Factors influencing interest in STEM careers: An exploratory factor analysis

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Abstract

Identifying the factors that contribute to interest in STEM will provide guidance for successful interventions as well as contribute to our understanding of how students learn STEM content and how STEM career trajectories are developed. Thus, this study aimed to develop an instrument of STEM career interest. The process of the instrument development involved four stages, namely establishing content validity, conducting a pre-test, conducting exploratory factor analysis, and performing construct reliability. In this study, an 80-item questionnaire was administered to 354 middle secondary school students (14 years of age). Exploratory factor analysis indicated that the 80 items were grouped into four main factors, namely environmental factors, STEM self-efficacy, perception of STEM careers and interest in STEM careers. Four sub-constructs were grouped under environmental factors and these are activities in the classroom, activities outside the classroom, social influences and media influences. STEM self-efficacy consisted of abilities in science, technology, engineering and mathematics while perception of STEM careers consisted of two sub-constructs i.e., job prospects and skills needed in STEM careers. STEM career fields were divided into two sub-constructs i.e., life sciences and physical sciences. It is expected that this instrument would be helpful in research and evaluation that is aimed at measuring STEM career interest in students.

Keywords: Interest in STEM careers, instrument development, social cognitive career theory (SCCT), exploratory factor analysis

Introduction

STEM education aims to realize the quality and quantity of skilled human capital needed in the STEM workforce that is capable of research, innovation and commercialization. Thus, careers in science, technology, engineering and mathematics (STEM) play an important role in creating innovation to generate ideas and in creating innovation to establish companies for economic development (Kier et al., 2013; Langdon et al., 2013). Many countries worldwide are facing problems in recruiting more individuals into science, technology, engineering, and mathematics (STEM) industries (Kier et al., 2014).

Globally, the number of students interested in STEM careers has decreased from year to year (Cridge & Cridge, 2015; Venville et al., 2013). The same situation is also occurring in Malaysia where the number of students pursuing science studies has declined noticeably since 2007. This scenario continues at the university level as evidenced by the number of student admission into Malaysian universities. In the 2014/2015 academic session, a total of 74,071 candidates from Higher School Certificate (STPM) / Matriculation / Foundation courses had submitted their applications to universities. Of these students, only 29,963 candidates applied for the science fields while a total of 44,108 candidates applied for the Arts fields (MOE, 2014). Malaysia has projected at least 500,000 workers in science and technology by 2020 but the small number of students choosing science suggests that the number of skilled workers such as scientists, engineers, and technologists will be reduced in the future.

Understanding and identifying the factors that influence students' career choice is critical because shortages in STEM skilled workforce would have an impact on future economic development (Kuechler et al., 2009). Moreover, identifying the factors contributing to interest in STEM careers may also contribute to the understanding of how students learn STEM content and provide guidance in designing intervention and teacher education programs (Hall et al., 2011; Nugent et al., 2015). Factors that influence STEM career choice are commonly based on the background, environmental factors and intrinsic factors of the individual (Nugent et al., 2015; Lent et al., 2000). This study aimed to develop an instrument which measures interest in STEM careers and the factors that influence interest in STEM careers for middle school students (14 years of age). At this stage, these students are developing their own interest and recognizing their academic strengths which would thus influence their interest in STEM careers. Therefore, developing appropriate interventions during high school before the students decide on subject choices related to their career interests is considered helpful and timely (Maltese & Tai, 2011; Nugent et al., 2015).

Literature Review

Theories and Models of Interest in STEM Careers

Several theories and models can be used as a basis for identifying the factors that influence interest in STEM careers. Related theories are the Social Cognitive Career Theory (SCCT), Holland's theory of career choice, and Super's Career Development Theory. The SCCT was developed by Lent et al. (1994; 2000) based on the social cognitive theory proposed by Bandura in 1977. The SCCT claims that aspirations and career choices are a result of personal factors which involve the environment and behavior (Maltese & Tai, 2011). This theory is in common with the theory of planned behavior (Ajzen, 2005) where both theories investigate self-efficacy and social influences as the effects of the action (Sahin et al., 2015). This theory has been used in previous studies to examine the factors that affect interest in STEM careers (Kier et al., 2014; Nugent et al., 2015; Sahin et al., 2015).

Holland's theory claims that career choice is compatible with personality type. Holland categorized a person's personality into six traits, namely being realistic or aggressive, investigative or intellectual, artistic or imaginative, social or extrovert and enterprising or conventional. Based on the six traits, realistic and investigative features are the most relevant to STEM careers. Research by Chen and Simpson (2015) found that individuals with an investigative personality tend to choose STEM majors.

Super's theory uses a process approach that develops across the lifespan of an individual. In Super's theory, there are several stages of career development, namely growth, exploration, establishment, maintenance and decline. The growth stage explains the formation of self-concept by identifying the significant people in the individual's family and school from which the individuals gain exposure to occupations. At this stage, individuals will highlight their interests and abilities by engaging themselves in social activities at school or at home. Super's theory divided this stage into three parts: i. Fantasy (ages 4 to 10); ii. Interest (ages 11 to 12); and iii. Abilities (ages 13 to 14). The exploration stage is the stage where the individuals are in the age range of 15 to 24. At this stage, Super's theory is divided into three parts: i. Not fixed (ages 15 to 17); ii. Transition (ages 18 to 21); and iii. Trial (ages 22 to 24). Based on the theory, individuals between the ages of 14 to 17 tend to continuously explore their career interest which is not fixed. Thus, intervention and a supportive environment are very important in developing interests and abilities of students in STEM careers at this stage.

Based on the previous theories and models of interest in STEM careers, this study adapted the SCCT theory as the main theory and supported it with other theories, as mentioned previously. Based on career trajectory theories, it appears that there are four crucial factors affecting STEM careers, i.e. environmental factors, STEM self-efficacy, perception of STEM careers and interest in STEM careers. The following subtopics elaborate on the sub factors involved in each of the four main factors identified through the literature review.

Environmental Factors Affecting Interest in STEM Careers

Studies have shown that there are four environmental factors affecting interest in STEM careers. These environmental factors are activities in the classroom, activities outside the classroom, social influences, and media influences.

Activities in the Classroom

Students who are exposed to school environment and curriculum that support active involvement in scientific activities or STEM engender aspirations and interest in related STEM careers (Acher et al., 2013; Jacobs et al., 1998). Therefore, in the school environment, teaching and learning strategies are essential in developing the skills needed in jobs related to STEM fields. Based on previous studies, teaching and learning strategies that can improve skills in the STEM fields are problem solving strategies, hands-on activities, science content associated with everyday life applications, cooperative learning, investigative activities, group work and active learning (Buschor et al., 2014; Sahin et al., 2015).

Activities Outside the Classroom

Informal STEM education acts as a complement to formal education in attracting students to participate in STEM fields. Previous studies have shown the positive effects on students engaged in informal STEM activities in terms of knowledge, attitude and interest in STEM and the desire to engage in STEM careers. Among the activities outside the classroom that were carried out are science field work, science camps, learning in science centers, museums, zoos, robotics competitions, clubs related to STEM activities, and interviews with scientists (Archer et al., 2013; Ayar, 2015; Gwen et al., 2016 ; Mills & Katzman, 2015; National Governors Association, 2016; Sahin et al., 2015).

Based on studies conducted by Denson et al. (2015), the benefits of informal STEM include getting informal mentoring, learning in a fun way, applying mathematics and science simultaneously, building participants' confidence in the necessary STEM skills, and fostering camaraderie among the participants. These skills are indispensable and important for nurturing a competent workforce in the field of STEM in the future.

Social Influences

Social influence is the influence of the person closest to the student such as the influence of parents, family members, teachers, friends, counselors, role models and local communities. Buday et al. (2012) found that social support is related to the choice of a career and contributes to a positive perception of the career.

In line with Bandura's (1977) social cognitive theory, parents, teachers, and friends not only play a role in deciding the choice of a career, but also play an important role in the development of self-efficacy. This is confirmed by previous studies which found that students' self-efficacy or the students' belief in their own ability in the STEM subject increased when parents, teachers and friends stressed the value and importance of STEM skills (Nugent et al., 2015; Rice et al., 2013).

Among the types of social influences, previous studies have indicated that parents are the most influential on students in STEM-related career decision-making (Nugent et al., 2015; Sahin et al., 2015; White & Harrison, 2012). Parents who manage to influence their children in a profession have enough information to pass on to their children in order to help in the process of career selection (Hall et al., 2011).

Cridge and Cridge (2015) state that parents play an important role in children's life, including in the choice of career in the early stages of life. Previous research findings have shown that parental education has a relationship with students' ambition in university. As early as 4 years of age, children would already be aware of the work done by their parents. They have positive and negative feedback related to work and understand the differences in careers. In the early ages, parents often guide their children to develop skills and observe their children's academic progress. Parents provide support to their children by sending them to tuition centers to improve their achievement in science and mathematics in the early stages of schooling.

When the children enter secondary school, parents affect the children in their decision-making in choosing a career by providing financial support to the children. However, at university, parents who are unsure of the requirements in higher institutions or have financial worries will often impart negative reinforcement to their children, especially if the children want to pursue studies in competitive or difficult disciplines. Therefore, attention should be given to parents so that they are aware of the importance of their role in encouraging their children to consider various career options by providing knowledge to the parents about career choices. This suggests that parental attitudes play an important role in students' consideration of future job planning (Hall et al., 2011).

Family members such as siblings and relatives can also affect students' interest in STEM careers. This is because students can obtain information from them and can look more closely at the lives of family members who are involved in STEM careers. Family members' attitude towards science or STEM also influences career choices in STEM (Archer et al., 2013; White & Harrison, 2012).

Support through formal educational settings is important to attract students' interest in STEM careers. Educators act as role models or mentors who can nurture interest and self-efficacy towards STEM (Buday et al., 2012; Cridge & Cridge, 2015; Sahin et al., 2015). Teachers' background, education level, their social networks, and their trust strongly influence how they communicate with their students in terms of the students' preferences in higher education. Teachers' expectations, students' knowledge and achievement in STEM-related subjects also affect students' perception of their abilities (Cridge & Cridge, 2015).

Students' interest in science, achievement in science and aspiration towards STEM careers are highly dependent on the teaching approaches and teachers' quality (Nugent et al., 2015). The characteristics of an effective educator include using the latest teaching aids (Nugent et al., 2015), communicating effectively (Shumba & Naong, 2012), demonstrating quality teaching (White & Harrison, 2012), and encouraging students to learn (Nugent et al., 2015). These qualities have a major impact on student achievement beyond students' background such as poverty and minority status (Nugent et al., 2015).

Support from friends also influence the ways of thinking and it is the key in developing strong expectations in STEM careers (Buday et al., 2012; Cridge & Cridge, 2015). Peers who share an interest in STEM will help each other develop their vision as a scientist in the future. The attitude of friends, their achievements and norms have a strong influence on motivation and choice of courses (Nugent et al., 2015). Previous research has found that peers who favored science subjects are more intelligent and motivated than peers who favored the humanities (Taconis & Kessel, 2009). This finding reinforces that friends can affect students in the selection of STEM careers.

Counselors also play an important role in encouraging students to consider career options (Hall et al., 2011). At school, students talk to counselors and teachers about their future career. However, less than 10% of the counselors come from science background and they do not have enough information or expertise in STEM careers. Hence, if school counselors lack knowledge about career options, many students would not consider STEM careers as an option.

Toglia (2013) states that counselors have a significant impact on career choices of women. Counselors who lack information and training related to gender-free counseling affect the outcome of career selection of women in STEM fields. This will lead to a gender imbalance in STEM occupations that are perceived more appropriate for and dominated by men. Overall, it appears that career counselors affect students' interest in STEM careers in relation to their motivation and abilities or expertise to guide students about opportunities in STEM careers.

The local community also plays an important role in fostering interest in STEM careers by providing support to STEM outreach programs and establishing STEM informal learning centers in the community. Such informal learning centers aim to expose and foster public interest in STEM. Environmental factors that support the importance of STEM provide information to the public regarding the need to master STEM fields and create interest in STEM careers among the younger generation, especially students.

Media Influences

Sources of information may affect the dissemination of knowledge either in print or electronic form. Based on previous studies, media such as the internet, newspapers, popular scientific magazines, books, movies, and science-related programs on television can influence interest in STEM and STEM careers (Cavas et al., 2011; Venville et al., 2013). Media enables information about STEM to be disseminated quickly through a medium that is fun and helps make exploration of STEM knowledge enjoyable for students.

A study conducted by Wyss et al. (2012) found that video interviews with individuals involved in the field of STEM professions, as a means to provide job information in STEM, affected students' interest to engage in STEM careers. Thus, the media plays an important role in fostering interest in studying STEM and in STEM careers as they have the characteristics of attracting students through the use of interesting illustrations and presentations that are easy to understand while taking into account the age of the participating students.

STEM Self-Efficacy

STEM self-efficacy refers to the beliefs of an individual in meeting the standard in certain careers. There are two beliefs that might be relevant or constraining in developing one's self-confidence associated with the selection of a challenging science career. First is the belief that one cannot be successful in a particular career. The second is the belief in the demand of combining a career with one's personal life (Buday et al., 2012).

Self-efficacy is a well-researched construct which has been shown to be positively related to student performance across grade levels and disciplines, including science. Science self-efficacy has been shown to influence student selection of science-related activities, the cognitive effort they expend on these activities, and their ultimate success (Nugent et al., 2015). In SCCT, students are more likely to pursue careers in which they are confident of their capabilities and less likely to be drawn to careers where they doubt their skills and performance (Nugent et al., 2015). Self-efficacy in STEM has been shown to be a predictor of pursuing a college major in STEM (Wang, 2013; Heilbronner, 2011).

Perception of STEM Careers

The overview of the environmental and job prospects in STEM careers will affect a person's interest in the related career field (Kier et al., 2013; Nugent et al., 2015). In this study, perception of STEM careers was selected as the predictor of interest in STEM careers instead of outcome expectancy in SCCT. Perception of careers in STEM refers to the perception of job prospects in STEM fields and the skills needed by workers in STEM fields. Job prospects in STEM fields include the working environment in terms of safety, job satisfaction, perception of STEM as a prestigious career, high employment opportunities, higher income, and contribution to society (Sahin et al., 2015; Kier et al., 2013). Basic skills to be mastered in careers related to STEM fields are higher order thinking skills, creative problem-solving skills, teamwork, as well as constructing, designing and repairing things.

Interest in STEM careers

In this study, interest in STEM careers was adapted from Langdon et al. (2013) and Faber et al. (2013). Based on Langdon et al. (2013), STEM careers include jobs involved in research, applying knowledge from one or more of the elements of science, mathematics, engineering and technology, producing new ideas (innovations and industries), and contributing directly to innovation and economic development. STEM careers measured in this study were based on 12 STEM related disciplines, namely Physics, Environmental works, Biology and Zoology, Mathematics, Earth science, Computer science, Medical science, Chemistry, Energy, and Engineering. In addition, there are 10 types of scientists in the real world. These are business scientists, communicators, developers, entrepreneurs, explorers, investigators, policy regulators, service providers, and science teachers/educators (Science Council, 2016). Based on these 10 types of scientists, two types of scientists fit into this study's definition of STEM careers, i.e. Entrepreneur scientists and science teachers. Entrepreneur scientists help to create innovation and economic development while science teachers/educators help to ensure that STEM fields continue to grow through the delivery of knowledge concerning STEM. In this study, these 12 STEM careers were further categorized into two general disciplines related to STEM i.e., life sciences and physical sciences. These two main STEM disciplines provided the research a way of determining the tendency of students' interest in STEM careers. Therefore, this study aimed to develop a questionnaire on interest in STEM careers as well as the factors influencing interest in STEM careers i.e., environmental factors, STEM self-efficacy and perception of STEM careers.

Research Methodology

In this study, the following four steps were employed in developing the instrument on factors that influence interest in STEM careers:

Stage 1: Establishing content validity; literature and content validity by experts in STEM fields;

Stage 2: Conducting a pre-test;

Stage 3: Conducting exploratory factor analysis;

Stage 4: Determining construct reliability and interpretation of total score mean.

Research Context

Data used in the validation process were collected from 354 secondary school students (14 years of age) in one of the 13 states in Malaysia. The respondents in this study represented students in three types of schools in Malaysia, namely daily schools, boarding schools, and Junior Science Colleges. For all students, it was the first time that they had seen the items. Table 1 shows the demographics of the respondents from the participating schools.

Table 1. Demographics of Respondents

Variables	Descriptions	N (Respondents)

Type of Schools	Daily school Boarding school Junior science college	101 119 134
Gender	Male Female	174 180

Instrument Development

Stage 1: Establishing Content Validity

The literature review consisted of a search for studies addressing students' interest in STEM and STEM careers, factors affecting interest in STEM careers and social cognitive career theory. The search included the use of ERIC, JSTOR, and Google Scholar and searching under the terms students' STEM interest, instruments measuring STEM, students' perception of STEM and social cognitive career theory and STEM, beginning from the year 2010 until 2016. The literature review and theoretical framework guided the development of our initial pool of survey items as well as other instruments that measure STEM courses and careers, for example from Kier et al. (2014) and Faber et al. (2013).

Expert validity was conducted, and the experts included science educators and ministry officials in the STEM fields. Two experts from the Ministry of Education provided input related to STEM education in Malaysia, namely an expert in STEM education and an expert in the area of counseling. These experts validated each item in terms of content. Based on literature review and expert validity, four main constructs were identified in this study i.e., environmental factors, STEM self-efficacy, perception of STEM careers, and interest in STEM careers. Constructs involved in this study are summarized in Table 2. The complete questionnaire is available in Appendix 1.

Table 2. Constructs and Subconstructs of the Questionnaire

No	Construct	Adaptation Sources	Subconstruct	Examples of Items
1	Environmental factors (34 items)	Constructed by the researchers Nugent et al. (2015), Kier et al. (2013), and Buday et al. (2012)	Activities in the classroom Activities outside the classroom Social influences Media influences	I learned to evaluate the results of experiments. I attended STEM related carnivals. My parents encouraged me to pursue a career in STEM. I like reading books about STEM.

4	Self-efficacy (20 items)	Nugent et al. (2015), Kier et al. (2013) and Buday et al. (2012)	Science	I can obtain good grades in science subjects.
			Technology	I can use the computer properly.
			Engineering	I am sure that I can build a robot from Lego.
			Mathematics	I can solve mathematical problems properly.
5	Perception of STEM careers (14 items)	Constructed by the researchers	Prospects in STEM careers	The income of workers in STEM fields is high.
			Skilled needed in STEM careers	Workers in STEM fields require creative problem-solving skills.
6	Interest in STEM careers (12 items)	Adapted from Faber et al. (2013)	Physical Sciences	Aviation engineer, alternative energy technician, lab technician, physicist, astronomer.
			Life Sciences	Pollution control analyst, environmental engineer or scientist, erosion control specialist, energy systems engineer and maintenance technician.

Stage 3: Conducting a pre-test

A pre-test was conducted in one of the neighboring schools. A total of 36 respondents (14 years of age) were involved. The main aim of the pre-test was to identify respondents' understanding of the items used in the instrument. Students were briefed on the nature of the study and how to answer the questionnaire. Students were able to understand all the items in the instrument. The time taken to answer all the items was between 15 to 20 minutes.

Stage 4: Conducting exploratory factor analysis

Exploratory factor analysis is a statistical method used to explore the dimensionality of an instrument by finding the smallest number of interpretable factors needed to explain the correlations among the set of items (McCoach, Gable & Madura, 2013). Exploratory factor analysis takes a large set of variables and looks for a way in which the data may be reduced or summarized using a smaller set of factors or components. It does this by looking for clumps or groups among the inter correlations of a set of variables (Pallant, 2011). In this study, exploratory factor analysis was performed to examine the internal structure of the set of 80 items and to validate the sub-constructs underlying the four main constructs i.e., environmental factors, self-efficacy, perception of STEM careers, and interest in STEM careers. Environmental factors consist of four sub-constructs: activities in the classroom, activities outside the classroom, social influences and media influences. The construct in this study was developed based on SCCT theory, literature review on the factors affecting interest in STEM careers and content validity by experts in STEM fields. This study initially did not extend the analysis to the level of confirmatory factor analysis as this study only aimed to explore the sub-constructs underlying the identified construct - a process of developing an instrument. However, the study has since then extended the analysis to include confirmatory factor analysis (CFA) that aimed to test the pattern of relationship among the factors and confirm the CFA model. The results of this analysis, however, is not reported in this paper.

Stage 5: Determining reliability and interpretation of total score mean

The reliability for each construct was determined based on Cronbach's alpha values. The interpretation of total score mean was also presented based on adaptation of the interpretation from Nunnally (1997).

Research Findings

Exploratory Factor Analysis for Environmental Factors

For environmental factors, a total of 34 items were identified. These 34 items were subjected to principal component analysis (PCA) using SPSS version 23. Prior to performing PCA, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The Kaiser-Meyer-Olkin value was .915, exceeding the recommended value of .6 (Pallant, 2011) and the Bartlett's test of sphericity reached a statistical significance, supporting the factorability of the correlation matrix as shown in Table 3.

Table 3. The Findings from Kaiser-Meyer-Olkin and Bartlett's Test for Environmental Factors

Kaiser-Meyer-Olkin's Measure of Sampling Adequacy		**.915**
Bartlett's Test of Sphericity	Approx. Chi-Square	5729.671
	Df	561
	Sig.	.000

Principal component analysis revealed the presence of seven components with eigenvalues exceeding 1. An inspection of the scree plot revealed a clear break after the fourth component as shown in Figure 1. Thus, the decision was made to retain these four components for further investigation.

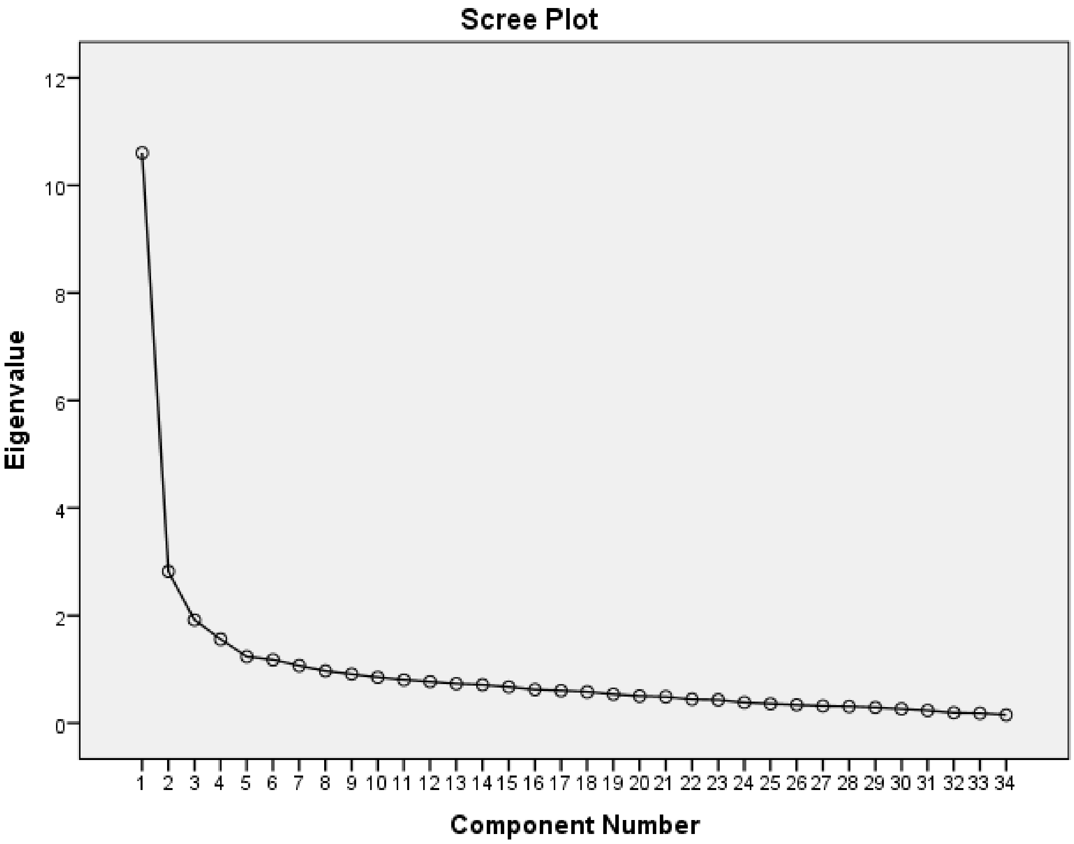

Figure 1. Scree Plot for Environmental Factors

To aid the interpretation of the four components, varimax rotation was used to generate orthogonal factors. The four components' solution explained a total of 49.70% of the variance, with component 1 contributing 19.57%, component 2 contributing 12.08%, component 3 contributing 10.31 %, and component 4 contributing 7.72%, as shown in Table 4.

Table 4. Total Variance Explained for Environmental Factors

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.604	31.188	31.188	10.604	31.188	31.188	6.656	19.576	19.576

2	2.819	8.291	39.479	2.819	8.291	39.479	4.109	12.085	31.661
3	1.917	5.639	45.117	1.917	5.639	45.117	3.508	10.318	41.979
4	1.558	4.583	49.700	1.558	4.583	49.700	2.625	7.721	49.700

Table 5. Rotated Component Matrix for Environmental Factors

	Component			
	Media influences	Activities outside the classroom	Social influences	Activities in the classroom
d7	.825			
d4	.819			
d1	.801			
d3	.795			
d6	.782			
d5	.780			
d8	.732			
d2	.713			
d10	.622			
d9	.566			
b12		.728		
b13		.710		
b8		.681		
b10		.656		
b9		.626		
b11		.595		
b7		.489		
b1		.459		
c3			.592	
c5			.552	
c6			.546	
c11			.512	
c9			.510	
c8			.507	
c1			.506	
c2			.495	
c7			.491	
c10			.472	
c4			.430	
b3				.775
b2				.720
b4				.645
b5				.601
b6				

Based on factor loading values as shown in Table 5, item b6 was removed because of low factor loading whereas item b1 was categorized into another group. We decided to retain item b1 in the outside of classroom activity component. We believe that students are highly likely to conduct design activities outside the classroom and not in the classroom as shown in earlier studies. Overall, based on exploratory factor analysis, environmental factors consist of four sub factors i.e., activities in the classroom (component 4), activities outside the classroom (component 2), social influences (component 3), and media influences (component 1).

Exploratory Factor Analysis for STEM Self-Efficacy

20 items were developed for self-efficacy. These 20 items were subjected to principal component analysis (PCA) using SPSS version 23. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above and the Kaiser-Meyer-Olkin value was .881, exceeding the recommended value of .6 (Pallant, 2011) and the Bartlett's test of sphericity reached a statistical significance, supporting the factorability of the correlation matrix as shown in Table 6.

Table 6. Findings from Kaiser-Meyer-Olkin and Bartlett's Test for Self-Efficacy

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.881
Bartlett's Test of Sphericity	Approx. Chi-Square	4192.599
	Df	190
	Sig.	.000

Principal component analysis revealed the presence of four components with eigenvalues exceeding 1. An inspection of the scree plot revealed a clear break after the fourth component as shown in Figure 2.

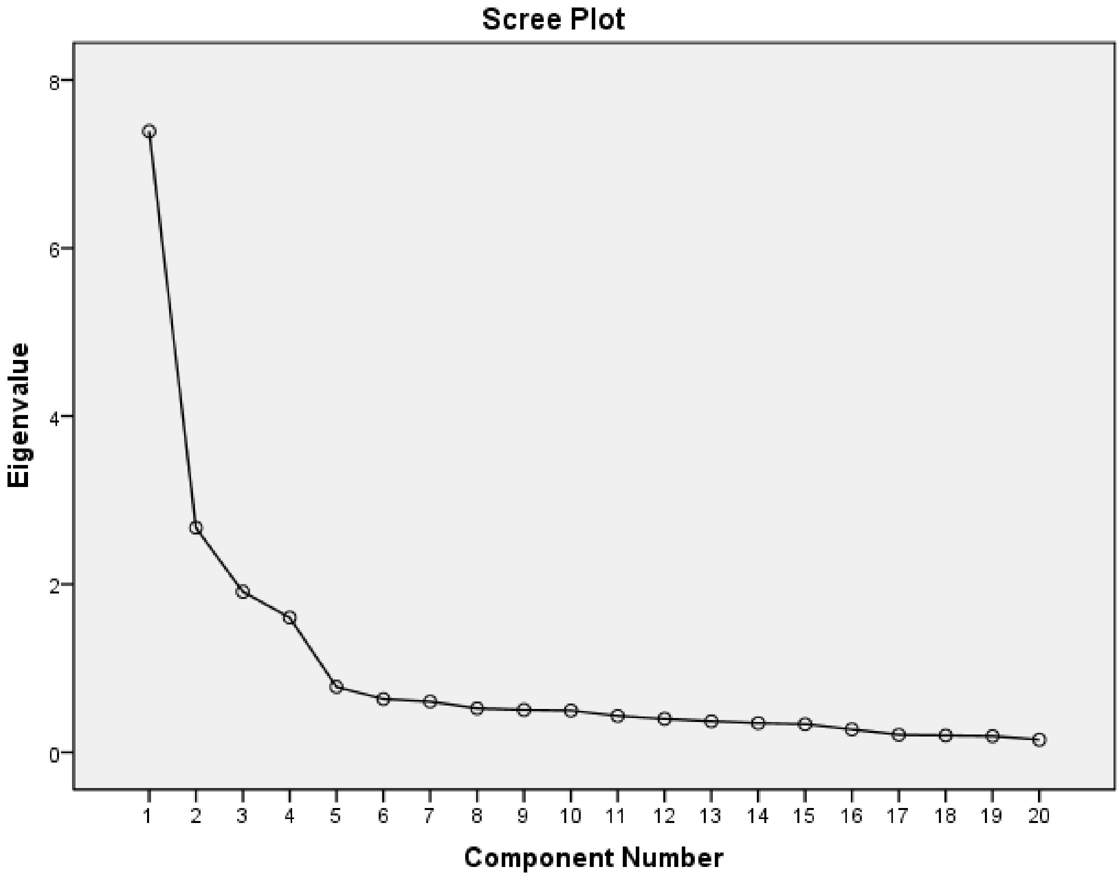

Figure 2. Scree Plot for Self-Efficacy

Varimax rotation was selected because the factors in self-efficacy were determined according to STEM fields. The four components' solution explained a total of 67.86% of the variance, with component 1 contributing 18.05%, component 2 contributing 17.14%, component 3 contributing 16.64%, and component 4 contributing 16.04 %, as shown in Table 7.

Table 7. Total Variance Explained for Self-Efficacy

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.390	36.952	36.952	7.390	36.952	36.952	3.609	18.046	18.046
2	2.671	13.353	50.305	2.671	13.353	50.305	3.429	17.144	35.190
3	1.910	9.552	59.858	1.910	9.552	59.858	3.329	16.643	51.833
4	1.602	8.010	67.868	1.602	8.010	67.868	3.207	16.035	67.868

Based on the factor loading values in the rotated component matrix as shown in Table 8, all the 20 items belonged to the four elements, namely i) Science (e1 to e5), ii) Technology (e6 to e10), iii) Engineering (e11 to e15), and iv) Mathematics (e16 to e20).

Table 8. Rotated Component Matrix for Self-Efficacy

	Component			
	Science	**Mathematics**	**Engineering**	**Technology**
e4	.851			
e2	.811			
e3	.807			
e1	.721			
e5	.693			
e20		.869		
e16		.842		
e17		.766		
e19		.743		
e18		.646		
e13			.816	
e14			.805	
e15			.750	
e12			.746	
e11			.668	
e8				.818
e9				.812
e6				.792
e10				.748
e7				.722

Exploratory Factor Analysis for Perception of STEM Careers

14 items were developed for perception of STEM careers. These 14 items were subjected to principal component analysis (PCA). Prior to performing PCA, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The Kaiser-Meyer-Olkin value was .880, exceeding the recommended value of .6 (Pallant, 2011) and the Bartlett's test of sphericity reached a statistical significance, supporting the factorability of the correlation matrix as shown in Table 9.

Table 9. Findings from Kaiser-Meyer-Olkin and Bartlett's Test for Perception of STEM Careers

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.880
Bartlett's Test of Sphericity	Approx. Chi-Square	2533.864
	Df	91
	Sig.	.000

Initially, principal component analysis revealed the presence of three components with eigenvalues exceeding 1. An inspection of the scree plot revealed a clear break after the thirdcomponent as shown in Figure 2.

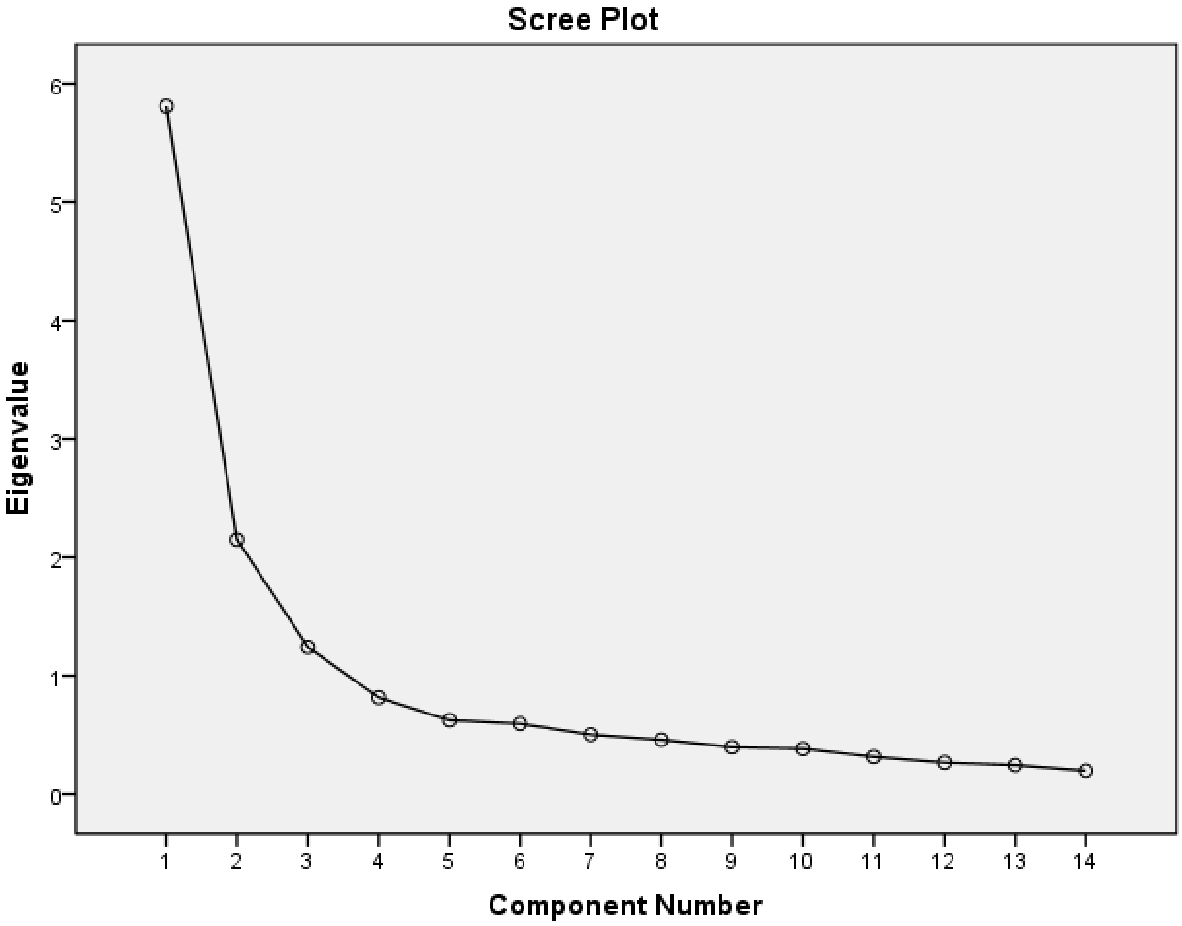

Figure 3. Scree Plot for Perception of STEM Careers

However, we decided to keep to two components as determined earlier using varimax rotation. The two solutions explained a total of 56.86% of the variance, with component 1 contributing 30.03% and component 2 contributing 26.83 %, as shown in Table 10.

Table 10. Total Variance Explained for Perception of STEM Careers

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.811	41.506	41.506	5.811	41.506	41.506	4.204	30.029	30.029
2	2.149	15.350	56.856	2.149	15.350	56.856	3.756	26.827	56.856

Based on the factor loading values in the rotated component matrix as shown in Table 8, all the 14 items belonged to the two components as was decided earlier in this study. Table 11 shows the rotated component matrix for perception of STEM careers belong into two sub factors i.e., job prospect in STEM careers and skills needed in STEM careers.

Table 11. Rotated Component Matrix for Perception of STEM Careers

	Component	
	Job Prospect	Skills Needed
f2	.774	
f6	.766	
f3	.749	
f4	.740	
f1	.736	
f5	.620	
f8	.612	
f7	.453	
f10		.858
f11		.856
f12		.844
f13		.763
f14		.638
f9		.515

Exploratory Factor Analysis for Interest in STEM Careers

12 items were developed for interest in STEM careers. These 12 items were subjected to principal component analysis (PCA). Prior to performing PCA, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of .3 and above. The Kaiser-Meyer-Olkin value was .875, exceeding the recommended value of .6 (Pallant, 2011) and the Bartlett's test of sphericity reached a statistical significance, supporting the factorability of the correlation matrix as shown in Table 12.

Table 12. Findings from Kaiser-Meyer-Olkin and Bartlett's Test for Interest in STEM Careers

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.875
Bartlett's Test of Sphericity	Approx. Chi-Square	1439.306
	Df	66
	Sig.	.000

Initially, principal component analysis revealed the presence of two components with eigenvalues exceeding 1. An inspection of the scree plot revealed a clear break after the two components as shown in Figure 2.

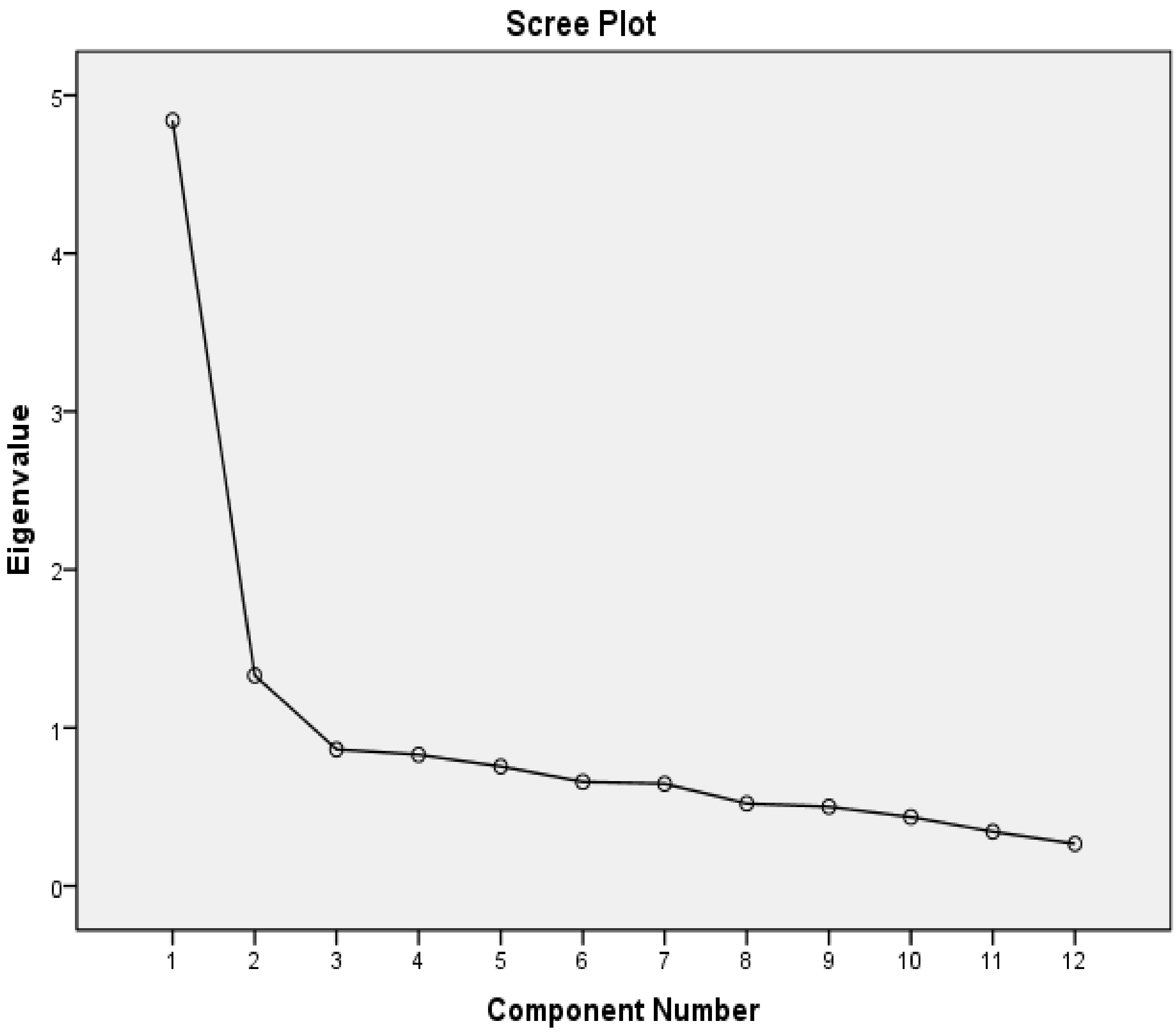

Figure 4. Scree Plot for Interest in STEM Careers

To aid interpretation of the two components, varimax rotation was performed. The two solutions explained a total of 51.450% of the variance, with component 1 contributing 25.749% and component 2 contributing 25.701%, as shown in Table 13.

Table 13. Total Variance Explained for Interest in STEM Careers

	Initial Eigenvalues			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.842	40.348	40.348	4.842	40.348	40.348	3.090	25.749	25.749
2	1.332	11.102	51.450	1.332	11.102	51.450	3.084	25.701	51.450

Based on the factor loading values in the rotated component matrix as shown in Table 14, all the 12 items belonged to the two components i.e., physical sciences and life sciences. Physical sciences are items/work related to physics, mathematics, computer sciences, energy, engineering and entrepreneur or business scientist careers. In contrast, careers in life sciences consist of jobs related to environmental works, biology and zoology, earth science, medical science, chemistry and science teachers or educators.

Table 14. Rotated Component Matrix for Interest in STEM Careers

	Component	
	Life Sciences	Physical Sciences
g7	.821	
g3	.777	
g8	.656	
g5	.609	
g2	.536	
g12	.494	
g10		.832
g9		.805
g6		.634
g1		.571
g11		.547
g4		.424

Reliability Analysis

Overall, the Cronbach's alpha value for each factor was between .817 and .933. Thus, each value indicated that all items showed high reliability as shown is Table 15.

Table 15. Cronbach's Alpha Value

No.	Construct	Element	Cronbach's Alpha Value
1	Learning experiences	In the classroom	.704
		Outside the classroom	.833
2	Social influences	-	.817
3	Media influences	-	.933
4	Self-efficacy	Science	.892
		Technology	.849
		Engineering	.856
		Mathematics	.897
5	Perception of STEM careers	Job prospect	.858
		Skills needed in STEM career	.873
6	Interest in STEM careers		.863

Interpretation of Total Score Mean

The level for each factor was interpreted through the total score mean value and categorized as shown in Table 16. The total score mean interpretation was adapted from Nunnally (1997) where scores are indicated as low, medium low, medium high and high based on the total score mean obtained.

Table 16. Mean Value and Interpretation of Total Score Mean

Total Score Mean	Interpretation of Total Score Mean
1.00 - 2.50	Low
2.51 - 5.00	Medium Low
5.01 - 7.50	Medium High
7.51 - 10.00	High

(Adapted from Nunnally, 1997)

Discussion and Implications

We were interested in developing an instrument to identify not only if students were interested in STEM careers but also the factors that influenced their interest in STEM careers. The development of this survey instrument was based on previous instruments (Kier et al., 2014; Faber et al., 2013), as well as a framework, namely the Social Cognitive Career Theory (Lent et al. 1994, 2000). Kier et al. (2014) have developed STEM career interest survey (STEM-CIS) and leveraged the SCCT to develop the survey. To investigate the instrument's reliability and psychometric properties, the 44-item survey has been administered to over 1,000 middle school students (grades 6-8) in southeastern USA.

Confirmatory factor analyses indicate that the STEM-CIS is a strong, single factor instrument and has four discipline-specific subscales. Additionally, Faber et al. (2013) have developed school student attitudes towards STEM (S-STEM) survey to measure attitude towards STEM. The survey has been administered to over 10,000 fourth through twelfth grade students in North Carolina who participated in STEM education program. The SCCT has been used and psychometrically evaluated in predicting interest with middle school students and it has now been applied in this newly developed STEM career interest survey.

Based on the exploratory factor analysis, four environmental sub factors were determined, namely activities in the classroom, activities outside the classroom, social influences and media influences. Additionally, self-efficacy included four subconstructs i.e., self-efficacy towards i) Science, ii. Technology, iii. Engineering, and iv. Mathematics. Perception towards STEM careers contained two subconstructs i.e., job prospects in STEM careers and skills needed in STEM careers. Interest in STEM careers was divided into two STEM fields i.e., life sciences and physical sciences.

Based on the literature review and the SCCT model by Lent et al. (2000), environmental factors influence an individual's self-efficacy and perception of STEM careers. Interaction of both factors influence their interest in STEM careers. This shows that environmental, self-efficacy, perception of STEM careers and interest in STEM careers all play an important role in influencing students' decision in choosing their careers and fields of study (Lent et al., 2000; Nugent et al., 2015)

Activities in the classroom and activities outside the classroom were considered as formal and informal learning, respectively. In Malaysia, STEM education is relatively new. STEM is still taught as separate subjects in the formal learning environment in schools. Its implementation in reality is seen in informal learning contexts such as Science clubs and STEM outreach programs. Students are engaged in STEM integrated activities through projects and problem-based activities related to solving real world problems.

For future research, these identified factors need to undergo CFA analysis to enhance the validity and reliability of the developed instrument. Factors identified in this study serve as a guide in constructing a model of interest in STEM careers. These factors will serve as a guide in planning interventions aimed at enhancing students' interest in STEM careers in the future. In addition, identifying the factors that contribute to interest in STEM careers will provide guidance for teacher education and professional development as well as contribute to our understanding of how students learn STEM contents and how STEM career trajectories are developed.

Conclusion

Researchers or educators in science, technology, engineering and mathematics may use the STEM Career Interest Instrument developed in this study, either as a single subscale or a combination of subscales or all the subscales as one instrument, as required in their context. As such, we expect that it will be beneficial to researchers, educators, and evaluators in measuring STEM career interests and the effects of related factors on changes in students' interest in STEM subjects and careers. The knowledge that we gain from the use of this instrument may help to inform the effort that needs to be taken at the secondary school level as we seek to increase students' interest in STEM subjects, majors, and careers.

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References

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). Science aspirations, capital, and family habitus: how families shape children's engagement and identification with science. *American Educational Research Journal*, *49*(5), 881–908.

Ayar, M.C. (2015). First-hand experience with engineering design and career interest in engineering: an informal stem education case study. *Educational Sciences: Theory & Practice, 15*(6),1655-1675.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191-215.

Buday, S. K., Stake, J. E. & Peterson, Z. D. (2012). Gender and the choice of a science career:the impact of social support and possible selves. *Sex Roles*, *66*, 197–209. DOI 10.1007/s11199-011-0015-4.

Buschor, C. B., Berweger, S., Frei, Keck, R., & Kappler, C. (2014). Majoring in STEM- what accounts for women's career decision making? A mixed method study. *Journal of Educational Research*, *107*(3), 167–176.

Cavas, B., Cakiroglu, J., Cavas, P., & Ertepinar, H. (2011). Turkish students' career choices in engineering: experiences from turkey. *Science Education International*, *22*(4), 274–281.

Chen, P. D., & Simpson, P. A. (2015). Does personality matter? Applying Holland's typology to analyze students' self-selection into Science, Technology, engineering, and Mathematics majors. Journal of Higher Education, *86*(5), 725–750.

Cridge, B. J. & Cridge, A. G. (2015). Evaluating how universities engage school students with science: A model based on the analysis of the literature. *Australian University Review, 57*(1), 34-44.

Denson, C. D., Stallworth, C. A., Hailey, C., & Householder, D. L. (2015). Benefits of informal learning environments: a focused examination of STEM-based program environments. *Journal of STEM Educatio*n, *16*(1), 11–15.

Ejiwale, J. A. (2012). Facilitating teaching and learning across stem field. *Journal of STEM Education, 13*(3): 87-94.

Faber, M., Unfried, A., Corn, J., & Townsend, L. W. (2013). Student attitudes toward STEM : The development of upper elementary school and middle / high school student surveys student attitudes toward STEM : The development of upper elementary school and middle / high school student surveys. American society for engineering education. 120th ASEE Annual Conference & Exposition.

Gwen, N. Bradley, B., Neal, G. & Greg, W. (2016). Robotics camps, clubs & competitions: results from the us robotics projects. *Robotics & Autonomous System, 75*, 686-691.

Hall, C., Dickerson, J., Batts, D., Kauffmann, P., Bosse, M. (2011). Are we missing opportunities to encourage interest in stem fields?. *Journal of Technology Education, 23*(1), 32-46.

Heilbronner, N. N. (2011). Stepping onto the STEM pathway: Factors affecting talented students Declaration on STEM major in college. *Journal for the Education of the Gifted*, *34*, 876-899.

Jacobs, J. E. (1998). The career plans of science-talented rural adolescent girls. *American Educational Research Journal, 35*(4), 681-704.

Kier, M., Blanchard, M., Osborne, J., & Albert, J. (2014). The development of the stem career interest survey (STEM-CIS). *Research in Science Education, 44*, 461–481.

Kuechler, W. L., McLeod, A., & Simkin, M.G. (2009). Why don't more students major in IS? *Decision Sciences Journal of Innovative Education, 7*(2), 463–488.

Langdon, D., McKittrick, G., Beede, D. (2013). STEM: Good jobs now and for the future. *Science, technology, engineering, and mathematics workforce trends and policy considerations*. Eds. Garcia, C.M & Cook, S. ISBN: 9781622578184. New York: Nova Science Publishers.

Lent, R. W., Brown, S., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior*, *45*(1), 79–122.

Lent, R. W., Brown, S., & Hackett, G. (2000). Contextual supports and barriers to career choice: a social cognitive analysis. *Journal of Counseling Psychology*, *47*(1): 36–49.

Maltese, A.V., & Tai, R.H. (2010). Eyeballs in the fridge: Sources of early interest in science. *International Journal of Science Education*, *32*(5), 669-685.

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: examining the association of educational experiences with earned degrees in STEM among U.S. students. *Science Education*, 95(5), 877–907.

McCoach, D.B., Gable, R.K.& Madura, J. P. (2013). *Instrument Development in the Affective Domain*. 3rd Edition. New York: Springer.

Mills, L. A., & Katzman, W. (2015). Examining the effects of field trips on science identity, 12th International Conference on Cognition and Exploratory Learning in Digital Age (CELDA 2015). 202–208. ISBN: 978-989-8533-43-2.

Ministry of Education (MOE). (2013). *Blueprint of Malaysia education development 2013-2025 (from kindergarten to after secondary).* Putrajaya *Student Application STPM / Matriculation / Foundation to Public Higher Education Institutions Academic Session*, 2014/2015.

National Governors Association. (2016). Retrieved from: www.nga.org/center [3 February 2016].

Nugent, G., Barker, B., Welch, G., Grandgenett, N., Wu, C. & Nelson, C. (2015). A model of factors contributing to STEM learning and career orientation. *International Journal of Science Education, 37*(7), 1067-1088.

Nunnally, J.C. (1997). The Study of Change Evaluation Research: Principle Concerning Measurement Experimental Design and Analysis. In Struening, E.L & Guttentag, M. (Editors). *Handbook of Evaluation Research*. Beverly Hills: Sage.

Pallant, J., 2011. *SPSS Survival Manual: A step by step guide to data analysis using SPSS*. 2nd Edition. Australia: Allen & Unwin.

Rice, L., Barth, J.M., Guadagno, R. E., Smith, G. P.A, & McCallum, D.M. (2013). The role of social support in students' perceived abilities and attitudes toward math and science. *Journal of Youth Adolescence*, *42*, 1028-1040.

Sahin, A., Gulacar, O., & Stuessy, C. (2015). High school students' perception of the effects of International Science Olympiad on their STEM career aspirations and twenty-first century skill development. *Research Science Education, 45,* 785-805.

Science Council. (2016). 10 types of Scientist. Retrieved from: http://sciencecouncil.org/about- us/10-types-of-scientist/ [18 July 2016]

Shumba, A. & Naong, M. (2012). Factor influencing students' career choice and aspiration in South Africa. *Journal of Social Science, 33*(2), 169-178.

Soutar, V., Parr, R., Prescott, R. & and Iorio, D.D. (2010). Set sail with science. The Science Teacher,51-55.

Toglia, T. (2013). Gender equity issues in CTE and STEM education. *Tech Directions*, *72*(7), 14-17.

Venville, G., Rennie, L., Hanbury, C., & Longnecker, N. (2013). Scientists Reflect on Why They Chose to Study Science. *Research in Science Education*, *43*(6), 2207–2233. http://doi.org/10.1007/s11165-013-9352-3.

Wang, J., & Staver, J. R. (2001). Examining relationships between factors of Science education and student career aspiration. *Journal of Educational Research, 94*(5), 312–319.

White, E. L., & Harrison, T. G. (2012). UK School Students' Attitudes towards Science and Potential Science - Based Careers, *Acta Didactica Napocensia*, *5*(4), 1-9.

Wyss, V. (2012). Increasing middle school student interest in STEM careers with videos of Scientists. *International Journal of Environmental and Science Education*, *7*(4), 501-522.

Young, D. J. & Woolnough, B. E. (1997). Factor affecting student career choice in science: an Australian study of rural and urban school. *Research in Science Education*, *27*(2), 195-214.

Appendix

INTEREST IN STEM CAREER QUESTIONNAIRE

SECTION A: PERSONAL DETAILS

Please check/tick (√) the appropriate box that corresponds to your answer or where relevant, specify your answers in the blank spaces provided.

1. Gender: Male Female
2. Races: Malay Chinese Indian Others: Please state:_______________
3. Types of School: Public School Boarding School Junior Science College
4. Monthly income: RM 1000 and above RM 1001 – RM 2499 RM 2500 – RM 4999 RM 5000 and above
5. a. Father's/Guidance's occupation: _______________________
   b. Mother's Occupation :___________________________
6. Number of family members :_____
   Ambition:____
7. What is the problem that you want to solve in the future? Please state :
   ____
   ____

SECTION B: LEARNING EXPERIENCE ACTIVITIES

I) Activities in the classroom

Please circle the number that reflects your answer for each statement

Never 1 → **10** **Always**

No	**Items**	**Never** →									**Always**
2	I conduct experiments or science projects in the laboratory or in the school environment.	1	2	3	4	5	6	7	8	9	10
3	I learn to evaluate the results of experiments.	1	2	3	4	5	6	7	8	9	10

4	I was taught the methods to solve problems in everyday life (e.g., how to dry clothes during the rainy season).	1	2	3	4	5	6	7	8	9	10
5	I work together with my friends as a team in doing activities in the classroom.	1	2	3	4	5	6	7	8	9	10

II) Outdoor Classroom Activities

No.	Items	Never →									Always
1	I invent products involving scientific and mathematical applications (e.g., creating robots or creating rockets).	1	2	3	4	5	6	7	8	9	10
7	I join STEM related clubs in school.	1	2	3	4	5	6	7	8	9	10
8	I visit STEM related museums.	1	2	3	4	5	6	7	8	9	10
9	I visit science centers (e.g., Planetarium, Petroscience, the Observatory).	1	2	3	4	5	6	7	8	9	10
10	I participate in STEM related competitions.	1	2	3	4	5	6	7	8	9	10
11	I visit research centers at factories or at universities.	1	2	3	4	5	6	7	8	9	10
12	I attend STEM related carnivals.	1	2	3	4	5	6	7	8	9	10
13	I attend STEM related camps.	1	2	3	4	5	6	7	8	9	10

SECTION C: SOCIAL INFLUENCES ON STEM EDUCATION AND CAREERS

No	Items	Strongly Disagree →									Strongly Agree
1	My parents encourage me to pursue a career in STEM.	1	2	3	4	5	6	7	8	9	10
2	My parents encourage me to participate in activities outside the school that are related to STEM.	1	2	3	4	5	6	7	8	9	10
3	My parents send me for science or math tuition.	1	2	3	4	5	6	7	8	9	10
4	There are members of my family who are involved in STEM careers.	1	2	3	4	5	6	7	8	9	10
5	My teacher encourages me to perform well in science or mathematics	1	2	3	4	5	6	7	8	9	10
6	Most of my friends like science or mathematics subject.	1	2	3	4	5	6	7	8	9	10
7	Most of my friends want to engage in STEM careers.	1	2	3	4	5	6	7	8	9	10
8	I can talk to my friends about the latest	1	2	3	4	5	6	7	8	9	10

	technology.										
9	My school counselor guides me about career opportunities in STEM.	1	2	3	4	5	6	7	8	9	10
10	There are activities related to STEM held in my community (for example STEM carnivals or camps)	1	2	3	4	5	6	7	8	9	10
11	There is a science center (Planetarium, Petroscience, Observatory) in my community.	1	2	3	4	5	6	7	8	9	10

SECTION D: MEDIA INFLUENCES ON INTEREST IN STEM CAREERS

No	Items	Strongly Disagree → Strongly Agree									
1	I like reading books about STEM.	1	2	3	4	5	6	7	8	9	10
2	I like listening to conversations about STEM on the radio.	1	2	3	4	5	6	7	8	9	10
3	I like reading articles about STEM in the newspaper.	1	2	3	4	5	6	7	8	9	10
4	I like watching STEM programs on television.	1	2	3	4	5	6	7	8	9	10
5	I like watching movies related to STEM.	1	2	3	4	5	6	7	8	9	10
6	I like surfing the internet for information related to STEM.	1	2	3	4	5	6	7	8	9	10
7	I like reading magazines related to STEM.	1	2	3	4	5	6	7	8	9	10
8	I like reading comics related to STEM.	1	2	3	4	5	6	7	8	9	10
9	I discuss matters related to STEM on social media with my friends	1	2	3	4	5	6	7	8	9	10
10	I like playing digital games related to STEM.	1	2	3	4	5	6	7	8	9	10

SECTION E: STEM LEARNING SELF-EFFICACY

I) SCIENCE

No	Items	Strongly Disagree → Strongly Agree									
1	I can obtain good grades in science subjects.	1	2	3	4	5	6	7	8	9	10
2	I can solve problems related to science concepts well.	1	2	3	4	5	6	7	8	9	10

3	I can write laboratory reports (experimental reports) correctly.	1	2	3	4	5	6	7	8	9	10
4	I can collect information on scientific concepts properly.	1	2	3	4	5	6	7	8	9	10
5	I am sure that I can carry out scientific experiments in the laboratory properly.	1	2	3	4	5	6	7	8	9	10

II) TECHNOLOGY

No	Items	Strongly Disagree → Strongly Agree									
6	I can download an image or video from the Internet.	1	2	3	4	5	6	7	8	9	10
7	I can handle everyday technological products easily (e.g., blender, microwave, toaster, rice cooker).	1	2	3	4	5	6	7	8	9	10
8	I can use the computer properly.	1	2	3	4	5	6	7	8	9	10
9	I can handle digital devices properly (e.g., smartphone, iPad, tablet)	1	2	3	4	5	6	7	8	9	10
10	I can use social media properly (Facebook, Instagram, Twitter).	1	2	3	4	5	6	7	8	9	10

III) ENGINEERING

No	Items	Strongly Disagree → Strongly Agree									
11	I am sure that I can build a robot from Lego.	1	2	3	4	5	6	7	8	9	10
12	I can use welding tools properly.	1	2	3	4	5	6	7	8	9	10
13	I can assemble furniture.	1	2	3	4	5	6	7	8	9	10
14	I can build electronic circuits.	1	2	3	4	5	6	7	8	9	10
15	I can repair a broken toy.	1	2	3	4	5	6	7	8	9	10

IV) MATHEMATICS

No.	Items	Strongly Disagree → Strongly Agree									
16	I can obtain good grades in mathematics subjects.	1	2	3	4	5	6	7	8	9	10
17	I am confident that I can record data accurately.	1	2	3	4	5	6	7	8	9	10
18	I can draw a graph from the provided	1	2	3	4	5	6	7	8	9	10

	data.										
19	I am competent in using scientific calculators.	1	2	3	4	5	6	7	8	9	10
20	I can solve mathematical problems properly.	1	2	3	4	5	6	7	8	9	10

SECTION F: PERCEPTION OF STEM CAREERS

No.	Items	Strongly Disagree → Strongly Agree									
1	The condition of STEM related workplace is safe.	1	2	3	4	5	6	7	8	9	10
2	I get satisfaction if I work in STEM related fields.	1	2	3	4	5	6	7	8	9	10
3	Careers in STEM fields are prestigious.	1	2	3	4	5	6	7	8	9	10
4	The income of workers in STEM fields is high.	1	2	3	4	5	6	7	8	9	10
5	Those in STEM fields can get jobs easily.	1	2	3	4	5	6	7	8	9	10
6	STEM fields can provide greater career opportunities.	1	2	3	4	5	6	7	8	9	10
7	Workers in STEM fields have enough time with their families.	1	2	3	4	5	6	7	8	9	10
8	Workers in STEM fields can help the lives of others.	1	2	3	4	5	6	7	8	9	10
9	Working in STEM fields require higher-order thinking skills.	1	2	3	4	5	6	7	8	9	10
10	Jobs in STEM fields require construction skills	1	2	3	4	5	6	7	8	9	10
11	Jobs in STEM fields involve repairing goods/products.	1	2	3	4	5	6	7	8	9	10
12	Jobs in STEM fields involve designing goods/products.	1	2	3	4	5	6	7	8	9	10
13	Working in STEM fields require creative problem-solving skills.	1	2	3	4	5	6	7	8	9	10
14	Workers in STEM fields are required to work as a team.	1	2	3	4	5	6	7	8	9	10

SECTION G: INTEREST IN STEM CAREERS

Below are descriptions of subject areas that involve math, science, engineering and/or technology, and lists of jobs connected to each subject area. As you read the list below, please let us know how interested you are in the subjects and the jobs by circling a number from 1 to

10 for each item to show your level of interest.
(Please note that lower numbers show you are less interested while higher numbers show higher interest).
Please CIRCLE the number that relates to how interested you are in the subjects or jobs.

Not at all **Very interested**

1 ⟶ 10

No	Items	Not at all → Very interested									
1	**Physics**: Aviation engineer, alternative energy technician, lab technician, physicist, astronomer.	1	2	3	4	5	6	7	8	9	10
2	**Environmental Works**: Pollution control analyst, environmental engineer or scientist, erosion control specialist, energy systems engineer and maintenance technician.	1	2	3	4	5	6	7	8	9	10
3	**Biology and Zoology**: Biological technician, biological scientist, plant breeder, crop lab technician, animal scientist, geneticist, zoologist.	1	2	3	4	5	6	7	8	9	10
4	**Mathematics**: Accountant, applied mathematician, economist, financial analyst, mathematician, statistician, market researcher, stock market analyst.	1	2	3	4	5	6	7	8	9	10
5	**Earth Science**: Geologist, weather forecaster, archaeologist, geoscientist.	1	2	3	4	5	6	7	8	9	10
6	**Computer Science**: Computer support specialist, computer programmer, computer and network technician, gaming designer, computer software engineer, information technology specialist.	1	2	3	4	5	6	7	8	9	10
7	**Medical Science**: Clinical laboratory technologist, medical scientist, biomedical engineer, epidemiologist, pharmacologist.	1	2	3	4	5	6	7	8	9	10
8	**Chemistry**: Chemical technician, chemist, chemical engineer.	1	2	3	4	5	6	7	8	9	10
9	**Energy**: Electrician, electrical engineer, heating, ventilation, and air conditioning technician, nuclear engineer, systems engineer, alternative energy systems	1	2	3	4	5	6	7	8	9	10

	installer or technician.										
10	**Engineering**: Civil, industrial, agricultural, or mechanical engineers, welder, auto-mechanic, engineering technician, construction manager.	1	2	3	4	5	6	7	8	9	10
11	**Entrepreneur or business scientists**: Designing STEM-related products through innovation.	1	2	3	4	5	6	7	8	9	10
12	**Science Teachers/Educators**: Educators who teach STEM and its applications at schools and universities.	1	2	3	4	5	6	7	8	9	10