ASIA PACIFIC JOURNAL
OF EDUCATORS AND EDUCATION

Volume 38, Issue 1, 2023
https://doi.org/10.21315/apjee2023.38.1.5

Research Article:

Persistence and Attrition in STEM Majors for a Career Choice

Nur Jahan Ahmad[1*], Siti Nor Fazila Ramly[1], Ahmad Muslihin Ahmad[2], Ahmad Adnan Mohd Shukri[1] and Rohaya Abdullah[1]

[1]School of Educational Studies, Universiti Sains Malaysia 11800 USM Pulau Pinang, Malaysia
[2]Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim Perak, Malaysia

*Corresponding author: jahan@usm.my

ABSTRACT

STEM fields are viewed as being important for global economic development, as well as for the well-being of society. Many factors, including knowledge of future pay and other occupational insights, influence university major selection. This paper reports the findings from an empirical study of diploma, undergraduate, and postgraduate on the relationship between gender equality and university support with students' views on STEM careers, as well as their persistence and attrition in STEM majors. The findings from PLS-SEM analysis shows that gender equality did positively affect students' views on STEM careers and students' persistence in STEM majors. It was also found that gender equality did not affect students' attrition. In contrast, the university support did not positively affect students' views on STEM careers and students' attrition in STEM majors. However, university support was found to positively affect students' persistence in STEM majors. The implications of the findings are that the university can channel its support systems in nurturing the students' skills and knowledge by providing physical and psychosocial support for the students to persist in STEM majors. Hence, encouraging more students to opt for STEM majors is necessary to enhance the global economy so that it can contribute to the well-being not just of the STEM graduates, but the society and nation as well.

Keywords: STEM, career, gender equality, persistence, attrition

Received: 31 August 2022; **Accepted:** 28 September 2022; **Published:** 31 July 2023

To cite this article: Ahmad, N. J., Ramly, S. N. F., Ahmad, A. M., Shukri, A. A. M., & Abdullah, R. (2023). Persistence and attrition in STEM majors for a career choice. *Asia Pacific Journal of Educators and Education, 38*(1), 73–95. https://doi.org/10.21315/apjee2023.38.1.5

INTRODUCTION

The demand for a skilled STEM workforce remains high, as it is frequently reported that professionals in these fields contribute significantly to the growth of the economy and global competitiveness in first-world countries (Kaleva et al., 2019; Hanson & Slaughter, 2016). There is also a great concern about "developing future scientists, technologists, engineers, and mathematicians to remain viable and competitive in the global economy has re-energized attention to STEM education" (Kelley & Knowles, 2016, p. 2). Therefore, the changes in the global economy and workforce have fuelled the need to address the global shortage of STEM workers, as future job growth is expected in STEM-related fields (Dasgupta & Stout, 2014; Bosman et al., 2017; Kennedy & Odell, 2014; Shin et al., 2016). These STEM jobs require multidisciplinary problem-solving approaches which include technology in industries such as manufacturing, defence, health care, finance, government, weather forecasts and even digital arts and music (Baron, 2015).

There are also some concerns about preparing students for STEM careers (Rogers-Chapman, 2014). There are some factors that influence the student's views toward STEM careers such as motivation, experience, and self-efficacy (Kaleva et al., 2019; Razali et al., 2020; Roberts et al., 2018). For instance, motivation is a powerful force that pushes students to keep working even in the face of challenges, to take advantage of rewards, and to demonstrate dedication to what they wish to do (Stoyanov, 2017). Also, the students do rely on peers, media, and parental motivations to develop their perceptions of STEM careers (Perry & Van Zandt, 2006; Lamb et al., 2018).

Furthermore, students' major selections are influenced by their knowledge of future earnings and other occupational insights (Xu, 2013). Higher salary is one's expectation that might provide motivation for the graduates to be in the STEM workforce as STEM (Wang & Degol, 2013) careers are considered high skilled jobs (Kamaruzaman et al., 2019). Thus, it is also vital for academic institutions to provide support to the students to sustain an ongoing conversation with students about their STEM career interests and keep them informed about the economic or occupational benefits once they decide to pursue a degree in STEM (Kitchen et al., 2018). Several explanations have been linked to college or university retention in the fields of science and engineering, including a lack of adequate preparation during preparation, difficulties adjusting to college life, a lack of engineering community atmosphere, limited exposure to engineering courses in the foundation and sophomore years, and financial obligations (Alkhasawneh & Hargraves, 2014).

There are studies conducted to investigate the differences of gender in many aspects in education; for instance, inventive thinking and creativity (Turiman et al., 2020), performance (Wang & Degol, 2017), career selection (Huang et al., 2020) and other aspects for comparison. Gender equality at the university is also crucial. There is persisting stereotyping that derive disparities such as masculine stereotypes about STEM such as parents' expectations of daughters, peer norms, and lack of personal goals which make girls move away from STEM fields during their childhood and adolescence periods (Dasgupta & Stout, 2014). Also, lack of female role models in STEM fields could also be the cause. Most subtle reasons are the gender bias in work area such as hiring and promotion, biased evaluation at work, harassment at work in male dominant field, as well as family responsibilities undermine the retention of women in STEM field (Bosman et al., 2017; Dasgupta & Stout, 2014).

As the demand for STEM work increases at a higher rate as compared with others (Melguizo & Wolniak 2012; Rogers-Chapman 2014), the understanding of certain factors affecting academic and career choices of graduates is essential for effective intervention and response (Dorie et al., 2014; Haron et al., 2019; Kasim & Ahmad, 2018). The expectancy–value theorists postulate that there are range of choices and achievements that begin in childhood and adolescence (Eccles, 1994; Eccles et al., 1997). Thus, based on this, the achievement-related behaviours such as educational and career choice are most directly related to expectations for success and the value attached to being recognised as available. For instance, in a study on a sample of college students in STEM majors discovered that institutional conditions, specifically the quality of academic programme, faculty teaching, accessibility of academic advising, and gender equality are some factors that may influence students' persistence and attrition in STEM majors before their degree completion (Xu, 2018).

Moreover, improving student retention and persistence in STEM majors is highly desirable for universities, as a declining student population can have a significant impact on current and future students, instructors, researchers, professional staff, and the university as a whole (Watkins & Mazur, 2013). Thus, understanding students' view on STEM careers, the university support and gender equality may answer the persistence and attrition in STEM majors among the tertiary students at universities.

LITERATURE REVIEW

Hypothesis Development

The following research hypotheses in this study were formulated.

The relationship between gender equality and students' views toward STEM careers

There are many researchers that discuss about STEM and gender especially women (Blackburn, 2017; Gomez et al., 2020; Sassler et al., 2017). Today, some of the most gender-segregated STEM workforces are found in highly affluent, reputably gender-progressive societies (Charles, 2017). Inequality has proven to be highly resilient in the industry. Gender is a dominant cultural frame that organizes everyday social relations, shapes individual identities, and inscribes gender inequality in social and economic institutions. In contemporary Western societies, persons are widely presumed to occupy one of two distinct gender categories, and many work tasks are presumed to be intrinsically masculine or feminine (Des Jardins, 2010). Many people believe that occupations like engineering and preschool teaching are highly segregated because they require aptitudes and bodies that map neatly onto the "Mars and Venus" gender dichotomy (Thebaud & Charles, 2018).

According to Wiebe et al. (2018), STEM careers are more visible in physical sciences than life sciences. Many other researchers have reported similar findings, including Halim et al. (2018), and Deming and Noray (2018), but limited in terms of the variables studied, one of it is gender (Eccles & Wang, 2016; Kaleva et al., 2019; Simon et al., 2017). In the case of STEM, the categorisation is often reinforced by the distinctively masculine cultural beliefs, norms, and practices that pervade STEM educational and work environments (Thebaud & Charles, 2018). In this study, the relationship between gender equality and student's view towards STEM career was studied according to the hypothesis:

H1: Gender equality does not positively affect diploma, undergraduate and postgraduate students' views on STEM careers.

The relationship between university support and students' views toward STEM careers

The university support toward students' development in their study majors differ and depends on the respective university administration. However, most of them include physical and psychosocial learning environments of students which can provide the students with support that will improve their learning experience in the university (Rivera & Li, 2020. The university support is important to provide positive views on STEM careers among the students. In terms of STEM majors, the university support may influence how the students' view STEM careers in the career programs of the initial phase of admission, counselling or academic talk with the students from time to time to ensure that students get the correct viewpoints toward STEM careers (Chen & Kelly, 2013; Rezayat & Sheu, 2020).

In addition, students obtain a broad overview of designated strands in STEM and the major clusters of careers through peers, media, and parental influences and thus develop their own perceptions toward STEM careers. Consequently, this will influence selections of majors in universities (Arcidiacono et al., 2012; Sadler et al., 2014). Negative views and perceptions on STEM careers might lead to unsure feelings about the importance of STEM majors, acquire minimal knowledge about the STEM workforce, and thus affect their major selection of their studies (Patterson et al, 2019). Thus, a good understanding of how STEM can contribute to the workforce at an early age, such as in school, is fundamental in attracting more future students to choose STEM majors at universities. In this study, the university is the advisory support given to students, the facilities, and infrastructure available and academic supports. The relationship between university support and students' view towards STEM careers was studied according to the hypothesis:

> H2: The university support does not positively affect diploma, undergraduate and postgraduate students' views on STEM careers.

The relationship between gender equality and attrition in STEM majors

Gender inequalities in STEM majors and careers are inevitable in several countries, including the US, UK, India, Australia and Malaysia. According to Memon and Jena (2017), there is a connection between gender equality and attrition. Women have a lower rate of incentive turnover when it comes to work satisfaction. Stamarski and Son Hing (2015) find the same thing in their research. They believe that companies with a lot of gender inequality have a lot of people leaving by attrition. According to Emerson (2019), two out of every three women reported being discouraged from STEM majors. In 2018, women made up only 28% of the STEM workforce. More than 32% of female college students who declare a STEM major will likely switch to a non-STEM major before graduation, whereas only 25% of their male counterparts do, and women may be 1.5 times more likely than men to leave STEM fields. In addition, The STEM Equity Monitor Report (2020) on women's STEM participation in Australia, the proportion of women studying STEM majors is lower than men, with only 9% of women enrolled in a STEM major in 2018, compared to 35% of men in the 2018 intake. In terms of gender equality, this statistic shows that men outnumber women in STEM majors. This pattern has been seen in several countries, including the US, the UK and Malaysia. In this study, the relationship between gender equality and attrition in STEM majors was studied according to the hypothesis:

> H3: Gender equality does not positively affect diploma, undergraduate and postgraduate students' attrition in STEM majors.

The relationship between university support and attrition in STEM majors

Most of the STEM attrition research is focusing on the students, lecturers, and parents but not many are focusing on the most important role, that is the university support. STEM attrition refers to potential to change STEM majors or dropping out of postsecondary education before earning a degree or certificate (Chen & Soldner, 2013; Sithole et al., 2017). Thus, how much students retain their STEM majors is the focus here. STEM attrition is believed can also be influenced by students' interactions or perceptions toward the university in terms of academic advising, career counselling and university support;

feelings of isolation in STEM fields because too few peers pursue STEM degrees and there are too few role models and mentors available (Chen, 2015).

The declining enrolment in STEM major recently in Malaysia has produced massive STEM promotion and programmes not only in school but also in the university (Kamsi et al., 2019; Meng et al., 2014). Similar national agendas can be found in many other countries, including the UK, the US and Australia. The dedication to promoting and improving STEM education goes far beyond words, as evidenced by consistent and funding support (Carlisle & Weaver, 2018; Chen & Kelly, 2013). For instance, many first-year engineering programmes provide comprehensive academic and social support to assist students in adjusting to their new environment and succeeding academically to keep students in engineering programmes (Santiago et al., 2012). In this study, the relationship between university support and attrition, which looking at the retention in STEM majors was studied according to the hypothesis:

> H4: University support does not positively affect diploma, undergraduate and postgraduate students' attrition in STEM majors.

The relationship between gender equality and persistence in STEM majors

Gender equality and persistence are found to be related. According to Milazzo and Goldstein (2017), gender equality encourages the continuation of gender differences, which led to heavy opposition to transition. Discriminatory norms and practises are often more likely to persist because of gender inequality (Stewart-Williams & Halsey, 2021). In terms of persistence in STEM majors, there is an imbalance gender equality. Women tend to drop or switch to other majors more likely than men do (Australian Government, 2020; Shapiro & Sax, 2011).

In contrast to this, according to Miller and Wai (2015) and Porter and Ivie (2019), there are no longer more women than men in the STEM majors. Female students have a higher persistence rate in male-dominated STEM majors than female-dominated STEM majors (Riegle-Crumb et al., 2016; Meyer & Strauß, 2019). This answers the previous research where women were reported to have lower persistence rate than men, particularly in physical science of STEM subjects such as engineering, technology, and mathematics which are dominated by male students. Thus, understanding how women participate in STEM higher education can help the government, universities and other sectors provide more targeted support for women as they progress through the STEM pathway, from school to university (Talley & Martinez Ortiz, 2017). Furthermore, it can assist in focusing support on specific fields and types of education to make the gender inequality smaller. In this study, the relationship between gender equity persistence in STEM majors was studied according to this hypothesis:

> H5: Gender equality does not positively affect diploma, undergraduate and postgraduate students' persistence in STEM majors.

The relationship between university support and persistence in STEM majors

STEM persistence refers to enrolment decisions that cause potential STEM graduates to retain in STEM fields until graduate (Chen & Soldner, 2013). The student persistence rate at the university is a measure of student success used by many universities (Elliott & Shin, 2002). This is because it reveals how well a university can retain students based on the quality of education, research, and services provided. Thus, the role of the advisory committee in the university and academic institution is also essential in ensuring STEM success (Rask, 2010). It is therefore fundamental for them to maintain ongoing conversations with students about their career interests and to keep them informed of economic or potential occupational benefits as soon as they decide to pursue a STEM major, as well as to provide a thorough understanding among students of how STEM can contribute to the workforce, and thus, attracting more future professionals to the network.

A study by Graham et al. (2013) found that institutional conditions specifically the quality of academic program, faculty teaching and accessibility of academic advising are the main factors which retain the students in their majors and may influence their persistence to degree completion (also in Xu, 2018). In this study, the relationship between university support and students' persistence in STEM was studied according to the hypothesis:

> H6: The university support does not positively affect diploma, undergraduate and postgraduate students' persistence in STEM major.

METHODOLOGY

PLS-SEM was used to investigate the relationships between the investigated variables in this study because it fits well for limited sample sizes (Hair et al., 2017). In this study, the sample size was 130 students. As the criteria vector, the research paradigm proposed in this study represents a positivist notion, as it formulates an empirically testable theory in relation to views on STEM careers, university support, gender equality, as well as persistence and attrition in STEM majors. As a result, an observational analysis involving SmartPLS 3.0 was used to validate the analysis model using Partial Least Square path simulation. The data was analysed using partial least squares structural equation modelling (PLS-SEM) with SmartPLS 3.0 (Ringle et al., 2015) computer software.

A collinearity analysis was performed to determine if there were two strongly correlated metrics. The analysis of study models can be hampered by collinearity between study constructs (Hair et al., 2014). One of the issues with collinearity in hierarchical models is the use of overlapping metrics as a single object to quantify two or more constructs. There will be a problem with multicollinearity if this happened. Overlapping objects are recycled as a result. The indicators' collinearity is calculated using VIF values, also known as variance inflation factors. VIF should not be greater than 5 to prevent the incidence of multicollinearity.

The interaction hypothesis between the structures analysed can be shown using path analysis. Among the stuff shown is the direction coefficient (β) between constructs with values ranging from –1 to +1. According to Hair et al. (2014), values of path coefficients close to +1 typically signify a meaningful association between structures, while values of path coefficients close to 0 usually do not.

Following that, the analytical value of t will be considered in the analysis of this segment. Hair et al. (2014) used an analytical value of 1.96 with a significance degree of 5%. A two-tailed test was used to create this item. Simultaneously, the value of p is used to perform this path analysis. According to Hair et al. (2017), in general, researchers report this *p*-value to be able to reject or struggle to reject obtained hypotheses results. An acceptable *p*-value must be below 0.05 for 5% significant.

To evaluate the hypotheses of this study, the value of the path coefficient (β), the empirical value of *t*, and the value of the coefficient *p* were used to establish the relationship between the constructs in this study.

Sample and Sampling

The targeted populations were diploma, undergraduate, and postgraduate university students from five (5) technical universities in Malaysia. A stratified random sampling procedure was utilised in this study with a population of 44,389. A sample of 130 students with 77 males and 53 females, from aged 18–40 years old were chosen. According to G*Power 3.1.9.4, the minimum samples required for this study was 107. Hence, the sample (n = 130) was accepted to be employed. Most of them majoring in Civil Engineering, Mechanical Engineering, Electrical Engineering or other related technical majors.

This study involved an instrument that was an adapted questionnaire of STEM Career Interest Survey (STEM-CIS) by Kier et al. (2014). The questionnaire contained variables which required both quantitative and qualitative responses. The STEM-CIS consisted of four parts which were Part A: Demographic Information (12 items), Part B: Students' Views on STEM Careers (11 items), Part C: Students' Persistence Factors to Retain STEM Majors in University (11 items), and Part D: Students' Probability of Dropping Major (11 items). For Part C and Part D, qualitative questions were asked to support the Likert scale items.

Part A included 11 questions about university, gender, race, age, level of current education at the university, academic year, major course, father's academic qualification, mother's academic qualification and family occupations (parents, siblings and relatives). Part B included the questions that were shown to be psychometrically sound for each of the subscales of science, technology, engineering and mathematics. Group of questions in Part C focused on factors that might influence students to retain STEM (engineering) majors at the university. The remaining questions in Part D were about the probability of students to drop engineering major.

Participation was entirely voluntary and anonymous. All individual survey responses were kept confidential and used for research purposes only. Respondents required to make a self-assessment by expressing their agreement based on a five-point Likert scale: (1) Strongly Disagree, (2) Disagree, (3) Neither Agree nor Disagree, (4) Agree and Strongly Agree (5). The 45-item survey was conducted online in considering the costs to 130 respondents. Respondents were invited to participate in the survey through email, or other social media platforms. The duration for the respondents to complete the survey were given about a week.

RESULTS

Demographic Information

A real phase study was conducted among students of higher education institutions in Malaysia. A total of 130 respondents had participated. Table 1 shows the descriptive analysis based on gender.

Table 1. Number of respondents based on gender

Gender	Frequency	Percentage (%)
Male	77	59.2
Female	53	40.8
Total	130	100.0

The student's age ranges from 18 to 40 years old. Most of the students were 18 years old (21.5%) followed by 23 years old (16.2%), and 22 years old (14.6%). Table 2 shows the numbers of students based on their academic levels.

Table 2 shows the level of education of the respondents which were diploma (23.6%), undergraduate (62.3%) and postgraduate (14.6%) candidates.

Table 2. Category of respondents based on level of current education at the university

Academic year	Frequency	Percentage (%)
Diploma	30	23.6
Undergraduate	81	62.3
Postgraduate	19	14.6
Total	130	100.0

Partial Least Squared Sequential Equation Modelling (PLS-SEM) Analysis

Figure 1 shows the hypothesised model that fits the data with the results of this study. To determine the degree of collinearity, tolerance (TOL) can be computed. The tolerance reflects the amount of variation in one indicator that is not clarified by the other indicators in the same block. The variance inflation factor (VIF) in Table 3, defined as the reciprocal of the tolerance, is a related measure of collinearity (Hair et. al., 2017). A tolerance value of 0.20 or lower and a VIF value of 5 or higher, in the sense of PLS-SEM, suggest a possible collinearity issue (Hair et al., 2011). From the table above, VIF value for all the constructs in this analysis were less than 5. (Hair et. al, 2014). This demonstrates that all constructs in this analysis were based solely on themselves and not on any other constructs (no multicollinearity).

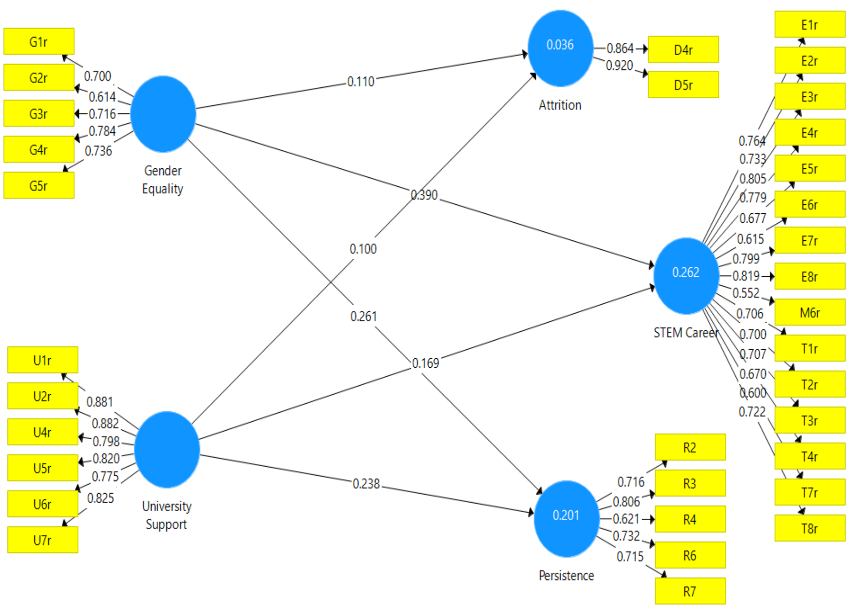

Figure 1. Proposed model for persistence and attrition in STEM majors for a career choice with path coefficient values (β) and R^2_{adj} values

Table 3. Table of VIF for measuring collinearity within constructs

	Attrition	Persistance	STEM career view
Gender equality	1.622	1.622	1.622
University support	1.622	1.622	1.622

The following results are presented based on the proposed hypothesised model in Table 4. The results were presented following the most significant to the less significant effects in this study.

H1: Gender equality does not positively affect diploma, undergraduate and postgraduate students' views on STEM careers

Table 4. Table of model's path coefficient

	Path coefficient (β)	Standard deviation (STDEV)	*t*-statistics (|O/STDEV|)	*p*-values	2.50%	97.50%
Gender Equality -> Attrition	0.110	0.119	0.927	0.354	–0.118	0.341
Gender Equality -> Persistence	0.261	0.102	2.554	0.011	0.064	0.462
Gender Equality -> STEM Career View	0.390	0.118	3.295	0.001	0.158	0.635
University Support -> Attrition	0.100	0.129	0.774	0.439	–0.169	0.341
University Support -> Persistence	0.238	0.104	2.286	0.022	0.050	0.455
University Support -> STEM Career View	0.169	0.134	1.254	0.210	–0.116	0.437

The path coefficient value for the relationship between gender equality and student views on STEM careers was 0.390 and the *t*-value was 3.295. At the 5% significant value, this value is greater than 1.96. The *p*-value is 0.001 in this case. At the 1% significant value, this value is less than 0.01. As a result, the hypothesis was rejected because gender equality did positively affect students' views on STEM careers ($\beta = 0.390$, $t = 3.295$, $p = 0.001$, SD = 0.118).

H5: Gender equality does not positively affect diploma, undergraduate and postgraduate students' persistence in STEM majors

The path coefficient value of 0.261 was shown between gender equality and student persistence in STEM majors with *t*-value of 2.554. At a significant value of 5%, this value is greater than 1.96. 0.011 is the value for the *p*-value. At the 5% significant value, this value was still less than 0.05. Hence, the hypothesis was rejected because gender equality did positively affect students' STEM major persistence ($\beta = 0.261$, $t = 2.554$, $p = 0.011$, SD = 0.102).

> H6: The university support does not positively affect diploma, undergraduate and postgraduate students' persistence in STEM majors

The path coefficient value for the relationship between university support and student persistence in a STEM major was 0.238 with *t*-value of 2.286. At the significant value of 5%, this value was more than 1.96. The p value was 0.022 which is less than 0.05 at 5% significant value. As a result, the hypothesis was rejected because university support did positively affect students' persistence in STEM major ($\beta = 0.238$, $t = 2.286$, $p = 0.022$, SD = 0.104).

> H2: The university support does not positively affect diploma, undergraduate and postgraduate students' views on STEM careers

The path coefficient value for the relationship between university support and student views of STEM careers was 0.169 with t value of 1.254. At the 5% significant value, this value was less than 1.96. The value of *p* is 0.210. At the 5% significant value, this value was greater than 0.05. Therefore, the hypothesis was failed to be rejected because university support did not positively affect students' views of STEM careers ($\beta = 0.169$, $t = 1.254$, $p = 0.210$, SD = 0.134).

> H3: Gender equality does not positively affect diploma, undergraduate and postgraduate students' attrition in STEM majors

The path coefficient value for the relationship between gender equality and student attrition in STEM majors was 0.110 and *t*-value was 0.927. At the 5% significant value, this value is less than 1.96. The magnitude of the *p*-value is 0.354. At the 5% significant value, this value exceeds the value of 0.05. As a result, the hypothesis was failed to be rejected because gender equality did not positively affect students' attrition in STEM major ($\beta = 0.110$, $t = 0.927$, $p = 0.354$, SD = 0.119). This means that there was no effect of gender equality on students' attrition.

> H4: University support affects diploma, undergraduate and postgraduate students' attrition in STEM majors

The path coefficient value for the relationship between university support and student attrition in STEM majors was 0.100 and *t*-value was 0.774. At the 5% significant value, this value is less than 1.96. The amount of the *p*-value is 0.4398, which is more than 0.05 at the 5% significant value. Thus, the hypothesis was failed to be rejected, and university support did not positively affect student attrition in STEM majors (β = 0.100, $t = 0.774$, $p = 0.4398$, SD = 0.129). This means that there was no effect of university support on students' attrition.

Table 5. Table of coefficient of determination, R^2

Variable	R-squared	R-square adjusted
Attrition	0.036	0.02
Persistence	0.201	0.189
STEM career	0.262	0.25

Table 5 shows R^2 coefficient, which is measured as the squared correlation between the real and expected values of a given endogenous construct, is a measure of the model's predictive capacity. The coefficient represents the sum of the exogenous latent variables' effects on the endogenous latent variable (R^2). To prevent bias against complex models, the adjusted coefficient of determination (R^2_{adj}) can be used as the parameter, as with multiple regression (Hari et al., 2017). According to the table, the value of R^2_{adj} for attrition is 0.02; this means that gender equality and university support clarified 2% of attrition. R^2_{adj} for persistence is 0.189, indicating that gender equality and university support described 18.9% of persistence. Lastly, STEM career shown a value of 0.25 for is R^2_{adj}. Hence, 25% of STEM career were explained by gender equality and university support.

Table 6. Table of effect size, f^2

Variable	Attrition	Persistence	STEM career
Gender equality	0.008	0.052	0.127
University support	0.006	0.044	0.019

In Table 6, the change in the R^2_{adj} value when a given exogenous construct is excluded from the model may be used to determine whether the omitted construct has a meaningful effect on the endogenous constructs, in addition to evaluating the R^2_{adj} values of all endogenous constructs. The effect size, f^2 scale is the name given to this metric. According to Cohen (1988), values of 0.02, 0.15 and 0.35 reflect minor, medium and high effects of the exogenous latent variable, respectively. If the impact size is less than 0.02 so there is no effect. According to Table 6, both gender equality and university support have f^2 value below than 0.02 which is 0.008 and 0.006, accordingly. This means that there was no effect of gender equality and university support on students' attrition. For student's persistence, gender equality has slightly higher effect with value of 0.052 compared to university support which only 0.044. Lastly, gender equality has small to medium effect with value of 0.127 to student's view on STEM career and university support have no effect (0.019).

DISCUSSION

Gender Equality and Students Views on STEM Careers

The results show that gender equality did positively affect diploma, undergraduate and postgraduate students' views on STEM careers. Meaning that students perceived gender equality to play a significant role in STEM careers. Thus, being equal among gender shows that both are talented, motivated, and smart (Yatskiv, 2017). This is consistent with Hitka et al. (2018) in their study which report that both men and women appreciate when their working relationships are satisfactory with each other in the workplace, as this would provide the opportunity for them to progress when they receive recognition and respect for the work they have achieved. In this study, both genders did not consider gender as challenge because both genders could work with each other such as completing group assignment even though the majority of students in engineering majors are males. Thus, education to both boys and girls on how to perceive genders without prejudice should be conducted at early age such as from kindergarten. The collaborations between genders also should be integrated at their early age.

On the other hand, some literatures point out STEM career is dominated by men (Cech & Blair-Loy, 2019; Yatskiv, 2017). However, these findings show that gender itself might not be the antecedent as achieving gender equality not only promotes greater equality in employment outcome (STEM career) but also help postpone early-marriages, reduce infant mortality rates, and improve health and education of future generations (The Organisation for Economic Co-operation & Development, 2011). From the data, 20 respondents expressed their interest to join a teaching profession after graduation. They mentioned that teaching professions such as lecturer at the university as well as in engineering line would offer them higher salary as well. This was based on their views as one of their parents works at the university.

Gender Equality and Persistence in STEM Majors

The results show that gender equality did positively affects diploma, undergraduate and postgraduate students' persistence in STEM majors. Meaning that gender equality plays an important role in retaining their STEM majors. From the data, 44 female participants mentioned that they did not have trouble and fully supported by the faculty and their male peers. However, they felt uneasy when they were given special treatment like "women's first". This finding supports the findings of previous studies by Sithole et al. (2017) and Chen and Soldner (2013), which assert that institutional factors and support for both genders are equal but do have the potential to influence students' persistence, particularly in the STEM programme specification.

In a study by King (2016), the results show that women persist in STEM at the same rate as men, not as mentioned earlier where many women were reported to leave STEM fields. In addition, King also argues that there is a need to re-examine patterns of STEM inequality to identify points in the pipeline where gender equality exists as some studies provide inaccurate notion that women are more likely to leave STEM majors, this will likely discourage young women who are interested in pursuing a STEM degree but are concerned about their chances for success. Furthermore, believing that college STEM females are less competitive than STEM males may have negative consequences for women who want to pursue these fields. Thus, it is very crucial to perceive genders as equals or to ensure both genders have equal opportunity to excel in STEM majors the university; hence, being able to persist in STEM majors at the university.

University Support and Persistence of STEM Majors

The results shows that university support did affect diploma, undergraduate and postgraduate students' persistence in STEM majors. Thus, the institutional conditions specifically the quality of academic program, faculty teaching and accessibility of academic advising are the main factors which keep students in their majors that may influence their persistence to degree completion (Xu, 2018). These academic experiences were found to influence the selection of occupations and predominantly on the selection of STEM jobs (Rask, 2010). Hence, the environment, the quality of facilitation and the role of advisory committee are in fact very crucial.

In addition, several explanations have been linked with college or university retention in the fields of engineering such as lack of adequate preparation during preparation, difficulties in adjusting to college life, lack of engineering community atmosphere, limited exposure to engineering courses in the foundation and sophomore years, and financial obligations are some possible reasons (Alkhasawneh & Hargraves, 2014). Thus, knowing students' major selection is guided by their knowledge about future earnings and other occupational viewpoint; therefore, it is very important for academic institutions to keep an ongoing conversation with students about their career interests and keep them informed about the economic or occupational advantages once they decide to earn a degree in STEM.

University Support and Students' Views on STEM Careers

The results have shown that university support did not positively affect diploma, undergraduate and postgraduate students' views on STEM careers. This finding is consistent with previous research (Kaleva et al., 2019; Mohtar et al., 2019; Roberts et al., 2018) which found that the factors influencing students' views are primarily their self-efficacy, parental support, and expected earnings, rather than the university or academic institution. Nevertheless, the finding by Rivera and Li (2020) suggest that academic institutions should improve the physical and psychosocial learning environments of students served by the university or academic institution. This is as well as the fact students' viewpoints about STEM technology and facilities may influence their STEM college learning and career orientation. This discovery was also discussed by Ikuma et al. (2019) and Rask (2010). As a result, the university is encouraged to continue working to promote STEM, which can have a positive effect on students' views of STEM careers.

In this study, the respondents' academic background, parental support, and other influencing factors may have overshadowed the influence of university support in terms of their perception of STEM careers. Further research should be conducted over a longer period to examine the changes in students' attitudes toward STEM careers as they progress through the learning process. Thus, according to expectancy-value theory, an individual who has subjective task value-related beliefs would stick to their insights and perspective of choices that would bring success to him or her (Wigfield & Eccles, 2002). In addition, the data also reports another scenario where the students mentioned that once they entered the engineering or other fields, it would be difficult for them to change or drop the majors as the university does not allow them to do so. Also, because many of them are on educational loan, they are also bound to the contract. Thus, changing major or dropping out major was out of the picture. However, the female respondents did agree that if they were given choices, they would change to other majors such as humanities or arts. However, all respondents do not opt to drop their major due to their financial contracts.

Gender Equality and Attrition in STEM Majors

The results show that gender equality did not positively affect diploma, undergraduate and postgraduate students' attrition on STEM majors. Meaning if the students want to drop their major, gender equality does not play any role. 65 male respondents and 42 female respondents did think about changing their major during their sophomore years. But in terms of dropping the STEM majors, all participants felt that the support by the peers (within one's gender) plays major roles, instead of gender equality. They agreed that many of them tend to follow their peers in terms of making decisions to retain or drop the major. Similar studies by Atkins et al. (2020) and Ikuma et al. (2019) and Sargent (2014), suggest that academic discussion with peers and support that they received would lead to positive outcome expectations, greater interest in STEM retain STEM majors, and better academic results all which at the end had positive effects on major goals. This shows that peer support at the university might contribute to the students' attrition at the university in comparison to gender equality.

University Support and Attrition of STEM Majors

The findings show that university support did not positively affect students' attrition in STEM majors. This shows that university support did not influence students' decision in dropping their STEM majors. For instance, when the respondents were asked about whether they would prefer to retain their majors, all participants agreed that they were going to retain their majors not because they wanted to but because the university system is very strict in terms of changing majors. According to Lent and Brown (2013), human will adapt their behaviours to accomplish something in life as well as resolve the predicaments or any setback along the ways. These are happening in all stages of human's life span. However, the most important period of a person's life is often during youth and adolescence period as the career and family development are within this stage (Ingersoll & Perda, 2010). Thus, knowing their responsibility to complete their degree, regardless of the university support, the students would maintain their majors even though some of the respondents did mention if they had the chance to change their major not due to lack of university support, but because the courses are difficult and challenging.

CONCLUSION

This research has revealed new insights and viewpoints into tertiary students' perspectives on STEM majors and professions. The respondents who were engineering students regarded engineering as exclusive and sophisticated major because they believed that only competent with higher academic ability could enrol in engineering majors. This gives them the trust and positive value in the sense that they were inspired and determined to stick with their majors; even though some of them were struggling with high cognitive level courses in the beginning.

Furthermore, gender equality is significant in students' views of STEM careers and persistence in STEM majors. This study posits that gender should be considered equal in STEM major and careers without any prejudice among both genders. Furthermore, this study represents that woman should be equitably represented, according to Sustainable Development Goal (SDG) number five (5), as gender inequalities still exist in every community. Women endure occupational segregation and salary disparities, as well as a lack of access to acceptable jobs. They are frequently denied basic schooling and health services, as well as being victims of abuse and discrimination. They are disproportionately underrepresented in political and economic decision-making. Thus, this study shows that gender equality is not a concern if it is still practised in the institution such as university. Thus, in relation to these, the university support such as the usage the facilities, mentoring, and support from the administration and lecturers regardless of genders are important for the students to retain in their majors; hence reducing attrition rate.

The university can channel its support's systems towards awareness of global citizenship among students. The development of sustainability curricula and training programmes should support students for careers in fields for the development society wellbeing. Hence, in order to increase human welfare, university education should address fairness and promote the development of STEM graduates who are committed to public-good principles and making professional contributions to society (Walker, 2015). However, empowering higher education institutions requires change. Universities thus play a crucial role in nurturing professionals who possess the skills and knowledge to cope with increasingly complex, transdisciplinary and cross-border problems, whose combination makes it even more important for these higher education institutions to transform the way knowledge is generated and shared. They need to develop abilities that allow the current generation to understand, empathize and practice collective values and principles that can guide one to lead quality lives. Thus, not just transforming higher educational institution for sustainable future, but also changing the mentality of students to opt for STEM majors that can contribute to the wellbeing not just for themselves, but for the society and nation as well.

ACKNOWLEDGEMENTS

This paper is produced based on USM Short Term Grant 304/PGURU/6315274. The main author would like to extend appreciation and gratitude to Research Community and Management Office (RCMO), and School of Educational Studies, Universiti Sains Malaysia. Also, to Professor Dr. Muhammad Kamarul Kabilan Abdullah, as mentor in this publication.

REFERENCES

Alkhasawneh, R., & Hargraves, R. H. (2014). Developing a hybrid model to predict student first year retention in STEM disciplines using machine learning techniques. *Journal of STEM Education: Innovations and Research, 15*(3), 35–42.

Arcidiacono, P., Hotz, V. J., & Kang, S. (2012). Modeling college major choices using elicited measures of expectations and counterfactuals. *Journal of Econometrics, 166*(1), 3–16. https://doi.org/10.1016/j.jeconom.2011.06.002

Atkins, K., Dougan, B. M., Sermen, M. S. D., Potter, H., Sathy, V., & Panter, A. T. (2020). Looking at myself in the future: How mentoring shapes scientific identity for STEM students from underrepresented groups. *International Journal of STEM Education, 7*(42), 1–15. https://doi.org/10.1186/s40594-020-00242-3

Australian Government. (2020). *STEM equity monitor: Summary report 2020*, 12. Retrieved from www.industry.gov.au/

Baron, L. (2015). An authentic task that models quadratics. *Mathematics Teaching in the Middle School, 20*(6), 335–340. https://doi.org/10.5951/mathteacmiddscho.20.6.0334

Blackburn, H. (2017). The status of women in STEM in higher education: A review of the literature 2007–2017. *Science & Technology Libraries, 36*(3), 235–273. https://doi.org/10.1080/0194262X.2017.1371658

Bosman, L., Chelberg, K., & Winn, R. (2017). How does service-learning increase and sustain interest in engineering education for underrepresented pre-engineering college students? *Journal of STEM Education: Innovations and Research, 18*(2), 5–9.

Carlisle, D. L., & Weaver, G. C. (2018). STEM education centers: Catalyzing the improvement of undergraduate STEM education. *International Journal of STEM Education, 5*(1), 1–21. https://doi.org/10.1186/s40594-018-0143-2

Charles, M. (2017). Venus, Mars, and math: Gender, societal affluence, and eighth graders' aspirations for STEM. *Socius, 3*. https://doi.org/10.1177/2378023117697179

Des Jardins, J. (2010). *The madame curie complex: The hidden history of women in science*. New York: CUNY Press.
Cech, E. A., & Blair-Loy, M. (2019). The changing career trajectories of new parents in STEM. *Proceedings of the National Academy of Sciences, 116*(10), 4182–4187. https://doi.org/10.1073/pnas.1810862116
Chen, X. (2015). STEM attrition among high-performing college students: Scope and potential causes. *Journal of Technology and Science Education, 5*(1), 41–59. https://doi.org/10.3926/jotse.136
Chen, X., & Soldner, M. (2013). *STEM attrition: College students' path into and out of STEM fields: A statistical analysis report*. Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education, 2014–001.
Chen, D., & Kelly, H. (2013). *Understanding the leaky STEM pipeline by taking a close look at factors influencing retention and graduation rates*. Paper presented at the 40th Annual Conference of the Northeast Association for Institutional Research.
Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Hillsdale: Lawrence Erlbaum Associates.
Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences, 1*(1), 21–29. https://doi.org/10.1177/2372732214549471
Deming, D. J., & Noray, K. L. (2018). *STEM careers and technological change*. NBER Working Paper Series, 25065(September).
Dorie, B. L., Jones, T. R., Pollock, M. C., & Cardella, M. (2014). *Parents as critical influence: Insights from five different studies*. School of Engineering Education Graduate Student Series. Paper 55. http://docs.lib.purdue.edu/enegs/55
Eccles, J. S. (1994). Understanding women's educational and occupational choices: Applying the Eccles et al. model of achievement-related choices. *Psychology of Women Quarterly, 18*(4), 585–609. https://doi.org/10.1111/j.1471-6402.1994.tb01049.x
Eccles, J. S., & Wang, M. T. (2016). What motivates females and males to pursue careers in mathematics and science? *International Journal of Behavioral Development, 40*(2), 100–106. https://doi.org/10.1177/0165025415616201
Eccles, J. S., Midgley, C., Wigfield, A., Buchanan, C. M., Reuman, D., Flanagan, C., & Mac Iver, D. (1997). Development during adolescence: The impact of stage–environment fit on young adolescents' experiences in schools and in families (1993). In J. M. Notterman (Ed.), *The evolution of psychology: Fifty years of the American psychologist* (pp. 475–501). American Psychological Association. https://doi.org/10.1037/10254-034
Elliott, K. M., & Shin, D. (2002). Student satisfaction: An alternative approach to assessing this important concept. *Journal of Higher Education Policy and Management, 24*(2), 197–209. https://doi.org/10.1080/1360080022000013518
Emerson. (2019). *Emerson global STEM survey*. Emerson. Retrieved from https://www.emerson.com/en-us/news/corporate/global-stem-survey-shows-growing-interest-in-careers-lack-of
Gomez Soler, S. C., Abadía Alvarado, L. K., & Bernal Nisperuza, G. L. (2020). Women in STEM: Does college boost their performance? *Higher Education, 79*(5), 849–866. https://doi.org/10.1007/s10734-019-00441-0
Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A.-B., & Handelsman, J. (2013). Increasing persistence of college students in STEM. *Science, 341*(6153), 1455–1456. https://doi.org/10.1126/science.1240487
Hair, J. F., Sarstedt, M., Hopkins, L., & Kuppelwieser, V. G. (2014). Partial least squares structural equation modeling (PLS-SEM). *European Business Review, 26*, 106–121. https://doi.org/10.1108/EBR-10-2013-0128

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Thousand Oaks, CA: Sage.

Halim, L., Abd Rahman, N., Wahab, N., & Mohtar, L. E. (2018). Factors influencing interest in STEM careers: An exploratory factor analysis. In *Asia-Pacific Forum on Science Learning and Teaching* (Vol. 19, No. 2, pp. 1–34). The Education University of Hong Kong, Department of Science and Environmental Studies.

Hanson, G. H., & Slaughter, M. J. (2016). *High-skilled immigration and the rise of STEM occupations in U.S. employment*. NBER working paper no. 22623. https://doi.org/10.3386/w22623

Haron, H. N., Kamaruddin, S. A., Harun, H., Abas, H., & Salim, K. R. (2019). Science, technology, engineering and mathematics initiatives at rural schools and its impact on learning motivation. *Journal of Physics: Conference Series, 1174*(1), 012002. https://doi.org/10.1088/1742-6596/1174/1/012002

Hitka, M., Kozubikova, L., & Potkany, M. (2018). Education and gender-based differences in employee motivation. *Journal of Business Economics & Management, 19*(1), 80–95. https://doi.org/10.3846/16111699.2017.1413009

Huang, J., Gates, A. J., Sinatra, R., & Barabási, A. L. (2020). Historical comparison of gender inequality in scientific careers across countries and disciplines. *Proceedings of the National Academy of Sciences, 117*(9), 4609–4616. https://doi.org/10.1073/pnas.1914221117

Ikuma, L. H., Steele, A., & Dan, S. (2019). Large-scale student programs increase persistence in STEM fields in a public university setting. *Journal of Engineering Education, 108*(3), 70–78. https://doi.org/10.1002/jee.20244

Ingersoll, R. M., & Perda, D. (2010). Is the supply of mathematics and science teachers sufficient? *American Educational Research Journal, 47*(3), 563–594. https://doi.org/10.3102/0002831210370711

Kaleva, S., Pursiainen, J., Hakola, M., Rusanen, J., & Muukkonen, H. (2019). Students' reasons for STEM choices and the relationship of mathematics choice to university admission. *International Journal of STEM Education, 6*(1), 1–12. https://doi.org/10.1186/s40594-019-0196-x

Kamaruzaman, M. F., Hamid, R., Mutalib, A. A., & Rasul, M. S. (2019). Comparison of engineering skills with IR 4.0 skills. *International Journal of Online & Biomedical Engineering, 15*(10), 15–28. https://doi.org/10.3991/ijoe.v15i10.10879

Kamsi, N. S., Firdaus, R. R., Razak, F. D. A., & Siregar, M. R. (2019, April). Realizing industry 4.0 through STEM education: But why STEM is not preferred? In *IOP Conference Series: Materials Science and Engineering* (Vol. 506, No. 1, p. 012005). IOP Publishing. https://doi.org/10.1088/1757-899X/506/1/012005

Kasim, N. H., & Ahmad, C. N. C. (2018). PRO-STEM module: The development and validation. *International Journal of Academic Research in Business and Social Sciences, 8*(1), 728–739. https://doi.org/10.6007/IJARBSS/v8-i1/3843

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education, 3*(1), 1–11. https://doi.org/10.1186/s40594-016-0046-z

Kennedy, T. J., & Odell, M. R. (2014). Engaging students in STEM education. *Science Education International, 25*(3), 246–258.

Kier, M. W., Blanchard, M. R., Osborne, J. W., & Albert, J. L. (2014). The development of the STEM career interest survey (STEM-CIS). *Research in Science Education, 44*, 461–481. https://doi.org/10.1007/s11165-013-9389-3

Kitchen, J. A., Sonnert, G., & Sadler, P. M. (2018). The impact of college-and university-run high school summer programs on students' end of high school STEM career aspirations. *Science Education, 102*(3), 529–547. https://doi.org/10.1002/sce.21332

Lai, E. R. (2011). M*otivation: A literature review research.* Research Reports, April, 43.

Lamb, R., Annetta, L., Vallett, D., Firestone, J., Schmitter-Edgecombe, M., Walker, H., & Hoston, D. (2018). Psychosocial factors impacting STEM career selection. *The Journal of Educational Research, 111*(4), 446–458. https://doi.org/10.1080/00220671.2017.1295359

Lent, R. W., Brown, S. D. (2013). Social cognitive model of career self-management: Toward a unifying view of adaptive career behavior across the life span. *Journal of Counselling Psychology, 60*, 557–568. https://doi.org/10.1037/a0033446

Melguizo, T., & Wolniak, G. C. (2012). The earnings benefits of majoring in STEM fields among high achieving minority students. *Research in Higher Education, 53*(4), 383–405. https://doi.org/10.1007/s11162-011-9238-z

Memon, N. Z., & Jena, L. K. (2017). Gender inequality, job satisfaction and job motivation: Evidence from Indian female employees. *Management and Labour Studies, 42(*3), 253–274. https://doi.org/10.1177/0258042X17718742

Meng, C. C., Idris, N., & Eu, L. K. (2014). Secondary students' perceptions of assessments in science, technology, engineering, and mathematics (STEM). *Eurasia Journal of Mathematics, Science and Technology Education, 10*(3), 219–227. https://doi.org/10.12973/eurasia.2014.1070a

Meyer, J., & Strauß, S. (2019). The influence of gender composition in a field of study on students' drop-out of higher education. *European Journal of Education, 54*(3), 443–456. https://doi.org/10.1111/ejed.12357

Milazzo, A., & Goldstein, M. (2019). Governance and women's economic and political participation: Power inequalities, formal constraints and norms. *The World Bank Research Observer, 34*(1), 34–64. https://doi.org/10.1093/wbro/lky006

Miller, D. I., & Wai, J. (2015). The bachelor's to Ph.D. STEM pipeline no longer leaks more women than men: A 30-year analysis. *Frontiers in Psychology, 6*, 37. https://doi.org/10.3389/fpsyg.2015.00037

Mohtar, L. E., Halim, L., Rahman, N. A., Maat, S. M., Iksan, Z. H., & Osman, K. (2019). A model of interest in STEM careers among secondary school students. *Journal of Baltic Science Education, 18*(3), 404–416. https://doi.org/10.33225/jbse/19.18.404

Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS.* Routledge. https://doi.org/10.4324/9781003117407

Patterson, R., Pope, N., & Feudo, A. (2019). *Timing is everything: Evidence from college major decisons.* CESifo Working Paper. https://doi.org/10.2139/ssrn.3323184

Perry, N., & VanZandt, Z. (2006). Focus on the future: A career development curriculum for secondary school students. IDEA.

Porter, A. M., & Ivie, R. (2019). *Women in physics and astronomy.* Technical report, AIP Statistical Research Center, College Park, MD.

Rask, K. (2010). Attrition in STEM fields at a liberal arts college: The importance of grades and pre-collegiate preferences. *Economics of Education Review, 29*(6), 892–900. https://doi.org/10.1016/j.econedurev.2010.06.013

Razali, F., Manaf, U. K. A., & Ayub, A. F. M. (2020). STEM education in Malaysia towards developing a human capital through motivating science subject. *International Journal of Learning, Teaching and Educational Research, 19*(5), 411–422. https://doi.org/10.26803/ijlter.19.5.25

Rezayat, F., & Sheu, M. (2020). Attitude and readiness for stem education and careers. *International Journal of Educational Management, 34*(1), 111–126. https://doi.org/10.1108/IJEM-07-2018-0200

Riegle-Crumb, C., King, B., & Moore, C. (2016). Do they stay or do they go? The switching decisions of individuals who enter gender atypical college majors. *Sex Roles, 74*(9), 436–449. https://doi.org/10.1007/s11199-016-0583-4

Ringle, C. M., Wende, S., & Becker, J. M. (2015). SmartPLS 3. SmartPLS GmbH, Boenningstedt. *Journal of Service Science and Management, 10*(3), 32–49.

Rivera, H., & Li, J. T. (2020, April). Potential factors to enhance students' STEM college learning and career orientation. In *Frontiers in Education* (Vol. 5, p. 25). Frontiers Media SA. https://doi.org/10.3389/feduc.2020.00025

Roberts, T., Jackson, C., Mohr-Schroeder, M. J., Bush, S. B., Maiorca, C., Cavalcanti, M., & Cremeans, C. (2018). Students' perceptions of STEM learning after participating in a summer informal learning experience. *International Journal of STEM Education, 5*(1), 1–14. https://doi.org/10.1186/s40594-018-0133-4

Rogers-Chapman, M. F. (2014). Accessing STEM-focused education: Factors that contribute to the opportunity to attend STEM high schools across the United States. *Education and Urban Society, 46*(6), 716–737. https://doi.org/10.1177/0013124512469815

Sadler, P. M., Sonnert, G., & Hazari, Z. (2014). The role of advanced high school coursework in increasing STEM career interest. *Science Educator, 23*(1), 1–13.

Santiago, L. Y., & Hensel, R. A. (2012, June). Engineering attrition and university retention. In *2012 ASEE Annual Conference & Exposition* (pp. 25–538).

Sargent, J. F. (2014). *The U.S. science and engineering workforce: Recent, current, and projected employment, wages, and unemployment.* The U.S. Science and Engineering Workforce: Employment and Wage Trends, 1–47.

Sassler, S., Glass, J., Levitte, Y., & Michelmore, K. M. (2017). The missing women in STEM? Assessing gender differentials in the factors associated with transition to first jobs. *Social Science Research, 63*, 192–208. https://doi.org/10.1016/j.ssresearch.2016.09.014

Shapiro, C. A., & Sax, L. J. (2011). Major selection and persistence for women in STEM. *New Directions for Institutional Research, 2011*(152), 5–18. https://doi.org/10.1002/ir.404

Shin, J. E. L., Levy, S. R., & London, B. (2016). Effects of role model exposure on STEM and non-STEM student engagement. *Journal of Applied Social Psychology, 46*(7), 410–427. https://doi.org/10.1111/jasp.12371

Simon, R. M., Wagner, A., & Killion, B. (2017). Gender and choosing a STEM major in college: Femininity, masculinity, chilly climate, and occupational values. *Journal of Research in Science Teaching, 54*(3), 299–323. https://doi.org/10.1002/tea.21345

Sithole, A., Chiyaka, E. T., McCarthy, P., Mupinga, D. M., Bucklein, B. K., & Kibirige, J. (2017). Student attraction, persistence and retention in STEM programs: Successes and continuing challenges. *Higher Education Studies, 7*(1), 46–59. https://doi.org/10.5539/hes.v7n1p46

Stamarski, C. S., & Son Hing, L. S. (2015). Gender inequalities in the workplace: the effects of organizational structures, processes, practices, and decision makers' sexism. *Frontiers in Psychology, 6*, 1400. https://doi.org/10.3389/fpsyg.2015.01400

Stewart-Williams, S., & Halsey, L. G. (2021). Men, women and STEM: Why the differences and what should be done? *European Journal of Personality, 35*(1), 3–39. https://doi.org/10.1177/0890207020962326

Stoyanov, S. (2017). *An analysis of Abraham Maslow's A Theory of Human Motivation.* Macat Library.

Stoet, G., & Geary, D. C. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. *Psychological Science, 29*(4), 581–593. https://doi.org/10.1177/0956797617741719

Sublett, C., & Plasman, J. S. (2017). How does applied STEM coursework relate to mathematics and science self-efficacy among high school students? Evidence from a national sample. *Journal of Career and Technical Education, 32*(1), 29–50. https://doi.org/10.21061/jcte.v32i1.1589

Talley, K. G., & Martinez Ortiz, A. (2017). Women's interest development and motivations to persist as college students in STEM: A mixed methods analysis of views and voices from a Hispanic-Serving Institution. *International Journal of STEM Education, 4*(1), 5. https://doi.org/10.1186/s40594-017-0059-2

Tan-Wilson, A., & Stamp, N. (2015). *College students' views of work–life balance in STEM research careers: Addressing negative preconceptions.* CBE Life Sciences Education. https://doi.org/10.1187/cbe.14-11-0210

Thébaud, S., & Charles, M. (2018). Segregation, stereotypes, and STEM. *Social Sciences, 7*(7), 111. https://doi.org/10.3390/socsci7070111

The Organisation for Economic Co-operation & Development. (2011). *Meeting of the OECD council at ministerial level.* Paris: OECD.

Turiman, P., Osman, K., & Wook, T. S. M. T. (2020). Inventive thinking 21st century skills among preparatory course science students. A*sia Pacific Journal of Educators and Education, 35*(2), 145–170. https://doi.org/10.21315/apjee2020.35.2.9

Walker, M. (2015). Imagining STEM higher education futures: Advancing human well-being. *Higher Education, 70*(3), 417–425. https://doi.org/10.1007/s10734-014-9843-9

Wang, M. T., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy–value perspective to understand individual and gender differences in STEM fields. *Developmental Review, 33*(4), 304–340. https://doi.org/10.1016/j.dr.2013.08.001

Wang, M. T., & Degol, J. L. (2017). Gender gap in science, technology, engineering, and mathematics (STEM): Current knowledge, implications for practice, policy, and future directions. *Educational Psychology Review, 29*(1), 119–140. https://doi.org/10.1007/s10648-015-9355-x

Watkins, J., & Mazur, E. (2013). Retaining students in science, technology, engineering, and mathematics (STEM) majors. *Journal of College Science Teaching, 42*(5), 36–41.

Wiebe, E., Unfried, A., & Faber, M. (2018). The relationship of STEM attitudes and career interest. EURASIA *Journal of Mathematics, Science and Technology Education, 14*(10), em1580. https://doi.org/10.29333/ejmste/92286

Xu, Y. J. (2013). Career outcomes of STEM and non-STEM college graduates: Persistence in majored-field and influential factors in career choices. *Research in Higher Education, 54*(3), 349–382. https://doi.org/10.1007/s11162-012-9275-2

Xu, Y. J. (2018). The experience and persistence of college students in STEM majors. *Journal of College Student Retention: Research, Theory & Practice, 19*(4), 413–432. https://doi.org/10.1177/1521025116638344

Yatskiv, I. (2017). Why don't women choose stem? Gender equality in stem careers in Latvia. *International Journal on Information Technologies & Security, 1*, 79–88.