Reversing Gender Stereotypes in STEM Colleges in a Gender-Segregated Region

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Abstract:
Women are the minority in science, technology, engineering, and mathematics (STEM) fields and degree programs in most countries throughout the world; however, reverse gender stereotyping is evident in countries such as Kuwait, UAE, Sweden, and Iran, where women outnumber men in STEM fields. In fact, in Kuwait, an Arabic country with gender segregation regulations, females have reversed the gender stereotype of the female minority in STEM fields. This research developed a STEM educational model for Arab/Persian Gulf regions to study causes of reversed gender stereotypes. The results showed 14 influential factors that cause males to develop Peter Pan syndrome, a condition in which a person lives in such a way that prevents them from developing valuable psychological maturity, meaning they never really grow up. Furthermore, 16 factors identified females as High-Ability Learners, meaning they readily develop abilities, interests, and psychological maturity. Male and female stereotypes lead to reverse gender outcomes in STEM fields.

Introduction

Although women are the minority in science, technology, engineering, and mathematics (STEM) fields and degree programs in most countries throughout the world, reversed gender stereotyping is evident in countries such as Kuwait, United Arab Emirates, Sweden, and Iran, where women outnumber men in education and STEM fields. In fact, the 2020 report of the National Academies of Sciences, Engineering, and Medicine states that Kuwaiti females experience no gender-related academic barriers, with females comprising 60%–80% of college students in STEM programs and 81.7% of governmental STEM jobs [1]. Comparatively, 59% of male graduates majored in science fields, with only 20% of males graduating from STEM colleges [2].

To the best of our knowledge, no previous research has investigated factors that contribute to reversed gender stereotyping in Kuwait. Therefore, the primary goal of this study was to identify factors that influence male and female performances and preferences in STEM education. This study employed sequential exploratory methodology to identify contributing elements. Interview results of a small sample of participants were used to build measurement tools for a broader population. This paper is in the QUAL stage, the first step of the sequential exploratory methodology. A STEM model framework was created to detect the connection between STEM model factors and the participants' experiences. Interview results revealed 14 influential factors as well as an educational gap between high school and college stages. Skills and individual characteristics were shown to determine student success rate, meaning students with characteristics of High-Ability Learners, were projected to succeed, while students with characteristics of Peter Pan syndrome, a condition in which a person lives in such a way that prevents them from developing valuable psychological maturity, were expected to face more challenges.

STEM Model Framework

This study created a STEM model using a STEM framework, literature review, education regulations in Kuwait, and educational statistical data to identify factors related to reversed gender stereotyping. The model used was created by expanding a previous STEM model consisting of three interdependent parallel categories (technological, economical, and sociocultural) by adding factors associated with the STEM education system and education regulations in the Middle East [3, 4]. This STEM model included 18 sub-factors derived from a literature review, as presented in Figure 1 and defined in Table 1. For the technological category, the STEM model included Availability (f1), Quality (f2), and Passion (f3). For the economical category, the model included Workforce (f4), Geography (f5), Finances (f6), and Prestige (f7), while the sociocultural category was classified into social institutions, habits, and traditions. Social institutions included Family (f8), Friends (f9), Schools (f10), and Communities (f11). Habits included Life Routine (f12), Study Method (f13), Maturity (f14), and Ability (f15), while traditions included Gender (f16), Language (f17), and Religion (f18). Sub-factors such as Passion (f3) and Prestige (f6) overlapped between main factors.

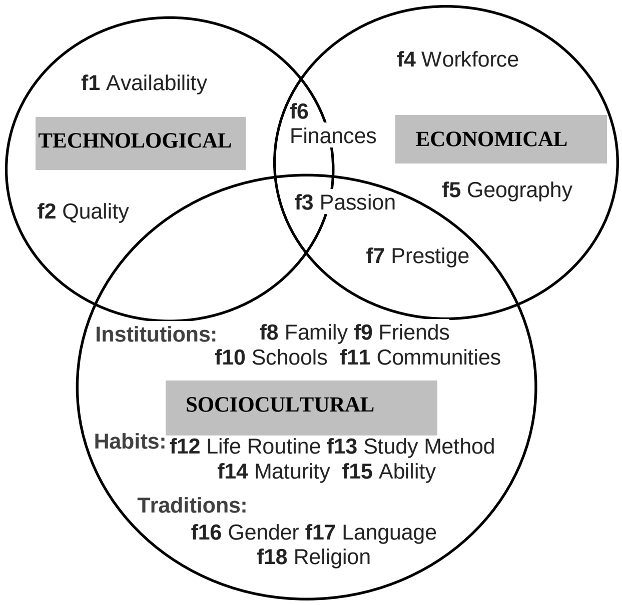


Figure 1. STEM Model

Literature Review

The National Academies of Sciences recommends practices to increase female inclusion in STEM fields in Kuwait and the United States [1]. They published a book as a collaborative work between the Kuwait Foundation for the Advancement of Sciences and the National Academies of Science, Engineering, and Medicine. The book includes experiences of Arabic educators and chapters that discuss multiple gender-gap issues in STEM, including research summaries to reduce the gap between males and females and support women. The book identifies males as the dominant gender in STEM fields. The present study relied on the influential factors noted by the book’s six researchers.

Claudia Buchmann, a professor and chairwoman of the Department of Sociology at Ohio State University, identified a connection between Passion (f3), Schools (f10), and Study Methods (f13). She found that lack of curriculum preparation (f3/f10) in science classes led to high rates of dropping out of college, even if a student had a high interest in the field (f3). In addition, standardized curriculum (f10) within a country was shown to affect gender performances (f13) and appeal (f3/f10) [1, p. 45]. Similarly, El-Bahey and Zeid investigated female student motivations to study computer science and information systems in Kuwait [1, p. 70].

Table 1. Definitions of STEM model factors

F1	**TECHNOLOGICAL:** the ways new practices and equipment can affect education with respect to technological capabilities	
f1	Availability	"The opportunity, at a micro or a macro level, to materially access technology at reasonable prices, whether at home, at work, at school or in public places" (such as public institutions or commercial outlets) [5]
f2	Quality	How good and convenient technology is in terms of efficiency and durability with 72 technology qualities, including aesthetically pleasing, functional shape (form), accessible, culture fit [6]
f3	Passion	How much individuals are emotionally connected to technology to facilitate their learning processes for STEM subjects
F2	**ECONOMICAL**: the effect of a country's financial status on students' education and technology	
f4	Workforce	How available jobs influence individuals to pursue or reject STEM education
f5	Geography	How the environment and physical location affect individuals' perceptions of STEM
f6	Finances	How the economic status of a country and individuals affect STEM and individuals
f7	Prestige	Having the latest trend and showing off had affected STEM and individuals
F3	**SOCIOCULTURAL**: the ways habits, traditions, and beliefs consciously or unconsciously reflect a majority of society groups	
F3.1	**Institutions**	Group of people who come together for a common purpose
f8	Family	Certain life situations between common ancestors that help shape preferences
f9	Friends	Relationship of mutual affection between people that helps shape preferences
f10	Schools	Physical, human, materials, and resources used by schools to promote academic performance
f11	Communities	Social gatherings with mutual interests or goals, including institutional and official/non-official clubs or gatherings
F3.2	**Habits**	Recurring actions of individuals
f12	Life Routine	Lifestyles and daily routines that affect individuals' preferences
f13	Study Method	Learning and processing information styles that affect individuals' preferences
f14	Maturity	Quality or state of being fully mentally and physically developed, reflecting judgment and wisdom
f15	Ability	Current possession of a skill
F3.3	**Traditions**	"A belief or behavior (folk custom) passed down within a group or society with symbolic meaning or special significance with origins in the past" [7]
f16	Gender	Gender role, or the outward manifestations of personality that reflect gender identity [8]
f17	Language	System of communication used by a particular country or community [9]
f18	Religion	Belief in and worship of a supernatural power and its influence on individuals' preferences

While observing attitudes and perceptions of students, they surveyed male and female students in STEM colleges to determine their reasons for joining. Results showed that the motivation was due to pragmatic factors such as interest (f3).

Hayfaa Almudhaf, the co-chair/senior advisor (ret.) of the Kuwait Institute for Scientific Research, studied Workforce (f4) and Prestige (f7) factors and found that, although women comprise 60%–80% of STEM fields, a majority of leadership and researcher positions are held by males (f4/f7/f11) [1, p. 4]. Munirah AlAjlan, an English as a Second Language (ESL) instructor at the College of Engineering and Petroleum at Kuwait University, compared preferential career paths between males and females in Kuwait and found that males prefer military jobs or private business (f4) [1, p. 7].

Hessa Amin, the deputy chief executive officer of FAWSEC Educational Company, a K–12 education company in Kuwait, investigated Finances (f6) and Prestige (f7) sub-factors as they relate to STEM education. Based on a survey of high school and college students, she proposed 14 factors that influence male willingness to enroll in STEM colleges, including financial salary (f6) and prestige (f7). Similarly, she determined that factors such as the involvement of parents and other family members (f8) and friends (f9) significantly impact the Family (f8) and Friends (f9) sub-factors [1, p. 39]. However, El-Bahey and Zeid found that parental advice (f8) and peer influence (f9) were not among the top influential factors [1, p. 70].

For the Communities (f11) and Religion (f18) sub-factors, most researchers agree that the dominance of males in almost all STEM fields greatly influences the willingness or unwillingness of male and female students. Amin proposed 14 factors. Including, religious factors (f18). Zaha AlSuwailan found that female interest in STEM education is influenced by the adopted textbook at the K–12 education levels (f10), specifically if a book's images have many female role models (f11) and community pictures depicting women in real life or in various fields of the workforce (f4) [1, p. 42].

For the Life Routine (f12) sub-factor, AlAjlan found that men socialize with leaders informally outside working hours (f12) where women are not welcome to join, giving them the advantage of receiving support from leaders [1, p. 11]. Amani, Al-Sanad, and Larkin surveyed female engineers in several fields in Kuwait to determine general attitudes toward gender bias among female engineers in the workplace. They found that women spend more time at home (f12), resulting in increased study time (f12/f13) [1, p. 25].

For the Ability (f15) sub-factor, Abrar Al-Awadhi, assistant professor of special education at Kuwait University, found that the number of students at the STEM college at the university decreased since 2010–2011. However, the same trend was observed for other non-STEM majors at the university due to students transferring to other universities or dropping out of college completely, meaning students were unable or unwilling to complete their courses [1, p. 40].

Education System Regulations

Kuwait, a small country on the Arabian Gulf (also known as the Persian Gulf), is an economically stable society with abundant access to technological innovations due to the predominance of the oil and gas industry within the country. Despite the unilateral access to technology, even for young children, public schools are segregated by gender, and the Ministry of Education (MOE) designs the textbooks and distributes them to public schools. The educational system consists of four levels: kindergarten, primary, middle, and high school [10]. High school in Kuwait is the most important stage in the educational system because high school students decide their college majors, which then determines available colleges. For example, a science major is able to attend almost any college, while a literature major has limited options. To switch from literature to a STEM program, students must retake high school. Figure 2 illustrates the process to switch between majors according to Kuwaiti education regulations. The MOE grants full scholarships for diplomas and bachelor's degrees as well as monthly allowances. Students can also join training programs and receive 2-year diplomas from the Public Authority for Applied Education and Training (PAAET). The only qualification to be enrolled in the PAAET is to earn the acceptance rate at high school [11]. In contrast to Kuwait University, each of the approximately 10 private universities in Kuwait require an entry exam [12].

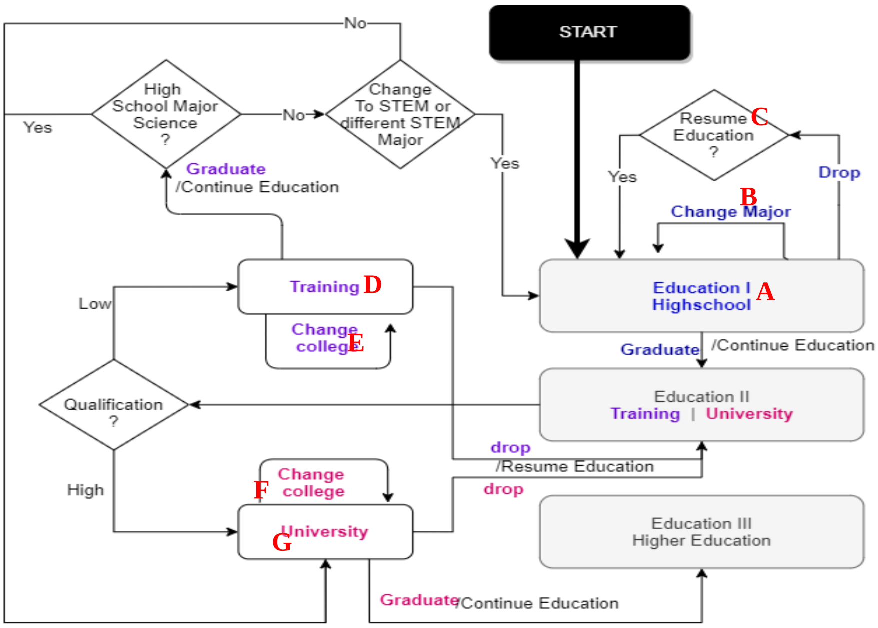


Figure 2. Educational Progress in Kuwait

Research Questions

To identify the factors behind reversed gender stereotypes and build a quantitative tool, the following research questions were considered:

> **RQ1:** What STEM Model Factors Influence Male Preferences and Performances in STEM Education?
>
> **RQ2:** What STEM Model Factors Influence Female Preferences and Performances in STEM Education?
>
> **RQ3:** How do Male and Female Preferences and Performances Compare based on STEM Model Factors

Method

Sample and Setting

The sample criteria were taken from education regulations in Kuwait. To maximize variation and account for unusual cases, this study included the following:

1. High school male science major who does not want to go to a STEM college
2. High school male science major who desires to go to a STEM college but is unable
3. High school male literature major
4. University male student who went to a STEM college and then switched to a non-STEM college
5. University male student who went to a STEM college and dropped out of college
6. University male student who went to a STEM college, dropped out, and then returned after some time
7. University male student who went to a non-STEM college
8. Male science major with a high GPA who enrolled in a training institute (first choice)
9. Male student who dropped out of a STEM college and enrolled in a training institute
10. High school female STEM major with a high GPA who wants to attend a STEM college
11. High school female student at a STEM college with a moderate GPA
12. Female graduate with a moderate GPA employed in a STEM job but no leadership position
13. Female employed in a STEM job but no leadership position

This study recruited 13 participants (nine males and four females) from organizations and educational institutes such as male high schools, female high schools, universities, and a training institute. Participation was incentivized with gift cards. Two interviewers conducted interviews via Zoom and Microsoft Teams, the same platforms used by schools during the COVID-19 pandemic, meaning all the students had necessary devices and familiarity with the applications. The study protocol was approved by university research compliance.

Instruments

Two instruments were developed for this study. Instrument 1, which consisted of 28 structured, open-ended interview questions, was used to investigate the existence of STEM model factors. The first column in Table 2 shows each interview question, and the second column shows the expected associative factor. Instrument 2 consisted of unstructured interview questions and spontaneous answers from the respondents to determine existing factors or identify new factors. Instrument 2 was only employed if the answers from the first interview were not clear or further investigation was needed.

Design

This research followed exploratory sequential research design, beginning with phase 1 - QUAL phase - which involves collecting and analyzing qualitative data to build a tool to collect quantitative data. The QUAL stage is foundational for developing a measurement tool to assess a broad population by identifying items to be included and essential factors that shape students' STEM preferences.

This study was carried out over an 11-week period. Data were collected using interviews conducted in the Arabic language, with infrequent English use. The interviewers recorded participants' answers to primary interviews; follow-up interviews were conducted if data was unclear or further investigation was needed as example for older participants. The older participants carry multiple cases, where they have more stories about their high school, college, and workplace.

The interviewers memorized the questions and factors prior to the interviews to allow maximum eye contact and engagement throughout the interviews. Each interview lasted 30–55 minutes, and sessions were recorded with permission from the participants. The interviewer began with an open-ended question to encourage free discussion. The questions were then read clearly from G-file (described below), and participants were given ample time to respond. The researcher then asked if the interviewee wanted to share additional information after the questions were finished.

Table 2. Interview questions to identify STEM model factors

#	Questions	Factors
1	How is school/college?	Open-ended
2	Why did you choose your major? **What is your opinion of STEM majors?	Open-ended, f3
3	Describe your routine on school days and weekends.	**f12, f12**
4	Do you have any hobbies, interests? How do they fit into your daily routine?	**f12, f13**
5	What technology device do you use for studying? Would you like to replace it and why?	**f1, f2**
6	What is your responsibility at home?	**f12, f15**
7	How do you prepare for a math exam? How do you prepare for an English/Arabic exam?	**f13**
8	Do you think high school English class is enough to be fluent in English? Do you wish to study abroad to learn English?	**f13, f17**
9	How do you complete your STEM assignments? What do you do if you do not know the answers?	**f1, f2, f8-11, f13**
10	Describe your current study environment. (Alone? At home? Café?)	**f1, f2, f13**
11	What do you think of your science/math curriculum?	**f10**
12	What do you think of the way of teaching the STEM subject? (Instructors' method)	**f10**
13	Are there any science or math clubs or *after-school activities at your school/college? What do you think of them? Do you join them?	**f10-11**
14	What do you think of your school/college administration and their point of view on STEM subjects?	**f10**
15	Do you have any friends? Do they share the same major?	**f9**
16	What do you do when hanging out with friends? Do you have any study groups?	**f9, f13**
17	Have you and your friends decided where you want to go after graduation? Did you discuss it multiple times? Debates?	**f9, f4, f5, f6, f7**
18	In your opinion, what are the most desired jobs in Kuwait? And what do you want to be? Why?	**f4, f6, f7, f5**
19	How do your parents see you after graduation? Do you share the same expectations?	**f8**
20	In your opinion, does studying abroad differ from studying in Kuwait? Why?	**f14, f10, f6, f7**
21	Who is your role model? Does he/she inspire you in your life? How?	**f14, f8,f9,10,f11**
22	At the college level, do you prefer to study in Arabic or English and why?	**f10, f17**
23	How many times do you need to read an English book to fully understand it? How many pages? If you see unfamiliar words, what do you do?	**f7**
24	Which majors do you think Islam would recommend at STEM colleges? And why?	**f16, f18**
25	What is your opinion of Kuwaiti politics? Do the results meet your expectations? (Note: Kuwait just had an election and no women won)	**f16**
26	If you had the authority to change one assembly member, would you put a woman? Who and why?	**f16**
27	What do you think about the large number of females attending STEM colleges?	**f16**
28	If you could go back in time, would you change anything related to your education? Do you wish you had done things differently?	**f14**

G-file

G-file is a data management tool that reveals the links between model factors and participant answers by organizing the interview questions and factors into a matrix. The first column contains the list of questions, each in a separate row, followed by 18 labeled factor columns, as shown in Table 3. The intersection between a question and a factor is marked (x) if the interviewee's analyzed theme indicated a factor. In addition, each answer was added to the last column, the raw-answer column. A separate G-file was used for each participant.

Table 3. STEM model factors that influence male preferences and performances

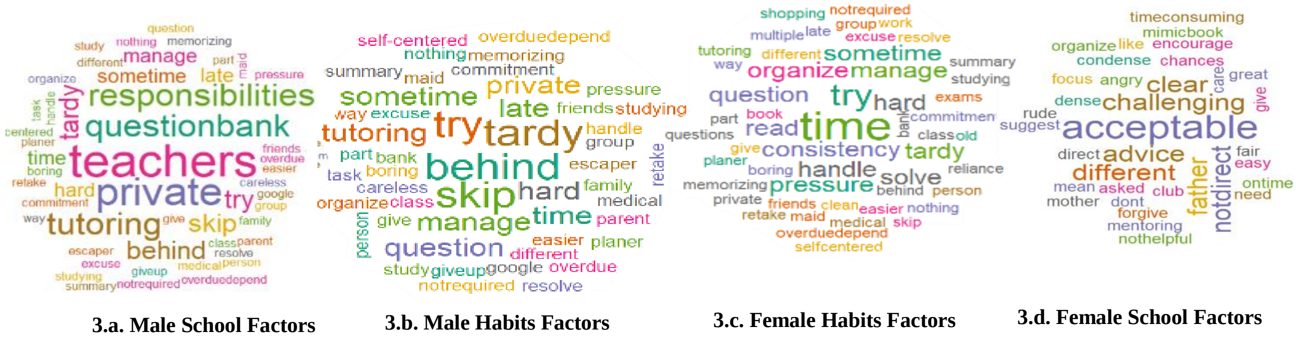
	ID	Males	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12	f13	f14	f15	f16	f17	f18
*H	1	SL			x	x		x	x			x		x	x	x	x			
	2	SN			x	x	x	x		x	x	x	x		x		x			
	3	L				x		x	x	x	x	x	x	x	x		x			
*U	4	S								x	x	x		x	x	x	x		x	
	5	AH			x	x		x				x	x		x	x	x		x	
	6	K			x	x			x			x		x	x	x	x			
	7	AZ						x	x	x		x				x				
T	8	MR				x	x	x	x	x		x			x					
	9	MSH			x	x		x	x			x			x	x	x			

*(H: high school, U: university, T: training institutes), ID is the participant sequence mention at the sample.

Results

Colaizzi's descriptive methodology was used to guide the data analysis and implement data interpretation techniques [13]. First, interview transcriptions were divided into paragraphs according to the questions, and then the paragraphs were divided to correspond to a question in the raw-answer column in the G-file according to the "cutting and sorting" of the Tactile approach. Second, significant statements were identified using keywords and keywords-in-context that highlighted a factor, as shown in Figure 3. Third, the "meaning" was formulated by examining all keywords and significant statements of a factor using comparison, contrast, and social science queries. Fourth, common themes among STEM model factors were compared to confirm their existence and new themes were recorded. Fifth, participant experiences were described using the theme and quoted statements, and then the descriptions were validated by two older participants. Finally, the findings were updated, and figures were generated.

The comparison of themes found with STEM model factors (step 4) was the primary step in this research. As shown in Table 3, columns marked with an x indicate STEM factors over the themes, which could then be used for the QUAN tool. Results showed that the Schools (f10) factor was prevalent, with themes such as teaching style, teacher-student connections, materials, commitment, and administration.



3.a. Male School Factors 3.b. Male Habits Factors 3.c. Female Habits Factors 3.d. Female School Factors

Figure 3. keywords and keywords-in-context for School factors and Habits factors

RQ.1 What STEM Model Factors Influence Male Preferences and Performances in STEM Education?

Table 3 shows that 14 factors influence male preferences and performances in STEM education: Passion (f3), Workforce (f4), Geography (f5), Finances (f5), Prestige (f7), Family (f8), Friends (f9), Schools (f10), Communities (f11), Life Routine (f12), Study Method (f13), Maturity (f14), Ability (f15), and Language (f17). Although the remaining four factors (Availability (f1), Quality (f2), Gender (f16), and Religion (f18)) did not significantly influence male STEM preference, the Availability (f1) and Quality (f2) factors of technology's current level meet the needs for self-fulfillment. To consider whether these two factors influence Kuwait's STEM performances and preferences, participants who lack technology or have inadequate equipment must be compared.

The Schools factor (f10) was shown to significantly influence all educational stages, specifically challenges related to school materials (e.g., books, assignments, quizzes), teaching style, and teacher/student relationships that affect participants' academic performances. Students who overcome those obstacles in high school then encounter further challenges related to course materials, instructors' teaching styles, and unfamiliarity with course concepts in addition to the language barrier that occurs when the teaching language switches from Arabic to English when they enter STEM colleges.

Maturity (f14) and Ability (f15) factors were shown to impact male students' abilities to face obstacles. Some participants' answers revealed limited skills that prevented adaptation to new study methods and materials. The Schools (f10) and Family (f8) factors directly affected participants' abilities and maturity. The school keywords were highly repeated over to private tutors, depending on the question banks, teacher's aperient, lack of guidance at school, and limited responsibilities at home, as shown in Figure 3.a.

The influence of specific factors varied throughout the educational stages, while student preferences and performances varied according to developmental growth. The factors that were shown to influence the preferences of young students, or students in the first years of high school, were Passion, Workforce, Geographical, Financial, Prestige, Friends, Family, and Communities. After experiencing higher-level academia, however, their preferences and performance factors changed to School, Study Method, Life Routine, Maturity, and Ability, and students' goals aligned more realistically with their cumulative GPAs. The preferences of older students, or students who returned to academia after dropping out of college, pausing their education, or transferring to another STEM institute, were influenced by Workforce, Prestige, Financial, and Family factors. These students exhibited more Maturity (f14) factors that helped them face obstacles and sustain academic advancement. Overall, the measurement tool considered 14 factors.

Table 4. STEM model factors that influence female preferences and performances

	Female	ID	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12	f13	f14	f15	f16	f17	f18
H	AM	10			x			x		x	x	x	x	x	x	x	x			
U	LA	11				x	x	x	x	x	x	x		x	x	x	x		x	x
E	AS	12			x			x	x	x		x	x	x	x	x	x	x	x	x
	SH	13			x				x	x		x	x	x	x	x	x	x		x

(H: high school, U: university, E: employee)

RQ.2 What STEM Model Factors Influence Female Preferences and Performances in STEM Education?

Table 4 shows that 16 factors influence female preferences and performances in STEM education to varying degrees throughout development growth stages. Conversely, the results also show that the technology factors (f1 and f2) do not influence female preferences. In high school, the influences were shown to be Passion, Family, Schools, Communities, Life Routine, Ability, Financial, Study Method, and Maturity, while Workforce, Geographical, Financial, Prestige, Friends, Schools, Ability, Family, Life Routine, Study Method, and Maturity were the influential factors for college students. In the workplace, Passion, Prestige, Family, Schools, Communities, Ability, Gender, and Religion were influential.

Research results showed that factors' influences depended on participants' motivation. If a participant was determined to enter a certain profession, the Workforce (f4) and/or Geographical (f5), Prestige (f7), and Financial (f6) factors were most influential. If a participant's motivation was Passion (f3), however, they engaged more with sociocultural factors such as Family (f8), Friends (f9), and Schools (f10). Overall, Maturity (f14) was shown to be most influential factor, indirectly affecting a person's ability to adapt to changes to Life Routine (f12) and Study Method (f13). Although Language (f17) was shown to influence STEM education, female participants demonstrated readiness and ability to learn and adapt quickly. In fact, a female interviewee who admitted to struggling with English during her first year of college handled it quickly.

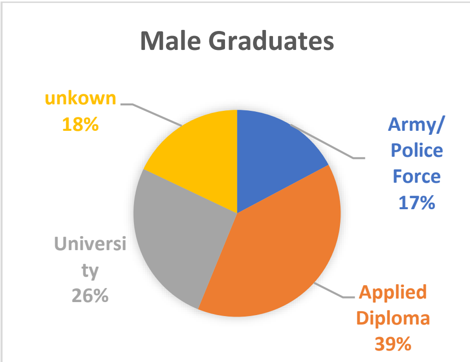


Figure 4. Male Graduates 2018/2019

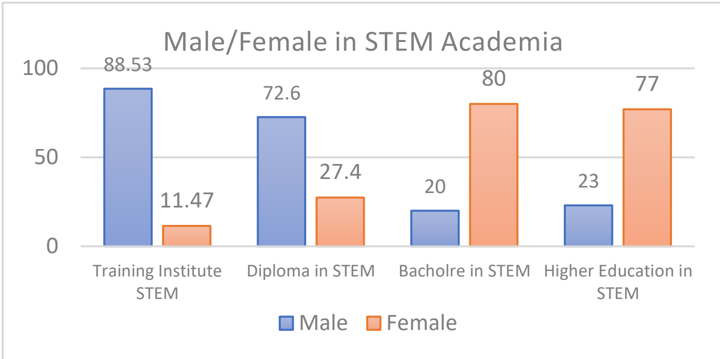


Figure 5. Male/Female Percentages in STEM Academia

RQ3: How do Male and Female Preferences and Performances Compare based on STEM Model Factors?

Although males and females confront the same educational obstacles in Kuwait, certain factors uniquely shape their abilities and maturities. Social and economic factors often motivate both genders to choose science for a major at high school as students consider potential careers, salaries, prestige, parental guidance, the influence of friends and relatives, and science qualifications to enter college. However, Maturity and Ability factors were shown to play a greater role in motivating females to enroll in STEM colleges than males. A desire to gain independence as well as their commitment to studying, school activities, and finding solutions to obstacles identified the female participants in this study as High-Ability Learners [14, 15]. On the other hand, for the same factors, the teenage male participants demonstrated a lack of effort, including a dependence on tutoring and question banks as well as a tendency to skip classes when they felt bored or stressed [16], which indicated Peter Pan syndrome, or a lack of developed maturity.

The study results were correlated to statistical data from Kuwait University and Kuwait's Central Statistics Bureau (CSB) for academic year 2018–2019 [2, 17]. In that year, 8839 males graduated from high school, 59% with a science major, while 48% of female graduates were science majors. Of the 8839 male graduates, 974 joined the police force, 128 joined the national guard, 334 joined the army, 3248 enrolled in PAAET colleges for diploma degrees, and 2159 enrolled in other universities, as shown in Figure 4 [17]. Also, statistics showed that the number of male students who failed that academic year was double the number of females in the science major [10], as shown in Table 5. University STEM opportunities are very competitive, especially in engineering and medical fields, and Kuwaiti males have abundant career options, which could influence their STEM preferences, but females have limited options, meaning they must demonstrate maximum academic performance to enter STEM colleges, resulting in increased motivation.

Figure 5 shows percentages of academic enrollment by gender in STEM majors. Although a higher percentage of males majored in science in high school, a higher percentage of males pursue diplomas compared to females who apply for advanced STEM degrees. Females more readily attempt to earn higher degrees with the highest possible scores. Thus, as shown in Figure 5, females comprise a large majority (77%) of STEM higher education [2]. STEM colleges also have reported an increased number of female students, but women still must achieve a higher GPA than males to be accepted into the programs. In fact, lawsuits have challenged and cases won that have forced the public college in Kuwait to offer equal college acceptance opportunities, regardless of gender [18]. With a female population of less than one million, four Kuwaiti women are in the top 20 over the 100 strongest women in the Middle East [19].

Table 5. Comparison of academic failings by gender in high school [10]

			Science				Literature			
Gender	Grade 10		Grade 11		Grade 12		Grade 11		Grade 12	
	m	f	m	f	m	f	m	f	m	f
Failing %	7.0	3.3	0.6	0.3	0.8	0.2	0.7	0.6	0.5	0.2

Recommended Improvements for the STEM Model and Suggested QUAN Factors

Results of this study show that the f3–f17 factors and three identified themes (school material, teacher connections with students, and teaching method) should be include in the QUAN instruments. A suggested changing into the STEM model into: the technological category (f1 and f2) demonstrated a neutral influence over STEM preferences in Kuwait society; however, the research occurred during the COVID-19 pandemic, which forced technological availability and access, meaning technological obstacles were previously resolved. However, we recommend considering one to two technological questions or reinvestigating the factor again in different situation to be able to measure their true influence.

The economical category (f4 and f5) was shown to influence STEM preferences, especially during the first year of high school when students are building their STEM preferences. The influence of economic factors shapes student preferences throughout the educational stages. Students often choose science majors as a result of societal pressures of Workforce (f4), Finances (f6), and Prestige (f7) factors. Because society highly values engineering and medical fields and only science majors can enroll in STEM colleges due to educational regulations, most students highly prefer STEM fields, which makes them more passionate (f3) to join science. Questions about economic factors should investigate preferences throughout all educational stages: before selecting a high school major, after finishing high school, at the beginning and middle of college/training, and at the end of college.

Study results suggest that the Geography (f5) factor should be combined with the Workforce (f4) factor to increase the influence on STEM preferences. Students with STEM preferences often change their preferences, even at young ages, after they face sociocultural obstacles. Young Kuwaiti students who grow up in wealthy environments (welfare and family) with minimal responsibility, have decreased chances to develop Maturity (f14), Life Routine (f12), and strong Ability (f15) factors to help them overcome obstacles. Results repeatedly showed that the Schools (f10) factor could be considered a *theme* instead of *meaning* where they significantly influence STEM performance, such as study method, school material, teacher connections with students and teaching style. Thus, they should be included as a subgroup under the Schools (f10) factor with condensed questions for investigation. Similarly, the Language (f17) factor should be a shared factor between Religion (f18) and Schools (f10), where results identified a significant language gap between high school and college since the teaching language in high school is Arabic and English at college. Overall, the sociocultural questions should be investigated throughout all the educational stages.

A measurement tool should investigate the diversity of a broader sample and consider the education regulations. Because Kuwaiti students often pause, drop, and return to school, the tool should include students who retake high school multiple times, and the questions should consider first-time students and students who retake high school or resume their education with additional sections for a sample of those who resume school or change their major to identify the obstacle that caused students to change majors, drop out of college, or transfer to training institutes. The questions should apply to young students at high schools and universities as well as older students.

The habits classification within the sociocultural category in the STEM model should be renamed to Maturity and include only Life Routine and Ability as sub-factors. In addition, the Study Method (f13) factor should be shared between Schools (f10) and habits to show that schools influencing the method of study, such as when a student describes the differences between study techniques at high school and college.

Conclusions

STEM education in Kuwait has demonstrated reversed gender stereotyping, meaning females surpass males in STEM fields. The results of this research show the existence of the f3–f17 factors from the QUAN measurement tool. Economic factors were shown to shape STEM preferences, and sociocultural obstacles, such as school materials, unfamiliar teaching methods, and the use of English as the primary teaching language, most often cause students to change their preferences. The results show that students were unprepared for subsequent educational stages. However, Ability (f15), Maturity (f14), and Passion (f3) factors equipped students to face obstacles, especially for females. Overall, this study introduced a measurement tool to capture the factors on a bigger scale. Future work could formulate a measurement tool to investigate the phenomenon in Kuwait in more depth.

Limitations

The main limitation of this study was that the researchers were part of the investigated society, meaning the data collection and analysis was susceptible to bias. Also, the accuracy of participant interpretation cannot be guaranteed since some participants are still high schoolers and may not have well-developed communication skills, which can lead to misperceptions of an experience. Another limitation of the study is that, because words can have multiple interpretations, the dialogues with participants could have been misinterpreted.

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