Form Four STEM stream students in the central region of Peninsular Malaysia. This finding suggests that the students are more likely to choose a career in STEM when their friends support and encourage them. According to Wang and Degol (2013), students' intention or desire to participate in science and mathematics is associated with peer support due to peer norms among teenagers. Hence, students' decision to engage in STEM can be influenced by their friends due to their norms. Conversely, the finding in this study indicates that students are not likely to develop STEM interest under their friends' influence. This finding is in contrast to previous studies which reported that friends had influence on students' interests (Vulperhorst et al., 2018; Wang & Degol, 2013). This finding suggests that STEM interest is not dependant on peer support, but reliant on personal interest in STEM. Bergin (2016) mentioned that interest is developed through exposure to a topic including its relevant information and subjects. As such, students' interests in STEM could possibly develop through personal exposure on subjects and information related to STEM but not due to the influence of friends.

Interest has been constantly reported as an important predictor of career choice (Humayon et al., 2018; Meddour et al., 2016; Razali et al., 2018). Aligned with the literature, this study found that STEM interest had statistical significance on career choice intention among Form Four STEM stream students in the central region of Peninsular Malaysia. This finding indicates that students' likes and dislikes on STEM had significant influence on their intention to choose a career in STEM. This is supported by Humayon et al. (2018) who reported that students with great interest towards a specific career were motivated to venture into the profession of their preference. In Meddour et al. (2016), interest was also reported as the most important predictor of career choice. Students' interests in specific academic subjects will affect their participation in the subjects. These students are also more likely to choose careers according to their own preference, hence making greater effort to achieve their career goals (Meddour et al., 2016).

Conclusions

Results in this study revealed that parents had significant influence on students' STEM interest and career choice intention, whereas teachers did not. Besides, friends were only influential in students' career choice intention, but not in their STEM interest. This study also found that STEM interest was a significant predictor of career choice intention.

There are a number of limitations in this study. The data was collected through a self-report survey, hence it could have led to issues on common method variance in the present study. In line with the research objective, this study focused on teacher, parental and friend influences on STEM interest and career choice intention, hence the mediating effect of STEM interest was not examined. Besides, the representativeness of the study was affected because the findings can only be generalised to Form Four students. The research scope was set according to restrictions by the authorities, excluding Form Five students who were preparing for exams. In addition, this study focused only on the central

region of Peninsular Malaysia, comprising the state of Selangor and the Federal Territories of Putrajaya and Kuala Lumpur. According to the MoE (2013), students from these areas have more access to STEM-related informed choices and career awareness, because the central region is the hub of the country where resources are prioritised.

Future studies could also further explore the underlying factors in explaining Form Four students' STEM interest and career choice intention by using a qualitative approach. It would also be useful to find out the reason parents were more influential compared to teachers and friends among the students in developing an interest and making a career choice in STEM. Future research could consider studying factors such as career counselling (Murcia et al., 2020), and school and passionate affinity groups (Bergin, 2016) to identify other possible factors that could influence the students' interest and career choice. . Researchers are also recommended to further investigate the mediating effect of STEM interest between the influence of teachers, parents and friends, and career choice intention. Similar research could be duplicated based on the model developed in this study. Future research could expand the scope of study by involving students from other contexts, including students who have just completed secondary or tertiary education, as they are more mature and likely to have clearer ideas about career choice. Additionally, future studies could be expanded to other regions in Malaysia to improve the representativeness and generalisability of the findings.

The empirical findings offer meaningful facts and data about the influence of teachers, parents and friends on STEM interest and career choice from STEM stream students' perspectives who are under the Malaysian STEM education system. Hence, the findings could be used as the latest reference for the authorities, researchers and policy makers to support the STEM initiatives, as well as the national education system and STEM workforce in Malaysia. For instance, parental influence was found to be an important factor that influences STEM interest and career choice intention among the students.

For future implications, policy makers and the relevant authorities could focus more on out-of-school STEM activities that involve parents' participation. This would ensure the parents are equally well-informed and aware about the latest updates in STEM fields so that they would also encourage their children to develop interests and career intentions in STEM. Similarly, STEM interest could be further emphasised to enable students to be more aware of the opportunities in STEM careers. This could also be done by including more interesting complementary STEM programs in the curriculum, such as inviting in-service STEM professionals to share their experiences with students and parents. Indeed, various initiatives have been made to encourage STEM interest and career choice (Shahali, Ismail & Halim, 2017). The findings of this study can help policy makers and stakeholders to design more relevant STEM programs and activities, and more effective strategies to promote STEM in Malaysia.

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Appendix: Questionnaire items

Teacher influence	T1	My teachers think that I should choose a career in STEM.
	T2	When it comes to choosing a career, I feel the need to do what my teachers think I should do.
	T3	I listen to my teachers' advice when it comes to choosing a career.
	T4	My teachers' teaching encourages me to choose a career in STEM.
	T5	My teachers' teaching improves my interest in choosing a career in STEM.
Parental influence	P1	My parents think that I should choose a career in STEM.
	P2	When it comes to choosing a career, I feel the need to do what my parents think I should do.
	P3	I listen to my parents' advice when it comes to choosing a career.
	P4	My parents encourage me to choose a career in STEM fields.
	P5	My parents' encouragement improves my interest in choosing a career in STEM.
Friend influence	F1	My friends think that I should choose a career in STEM.
	F2	When it comes to choosing a career, I feel the need to do what my friends think I should do.
	F3	I listen to my friends' advice when it comes to choosing a career.
	F4	My friends encourage me to choose a career in STEM.
	F5	My friends' encouragement improves my interest to choose a career in STEM.
STEM interest	SI1	I am interested in careers that use science, technology, engineering or mathematics.
	SI2	I like my Science/ Technology/ Engineering/ Mathematics classes.
	SI3	I like to work in laboratories.
	SI4	I like to do experiment to find the best way to do something.
	SI5	I like to follow step-by-step procedures.
Career choice intention	CCI1	I aim to choose a career in STEM.
	CCI2	I plan to choose a career in STEM.
	CCI3	I will choose a career in STEM.
	CCI4	I am going to choose a career in STEM.
	CCI5	I guess I would choose a career in STEM.
	CCI6	I expect to choose a career in STEM.
	CCI7	There is a high possibility that I will choose a career in STEM.

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