Demographic Factors Affecting Freshman Engineering Students’ Attitudes

Toward Mathematics at a University in Saudi Arabia

by

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Demographic Factors Affecting Freshman Engineering Students’ Attitudes Toward Mathematics at a University in Saudi Arabia

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Abstract

Title: Demographic Factors Affecting Freshman Engineering Students’ Attitudes Toward Mathematics at a University in Saudi Arabia

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This study of freshman engineering students enrolled at Imam Abdulrahman Bin Faisal University (IAU) in Saudi Arabia investigated the relationship between the students’ attitudes and their demographic characteristics. Specifically, the study assessed the relationship between students’ demographic characteristics and how the characteristics related to five variables associated with attitudes toward mathematics: attitude toward success in mathematics, confidence in learning mathematics, mathematics anxiety, awareness of the usefulness of mathematics, and effectance motivation in mathematics. A total number of 157 male students enrolled in Calculus 1 participated in the survey. Findings revealed that the freshman engineering students had positive attitudes toward mathematics; furthermore, the results indicated that there are positive relationships between the fathers’ career types and all the five attitudes of the students toward mathematics. Also, the mothers’ career types and geographical regions had a positive relationship with students’ confidence in learning mathematics. In contrast, the findings indicated that there are a negative relationship between mothers’ educational levels and two of the students’ attitudes (confidence in learning mathematics and
mathematics anxiety). Similarly, students’ attitudes toward success in mathematics were also impacted by their nationalities.

Interviews with 26 participants helped the researcher to discover students’ ideas about the survey’s questions in greater depth. The results of the interview indicate that the freshman engineering students’ attitudes are more affected by their fathers and their teachers. The reasons that form students’ attitudes toward mathematics can be divided into two parts: internal and external. The internal reasons result from the students themselves, which includes practice and preparation, assessments and grades, English language effect, time management, pride in themselves, competition with their colleagues, weak mathematical foundation, consideration of mathematics as a favorite subject, pressure of other courses, awareness of the relationship between mathematics in their daily lives and mathematics within other scientific subjects, awareness of the relationship between mathematics and their engineering major, and awareness of the benefit of mathematics in their future careers. The external reasons include teachers’ characteristics, parental support, and respect from their fathers.
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Dedication

I dedicate this work to my beautiful mother and to my great father Abdullah, who passed away before the completion of the project. I also dedicate this accomplishment to my beloved wife and our children. Furthermore, I would like to honor to my first professor, Dr. Sheik Anwar, through this project.
Chapter One
Introduction

Background to The Study

Mathematics is one of the most important sciences that plays a key role in our daily lives as individuals and societies. Mathematics is an essential part of people’s economy and the prosperity of nations. We find mathematics in sales and purchases, banking operations, business transactions, economic planning and world oil prices. Also, learning mathematics is important for individuals because it develops their critical thinking and makes the world more economically developed (Artigue, 2012).

Furthermore, mathematics is an indispensable tool of many different sciences such as Chemistry, Physics, Biology, Astronomy, and Engineering. It is a vital part of all these sciences and others that cannot be ignored (Singha, Goswami & Bharali, 2012; Nahari, 2014; Prakash, Jerlin & Fernandes, 2014; Kafata & Mbetwa, 2016).

Even though mathematics has this important status and is one of the primary subjects in most schools, many students in different countries have a disaffection with mathematics (Nur, 2010; Artigue, 2012; Goold, 2012). Teaching and learning mathematics is still one of the biggest challenges and problems that many countries face around the world (Singha et al., 2012; Salad, 2015). In 2003, the results of the Trends in International Mathematics and Science Study (TIMSS) documented that only 58% of countries that participated in the test around the
world were above the international average (Eng, Li & Julaihi, 2010). Thus, most countries have developed their own mathematics curriculum and are training their teachers to overcome problems that their students have (Eurydice network, 2011).

**Global challenges to teach and learn mathematics**

The issues involved in teaching and learning mathematics are a worldwide problem that a lot of countries face. They are considered among the greatest challenges that students and their teachers are faced with. For example, the United States is interested in raising the skills of its students, especially in mathematics; many studies point out the prevalence of poor academic achievement among American children compared to Chinese and Japanese children (Kafata & Mbetwa, 2016). Furthermore, California State University estimated that 66% of their students failed in Calculus 1 in 2005 (Eng et al., 2010). In Australia, also, one of the most important challenges that new students face in Australian universities is studying mathematics. In one year at a regional university, the first year students recorded a failure rate in mathematics up to 45% (Whannell & Allen, 2012).

In Europe, they are still working to solve this problem. In one year, the first-year Norwegian students at the University of Science and Technology registered a failure rate in mathematics ranging from 21.5% to 39.2% (Eng et al., 2010). According to Yee et al. (2014), 58% of Portuguese students attained a high school education in 2011. However, the results of the Program for International Student Assessment (PISA) documented that the rate of Portuguese student achievement was below the Organization for Economic Co-operation and Development (OECD)
average in 2012 (Kafata & Mbetwa, 2016). In addition, the concern about low student achievement in mathematics was the motivation for the European Union to set benchmarks in 2009 so that by 2020 there would be fewer than 15% of students with a weakness in mathematics (Eurydice network, 2011).

African countries registered the worst situations with mathematics. The problem of poor student performance in mathematics continues in Somalia, especially after the outbreak of the civil war. In one school in 1982-1983, 19 students passed in mathematics out of 270, which means 93% of the students failed (Nur, 2010; Salad, 2015; Kafata & Mbetwa, 2016). The poor performance of high school students in mathematics is a widespread problem in Kenya, also. In 1999, the failure rate in mathematics for the certificate of secondary education was 79.2% (Nur, 2010; Salad, 2015; Kafata & Mbetwa, 2016). Thus, mathematics is still an issue with African students.

In addition, education in India suffers from many problems; one of them is failure in mathematics. Many students have difficulty understanding basic concepts of mathematics (Ramanujam, Sachdev & Subramanian, 2007; Singha et al., 2012). Singha et al (2012) claimed that 60% of Indian students consider mathematics to be complex, and 80% of mathematics teachers believe that their students have a negative view of mathematics.

Arab countries are no better than other countries. TIMSS 2011 showed that all Arab countries were close to the bottom of the international list. This is why most Arab countries have developed and reformed education, particularly in
mathematics. However, in Jordan, for example, after 15 years of educational development in mathematics, teachers’ perceptions have not changed in regard to critical thinking (Innabi & El Sheikh, 2007; Matar, Sitabkhan & Brombacher, 2013; Innabi, 2014). Therefore, Arab countries need more work in solving this problem with their students.

In Saudi Arabia, mathematics is taught as a compulsory subject from the first grade of elementary school to the first grade of high school, which means ten grades. Then, the students who choose the scientific track continue studying mathematics in both 11th and 12th grades (El-Deghaidy & Mansour, 2015). The government of the Kingdom of Saudi Arabia pays great attention to education, and this is evident through the huge annual budget that is allocated to the Ministry of Education. In 2019, the educational budget was $51.42 billion (Ministry of Finance, 2018). However, the level of Saudi students in mathematics is still lower than the level of students in other countries that have lower economic support. The results of the TIMSS showed that Saudi students ranked 43 out of 45 in 2003, and 47 out of 49 participating countries in 2007. The Saudi Ministry of Education has indicated that their students fail to resolve all questions, particularly patterns and verbal problems (Alsolami, 2013). This is one of the reasons that encouraged Saudi Arabia, like other countries, to implement many reforms in education, especially in mathematics (Hamdan, 2015; Eurydice network, 2011).
Engineering students’ performance in mathematics

As mentioned previously, mathematics is a primary part of some majors, such as engineering. Engineering students are required to study many mathematics courses at the university. Therefore, mathematics and the way in which it is taught is an academic hurdle for engineering students, especially during the first year (Eng et al., 2010; Goold, 2012; Prakash, Jerlin & Fernandes, 2014; Prakash, Kannan & Jerlin, 2014; Harris et al., 2014). Many engineering students fail in mathematics and their grades in these courses are declining (Mwavita, 2005; Varela, 2014; Prakash, Kannan & Jerlin, 2014; Kafata & Mbetwa, 2016). The poor performance in mathematics courses is one of the main reasons why freshman engineering students drop out of engineering programs (Mwavita, 2005; Goold, 2012). Therefore, looking for the causes of this phenomenon among engineering students is very important in helping them overcome this problem. Many studies confirm that a student’s attitude towards mathematics is one of the main causes of this phenomenon.

According to Goodykoontz (2008), and Eng et al. (2010), the attitudes of students toward mathematics affect their academic achievement; thus, a more positive attitude may increase their performance in the subject. A study conducted by Kafata and Mbetwa (2016) confirmed that most students in Zambia reported that their poor performance in mathematics was due to their negative attitude towards mathematics. Furthermore, Syam and Salim (2014) claim that university students who are not enrolled in a mathematics major have a negative attitude towards the
subject, and this affects their performance in the courses. Similarly, Huang (2011) asserted that a high percentage of engineering students have negative attitudes toward Calculus, which causes them to fail. This result is affirmed also by the study conducted by Prakash, Kannan and Jerlin (2014) which identifies one of the causes for failure of engineering students in mathematics to be seeing mathematics as a difficult subject that causes anxiety from an early age.

Although it is useful to study the attitude of students toward mathematics, the most important part is to study why these attitudes occur. This will help families, teachers and educators to enhance and develop the attitudes of their students. This leads to an urgent need to study and find the factors that affect and shape the attitude of freshmen engineering students towards mathematics.

**The Purpose of Study**

As mentioned earlier, engineering students have challenges with mathematics courses in many countries. Freshman engineering students at Imam Abdulrahman Bin Faisal University (IAU), in Saudi Arabia, face the same problems and challenges as students in other countries. Many students fail or have low grades in their first mathematics courses, such as Calculus 1. Consequently, this research attempts to discover why there is this problem with freshman engineering students at IAU. Since the literature in Saudi Arabia lacks research that discusses this problem, according to the researcher’s knowledge, this study may be the first of its kind in Saudi Arabia. Therefore, the study attempted to investigate
the incipient factors that may be related to this problem, such as students’ demographic characteristics.

The purpose of this study is to examine the relationship between freshman engineering students' attitudes toward mathematics and demographic characteristics. Specifically, this investigation assesses the relationship between students' demographic characteristics and how these characteristics relate to the five variables: attitude toward success in mathematics, confidence in learning mathematics, mathematics anxiety, awareness of the usefulness of mathematics, and effectance motivation in mathematics. Thus, this study identifies positive and negative correlations between students’ demographic characteristics and attitude toward mathematics.

**Definition of terms**

*Mathematics* refers to the mathematics courses that are required for engineering students to take in their first year.

*Attitude towards mathematics* refers to “students' mental dispositions and feelings toward mathematics achievement” (Gray, 2008, p. 7), as related to their attitude toward success in mathematics, confidence in learning mathematics, mathematics anxiety, usefulness of mathematics, and effectance motivation in mathematics.

*Students’ demographic characteristics* refers to their nationality, geographical region, school type, fathers’ educational levels, mothers’ educational levels, fathers’ career types, and mothers’ career types.
School type refers to either the public or private high school that a student graduated from.

The Attitude Toward Success in Mathematics Scale “is designed to measure the degree to which students anticipate positive or negative consequences as a result of success in mathematics” (Fennema & Sherman, 1976, p. 325).

The Confidence in Learning Mathematics Scale “is intended to measure confidence in one’s ability to learn and to perform well on mathematical tasks” (Fennema & Sherman, 1976, p. 326).

The Mathematics Anxiety Scale “is intended to measure feelings of anxiety, dread, nervousness and associated bodily symptoms related to doing mathematics” (Fennema & Sherman, 1976, p. 326).

The Mathematics Usefulness Scale “is designed to measure students’ beliefs about the usefulness of mathematics currently, and in relationship to their future education, vocation, or other activities” (Fennema & Sherman, 1976, p. 326).

The Effectance Motivation Scale in Mathematics “is intended to measure effectance as applied to mathematics” (Fennema & Sherman, 1976, p. 326).

Attitude Toward Success in Mathematics, Confidence in Learning Mathematics, Mathematics Anxiety, Mathematics Usefulness, and Effectance Motivation in Mathematics are dependent variables in this study. Nationality, Geographical Region, School Type, Fathers’ Educational Levels, Mothers’ Educational Levels, Fathers’ Career Types, and Mothers’ Career Types are independent variables in this study.
Research Questions and Hypotheses

Research questions

The main research question of this study was: what is the relationship between the freshman engineering students’ attitudes toward mathematics and their demographic characteristics enrolled at IAU? The study addressed the following questions:

1. What is the relationship between students’ demographic characteristics and their attitude toward success in mathematics?

2. What is the relationship between students’ demographic characteristics and their confidence in learning mathematics?

3. What is the relationship between students’ demographic characteristics and their anxiety over mathematics?

4. What is the relationship between students’ demographic characteristics and their awareness of the usefulness of mathematics?

5. What is the relationship between students’ demographic characteristics and their effectance motivation in mathematics?

Research hypotheses

The following hypotheses were formulated for this study:

H₀₁: There is no significant relationship between students’ demographic characteristics and their attitude toward success in mathematics.

H₁₁: There is a significant relationship between students’ demographic characteristics and their attitude toward success in mathematics.
H₀₂: There is no significant relationship between students’ demographic characteristics and their confidence in learning mathematics.

Hₐ₂: There is a significant relationship between students’ demographic characteristics and their confidence in learning mathematics.

H₀₃: There is no significant relationship between students’ demographic characteristics and their anxiety over mathematics.

Hₐ₃: There is a significant relationship between students’ demographic characteristics and their anxiety over mathematics.

H₀₄: There is no significant relationship between students’ demographic characteristics and their awareness of the usefulness of mathematics.

Hₐ₄: There is a significant relationship between students’ demographic characteristics and their awareness of the usefulness of mathematics.

H₀₅: There is no significant relationship between students’ demographic characteristics and their effectance motivation in mathematics.

Hₐ₅: There is a significant relationship between students’ demographic characteristics and their effectance motivation in mathematics.

**Study Design**

This study used mixed methods to answer the research question, “what is the relationship between the freshman engineering students’ attitudes toward mathematics and their demographic characteristics enrolled at IAU?” A survey was given to a sample population of 157 engineering students enrolled in first-year mathematics classes offered at Imam Abdulrahman Bin Faisal University (IAU) in
Saudi Arabia. A multiple linear regression procedure was used to examine the relationship between predictor variables and dependent variables. This kind of statistical procedure estimates the relationship between sets of independent variables and one dependent variable. All hypotheses tested at the .05 alpha level. Then, 26 of the participants were interviewed to validate the findings from the survey and obtain deep and detailed explanations about their attitudes.

**Significance of The Study**

The importance of this study lies in several aspects:

First, it is enriching educational research in Saudi Arabia and Arab countries that are focused on the university level, especially on the learning of engineering students. The copyright libraries for Saudi Arabia, which are the King Fahd National Library and the Saudi Digital Library, are the biggest academic sources in Saudi Arabia and the Arab world, yet a study in this area about any Arabic country could not be found (Appendix A). Thus, this study filled a gap in the educational research in Saudi Arabia.

Second, meeting the needs of engineering students at IAU. The researcher met Dr. Abdulrahman Hariri, the Dean of Engineering College at IAU, at the Conference of Excellence in Teaching and Learning Science and Mathematics I on May 5, 2015, in Riyadh, Saudi Arabia. Dr. Hariri encouraged this researcher to focus his PhD research on engineering students after discussing the problems that engineering students at IAU face with mathematics. Many of them fail or get lower grades in the first mathematics courses, such as Calculus 1.
Third, the findings of this study may provide the Saudi Ministry of Education and Saudi universities with significant information about the effect of students’ demographic characteristics on their attitude toward mathematics. That may help them find some solutions to mitigate the impact of the demographic characteristics of students.

Fourth, the result of this study may help future Saudi and Arab researchers to continue studying other variables that might affect students’ attitudes or check the results of this study in different environments.

Finally, it is expected that the findings from this study will provide information for foreign researchers about how Saudi culture affects its students’ learning, attitudes, and performance. Cultural differences play a major role in students' achievement, which influences students’ attitudes. For example, Chinese culture emphasizes seeking knowledge and lifelong learning (Li, 2002); many studies confirm how Chinese culture affects its students. In a study conducted by a group of researchers on 71 American students and 68 Chinese students, the results showed that American students had a cognitive decline across time, compared to Chinese students who had a cognitive persistence (Telzer, Qu & Lin, 2017). On the other hand, according to a study that was conducted on 566 American and Turkish students, American students demonstrated their superiority in their academic choices based on their interests contrary to their Turkish counterparts (Isiksal, 2010).
The ways cultural differences between countries affect students are also prevalent between different cultures in the same country. Studies show that Chinese American students are very advanced in mathematics compared to their peers in American schools. The reason is that Chinese parents are doing a lot to enhance the arithmetic efficiency of their children (Huntsinger, Huntsinger, Ching & Lee, 2000). This finding confirms the importance of studying students' attitudes toward mathematics and its impact on their performance and grades in different cultures and countries. For this reason, this study added new information about the impact of Saudi culture on its students.

**Study Limitations and Delimitations**

**Limitations**

There are some limitations to this study:

1. The study focused on freshman engineering students in one Saudi university. Thus, the findings may not be generalized to fit all Saudi universities.

2. The study included freshman engineering students in Fall 2018 only, which means the reports are limited to students in one academic semester.

3. The study was undertaken at the beginning of Fall 2018; therefore, if it were undertaken over a longer period of time, such as at the beginning of the semester and at the end of the semester, the results would be more valid.

4. The lecturer was present during the survey, which may have affected students' responses.
5. Students took only ten to fifteen minutes for the limited survey due to time constraints of these student participants.

6. Some participants may not have shown their actual opinion when they answered the interview questions because they thought their professors would listen to or read their responses. Some participants did not take enough time to reflect properly in order to answer the interview questions. Also, some students overly praised their professors and smiled while answering. Hence, the participants may have had more negative attitudes toward mathematics than what they described.

7. The study is limited to male freshman engineering students and did not include any female participants.

8. The study was subject to the limitations recognized in the data collection by surveys and interviews.

**Delimitations**

Three major delimitations relate to this study. Firstly, the data that was used in the current study were limited to students who enrolled in Fall 2018 at Imam Abdulrahman Bin Faisal University (IAU), a public, scientific, and not-for-profit university located in the eastern province of the Kingdom of Saudi Arabia. Secondly, the data was also limited to those collected from freshman engineering students who enrolled at engineering college during that semester. Finally, the current study includes only data about attitudes, demographics, and interviews that
were given through those freshman engineering students’ responses of the surveys and the interviews.
Chapter Two
Review of Related Literature

Introduction

This chapter contains three sections. The first section presents information about the theoretical foundation on which this proposed study is grounded. The second section contains a review of past research studies related to the relationship between students’ demographic characteristics and their attitude toward mathematics, and how their attitudes also influence their mathematical performance. The third section contains a summary of the literature review and a discussion of its implication for the proposed study.

Overview of Underlying Theory

This study was based on the theory that attitude can affect a person’s beliefs, behaviors and achievements (e.g., Fennema & Sherman, 1976; Stipek & Granliski, 1991; and Tapia & Marsh, 2004). It explores students’ beliefs and attitudes about mathematics courses and how their demographic characteristics influence their beliefs and attitudes. Many researchers have studied the relationship between attitudes and mathematical achievement, such as Fennema and Sherman (1976), Stipek and Granliski (1991), and Tapia and Marsh (2004). They found a correlation between students’ attitudes toward mathematics and their achievement. Fennema and Sherman (1976) surveyed 1,600 high school students and identified nine factors that shape student attitudes towards mathematics and also influence their academic achievement. Those factors were attitude towards success in
mathematics, mathematics as a male domain, the teacher factor, confidence in learning mathematics, mathematics anxiety, usefulness of mathematics, effectance motivation, a father subscale, and a mother subscale. Stipek and Granliski (1991) used a questionnaire with 473 high school students to measure the effect of their attitudes before and after mathematics exams. Their findings confirmed that students’ attitudes impact their performance in mathematics and also could help to predict their future achievement. Students who tested as having less positive attitudes expect to have low achievement, while students with more positive attitudes expect to have high achievement in mathematics. Tapia and Marsh (2004) tested 545 high school students and concluded that there are six factors that shape student attitudes towards mathematics and influence their academic achievement. Those factors were self-confidence, anxiety, value, enjoyment, motivation, and parent/teacher expectations.

Many other researchers have studied the relationship between students’ attitudes and factors affecting those attitudes, such as N. Ali, Jusoff, S. Ali, Mokhtar and Salamat (2009), and Gegbe, Sundai and Sheriff (2015). They found a correlation between students’ demographic characteristics and their attitudes toward mathematics. N. Ali et al. (2009) surveyed 418 Malaysian university students (37.8% were male and 62.2% were female) to identify the factors that influence students’ performance. Researchers found that students’ demographic characteristics, such as educational level of parents and parents’ income, had a strong positive impact on their performance. Students whose parents had higher
education and higher income have better GPAs. Gegbe et al. (2015) used three questionnaires with 100 high school students and 15 mathematics teachers in Sierra Leone to determine the demographic factors that impact students’ mathematical performance. Researchers found that parents’ education level and parents’ career type had significant impact on students’ performance. The results of the study demonstrated that 73% of parents had just a high school certificate and 40% of them were farmers, which were reflected in the low performance of their children in mathematics.

Early research on emotional aspects showed the significance of the interaction between attitudes and academic achievement. In further research, Bramlett (2007) stated that in 1926, Thurston contributed to the focus on the emotional factors, like attitude, and its impact on other educational factors. Attitude is an essential part of human life; how people feel about things they love and hate, or like and dislike is a response to the things surrounding them. Maio and Haddock (2009) mentioned that emotion refers to the feeling of satisfaction or discomfort, love or hate, and support or rejection of a thing. Al Sheikh (1992) described attitude as a psychological and neurological readiness to act in a certain way toward a given subject. Similarly, Sarmah and Puri (2014) stated that attitude is an individual’s positive and negative response to a situation, concept, or object. The last two studies considered attitudes as a measure of the reaction towards a certain thing.
While the above studies are more general, McLeod (1992) was more specifically interested in mathematics and divided the affective domain in mathematics education into beliefs, attitudes, and emotions. Many studies confirm the difficulties of freshmen engineering students with their performance in mathematics (e.g., Parsons, 2004; Mwavita, 2005; Prakash, Kannan & Jerlin, 2014; Harris et al, 2014). Mwavita (2005) tested the variables that predict calculus success among 512 freshmen engineering students in the United States. The predictor variables were high school GPAs, ACTs mathematics, ACTs composition, and the total number of mathematics courses taken in junior and senior high school. The researcher concluded that many of the students fail to earn a grade of A, B, or C in calculus courses. Prakash, Kannan and Jerlin (2014) investigated the reasons for the failure of engineering students in mathematics. The researchers studied engineering students enrolling in 570 engineering colleges in India. They found that one of the important reasons for the failure of engineering students in mathematics is their considering mathematics as a difficult subject since childhood. Harris et al (2014) interviewed professors and freshmen engineering students who had problems with mathematics in order to identify the cause of their problem. Researchers confirmed that mathematics is still the central problem for freshmen engineering students, and universities should consider redesigning the mathematical curriculum for engineering students.

There are many additional studies dealing with the attitudes of freshmen engineering students and their significant impact on performance in mathematics.
Syam and Salim (2014) studied the reasons for the reduction of the number of students who study mathematics in many Gulf universities and especially in Qatar University. The researchers stated that students’ attitudes toward mathematics influenced their performance and their success in the subject, which led students to avoid mathematics. Eng et al. (2010) tested the factors that influence mathematics grades of 1,050 college students in Malaysia. They illustrated that positive attitudes of students may increase achievement and negative attitudes may decrease achievement in mathematics. Additionally, Nahari (2014) investigated the mathematics skills and attitudes of all freshmen engineering students in Dublin City University. The findings of this study showed positive motivation and good attitudes toward mathematics among all students. The researcher emphasized that it is necessary to study the attitudes of freshmen engineering students toward mathematics, in the beginning and in the end of the semester, in order to have a better understanding of how it affects their achievement and academic performance.

One of the most common and popular instruments that were developed to study the attitude toward mathematics is the Fennema-Sherman Mathematics Attitude Scales. It was created in 1976 to measure gender-related differences in mathematics achievement in high school. It became commonly used over the next four decades up to the present day to measure the attitude of students from middle school to the university level. This instrument can be used as a whole or as some of

The term Fennema’s theory first appeared when researchers started using the Fennema-Sherman scales. According to Tapia and Marsh (2004), Fennema’s theory explained mathematical achievement as the interaction between attitude, math anxiety, and behavior. Research that examined students’ attitudes confirmed that these attitudes are affected by several factors such as mathematics anxiety and enjoyment of the subject (Sarmah & Puri, 2014). Additionally, Fennema and Sherman (1976) added more factors such as attitude toward success, confidence in learning, and usefulness of mathematics.

There is a growing recognition in educational research that attitude has a significant impact on learning mathematics. Ernest (2003) explained how positive attitude causes success. Students’ success in mathematics will increase their positive attitude, which will lead them to work harder, whereas negative attitudes have the opposite effect. This operates like a cycle between the correlations as is illustrated in Figure 1.
The Failure Cycle in Mathematics

The Success Cycle in Mathematics

*Figure 1:* Failure and Success Cycles in Mathematics adapted (Ernest, 2003)
Review of Past Research Studies

As mentioned earlier in Chapter One, the failure of mathematics is a global problem that many students face coming from various disciplines and numerous countries. Many studies over time have tried to find the causes of this problem to address or reduce its effects. One of the main reasons for this phenomenon is students’ attitude toward mathematics; positive or negative attitudes have a clear impact on the students’ performance and grades in the subject. Therefore, even though it is necessary to study the attitude of students because there is a correlational relationship between their attitude toward mathematics and their mathematical performance, the more important thing is to investigate the factors that shape their attitude. It will thereby help parents and teachers to develop a positive attitude in their students, which will influence their results in mathematics.

The Effect of Attitude on Students’ Performance

Attitude 1: attitude toward success. People who are around the students influence students’ attitudes toward success. Rolland (2011) interviewed male African-American high school students about the factors that contribute to their academic success. She used a qualitative research method, interviewing six students and found that one of the causes of their success is the motivation from their peers. These findings are a complement to the results of a study by Trotter (1981) on the same demographic of students. He found that students with low achievements believed that their peers had a negative attitude toward schooling.
This resulted in peer pressure causing failure because they did not want to be outcasts from their friends.

Stereotypes affect the attitude of students toward success. According to Broverman, Vogel, Broverman, Clarkson and Rosenkrantz (1970), male and female youths tend to behave in a way that is consistent with the stereotype of their demographic. Likewise, Horner (1972) claimed that the fear of success is related to gender, age, and educational level. The motivation to avoid success is more a woman’s characteristic than a man’s, and is known to cause poor performance.

Similarly, Nelson, Newman, McDaniel and Buboltz (2013) assessed the level of fear of failure and its impact on male and female engineering students. Their sample was comprised of 220 undergraduate students (158 males and 62 females) from a southern university in the United States. Researchers used a questionnaire to collect data from the participants. The results of the study showed that women are more afraid of failure than men, which may affect their achievement.

Ashrafifard and Mafakheri (2017) studied the relationship between fear of success and attribution styles in 385 university students. They concluded that students who attribute the cause of their success to external factors such as luck, chance, etc., have a fear of success. This feeling causes them to doubt their abilities, which influences their performance. Many researchers support this idea, including Ryckman and Peckham (1987), Kloosterman (1993), and Zaynivand, AminiJavid and Moradi (2015).
**Attitude 2: confidence in learning mathematics.** Many studies demonstrate the effect of a students’ confidence on mathematical achievement. In Rowe’s study (1988) about the effect of single-sex classes on academic achievement in mathematics and science in Australia, he found that there is a strong relationship between confidence and achievement in mathematics. Students who study in single gender classes have greater confidence, which leads to a higher probability of achievement. On the other hand, all the classes in Saudi Arabia are single gender, but that does not increase students’ achievement in mathematics. This indicates that Rowe’s finding is not valid in every situation.

Liau, Kassim and Loke (2007) investigated the validity and reliability of the translated version of the Fennema-Sherman Mathematics Attitudes Scales with 2,380 Malaysian students from 29 high schools. The researchers found that confidence can be used to predict both mathematics anxiety and mathematics performance. Additionally, in the study by Bomholt, Goodnow, and Cooney (1994) on 663 Australian high school students about their perceptions of achievement, the researchers found confidence is one of the factors that influence what the students attempt.

According to Strutchens and Silver (2000), 87% of white eighth grade students who participated in the National Assessment of Educational Progress (NAEP) had confidence in doing well in mathematics if they try, while 67% of black eighth grade students had that confidence. Moreover, Signer, Beasley and Bauer (1996) studied the interaction of ethnicity and mathematical achievement on
mathematics attitudes of high school students in New York City. The researchers used open-ended interviews to collect the information from students. They found that students with low achievement in mathematics believe that they do not have the ability to improve grades rather than believing that they cannot succeed by increasing their effort.

There is widespread argument that confidence is influenced by gender and that girls are less confident in learning mathematics than boys. Eccles (1989) stated that gender differences in their math abilities starting in high school in the United States. She claimed that girls have lower estimates of their mathematics abilities than boys; even the girls who have good grades in mathematics are more confident in their English abilities than in their mathematics abilities. Eccles, Adler and Meece (1984) studied the sex differences in achievement of 200 high school students from grade 8 to 10. They found that low confidence among girls in mathematics may cause them to avoid future math courses and activities, especially if these courses are optional. Additionally, Lofland (1992) studied the confidence in learning mathematics of 425 undergraduate students from the University of Hawaii. She concluded that girls showed lower achievement in mathematics than boys. The reason was the females had less self-confidence in their mathematics ability than males. Also, Pajares and Miller (1994) used path analysis procedure to measure the role of some factors in mathematical problem solving. The sample of their study was 350 undergraduates (229 females and 121 males). Their finding showed that the poor performance of female students resulted from a lack of confidence in their
abilities. However, Tingley (1997) studied the attitude of 171 (65 males and 53 females) middle school American students and found that there were no sex differences between students in confidence. Both females and males students had the same confidence in learning. Also, Jazdzewski (2011) compared the attitude toward mathematics of 533 boys and girls students from Santa Cruz County, California. The researchers used the Fennema-Sherman Mathematics Attitude Scales and arrived at the result that boys and girls showed the same confidence in learning mathematics.

**Attitude 3: mathematics anxiety.** According to Hunt (1985), mathematics anxiety is a sense of discomfort and mental disability when confronted with a mathematical problem. Much of educational research confirms a negative correlation between mathematics anxiety and student performance. This correlation is confirmed by Guven and Cabakcor’s study (2013). Researchers investigated the factors that affect students’ problem-solving abilities using a correlational method with 115 seventh grade students in Turkey. They concluded that mathematics anxiety affected their problem-solving achievement negatively. The increase in mathematics anxiety can lead to low achievement, and the decrease in mathematics anxiety can cause higher achievement.

In a study on 140 Ivorian female students, Frazier-Kouassi (1999) measured female students’ attitude toward mathematics using the Fennema-Sherman Mathematics Attitudes Scale. She found that high-achieving students had less mathematics anxiety and felt comfortable toward the subject. She explained that
this situation occurred as a result of their positive previous experiences with mathematics. Similarly, Siebers (2015) surveyed 381 middle school students in northern Colorado to compare mathematics achievement with mathematic anxiety. The researcher found a statistically significant relationship between anxiety and achievement. High mathematics anxiety caused low achievement in students. Also, sixth grade students showed high achievement compared with the seventh and eighth grades students in middle school, which means they have lower mathematics anxiety. In addition, Liau et al. (2007) used the Fennema-Sherman Mathematics Attitude scales on 2380 Malaysian high school students and concluded that mathematics anxiety had a negative correlation with all other factors. For example, confidence, motivation, usefulness and attitude toward success in mathematics will decrease when mathematics anxiety increases and vice versa.

Some researchers believe that the cause of the anxiety effect on achievement is due to the impact of anxiety on students’ working memory. Ashcraft and Kirk (2001) did three experimental research studies with students from lower level undergraduate psychology classes to measure the effect of mathematics anxiety on their memory. From the first experiment with 66 students, they found that high mathematics anxiety reduced the engagement of students in mathematical activities and also reduced their grades in mathematics classes. The most important finding was that mathematics anxiety reduced students’ working memory capacity. This finding may explain why these students have less ability to solve mathematical problems. From the second experiment with 15 students, they
confirmed their finding in experiment 1 that poor performance of students with high mathematics anxiety was due to multiple difficult tasks involving working memory at one time. Finally, from their experiment 3 with 51 students, they concluded that mathematics anxiety affected students’ working memory, which led reduced working memory to negatively affect students’ performance.

There is a claim that mathematics anxiety is related to gender, which is that females have more mathematics anxiety than males. Musser, Burger, and Peterson (2004) stated that girls had more mathematics anxiety than boys; the reason for that was the girls’ belief that mathematics must be solved quickly and that there is only one solution to mathematical problems. This is confirmed by Devine, Fawcett, Szücs and Dowker’s study (2012). They tested the mathematics anxiety of 433 British students (165 women and 268 men). Their finding showed that males were less anxious than females in mathematics. They stated the reason for this finding is because traditionally mathematics is taught as a male domain. Therefore, when females are engaging in mathematical activities, they will have higher anxiety than males. However, Ma (1999) analyzed 26 studies (18 published articles, 3 unpublished articles, and 5 dissertations) using meta-analysis in order to study the relationship between mathematics anxiety and mathematical achievement. The researcher disagreed with the argument that females are more anxious about mathematics than males. He indicated that there is no statistically significant difference between males and females in mathematics anxiety.
**Attitude 4: usefulness of mathematics.** Many researchers emphasize the impact of the usefulness of mathematics on students' performance in the subject. Hackett and Betz (1989) studied the relationship between mathematical performance and the attitudes toward mathematics of 262 college students (109 males and 153 females). They concluded that the awareness of the usefulness of mathematics had a positive effect on mathematical achievement. The more students consider mathematics to be useful, the higher scores and higher performance they achieve. Furthermore, Lofland (1992) investigated the differences between attitudes toward mathematics of 425 male and female students at the University of Hawaii using the Fennema-Sherman Mathematics Attitude Scales. The researcher stated that the usefulness of mathematics for students is an important variable and has a strong positive correlation to achievement. Since mathematics is difficult for many students, it is likely that they may not continue to study mathematics if they do not recognize its usefulness for them now and in their future. This is asserted by Frazier-Kouassi’s study (1999) on 140 Ivorian female students using the Fennema-Sherman Mathematics Attitudes Scale to measure the attitude of female students toward mathematics. She found that the students with high grades had higher perceived usefulness of mathematics and those with low grades had lower perceived usefulness of mathematics.

Chouinard, Vezeau, Bouffard and Jenkins (1999) investigated the gender differences in attitudes of 1,885 middle and high school students toward mathematics. Researchers found that the usefulness of learning mathematics had a
significant impact on students’ attitude. Furthermore, Walker and McCoy (1997) interviewed African-American high school students to measure the relationship between their perception of mathematics and their motivation to learn the subject. These interviews reveal that most students did not realize the benefits of mathematics in their future careers. This will affect the choosing of their future major, so that they will, by avoiding mathematics courses, eliminate the possibility of following many fruitful career paths.

There are differences in the educational research about the impact of the mathematics usefulness as it is related to gender. The study by Farooq and Shah (2008) on 685 high school Pakistani students (379 males and 306 females) investigated gender differences in relation to their attitude toward mathematics. The researchers found that there were no differences between male and female students about the usefulness of mathematics and both genders had the same type of attitude. This finding is also confirmed by Mohamed and Waheed’s study (2011). They measured the attitude toward mathematics of 395 high school students in Maldives using the Fennema-Sherman Mathematics Attitude Scales. Researchers concluded that there was not a gender differential about the usefulness of mathematics, and both sexes had a positive attitude toward mathematics. However, Huang (2010) investigated the attitudes of 792 freshmen engineering students toward Calculus in Taiwan using an instrument that was modified from the Fennema-Sherman Mathematics Attitude Scales. He concluded that female students
realized the usefulness of mathematics more than male students. Therefore, female students had better performance in Calculus than males.

**Attitude 5: effectance motivation.** Many studies confirm the positive effect of motivation on mathematical achievement. Frazier-Kouassi (1999) studied 140 Ivorian female students. The researcher used the Fennema-Sherman Mathematics Attitudes Scale to measure the attitude of female students toward mathematics. She concluded that students who have great positivity about their problem-solving abilities, enjoy solving difficult problems, and who cannot be easily discouraged from difficult issues have high achievements in mathematics. Similarly, Mata, Monteiro and Peixoto (2012) studied the factors that explain the attitude towards mathematics of 1,719 Portuguese students from fifth to twelfth grade. Researchers found a positive relationship between students’ attitude and their motivation. Students with good achievement in mathematics had positive attitudes because their motivation was high.

On the other hand, Huang (2010) studied the attitudes toward Calculus of 792 freshmen engineering students in Taiwan using an instrument that was modified from the Fennema-Sherman Mathematics Attitude Scales. The researcher found that there was not a statistical difference in motivation between students with low and high achievements. He attributed this finding to the Taiwanese students studying and knowing the importance of mathematics in their study and their lives from an early age. Thus, their motivation for learning mathematics is very high.
Tella (2007) measured the effect of motivation on the mathematical performance of high school Nigerian students using a survey. The results showed that students with higher motivation acquired a better score than students with low motivation. When the student shows his lack of interest in the subject, this will make him less likely to interact with his teacher and classroom activities; this reflects a weakness in his motivation to learn mathematics. This finding is also confirmed by the result of the Abdurrahman and Garba’ study (2014) on 383 high school students in Nigeria. This study found a positive relationship between motivation and students’ performance. Students with high performance in mathematics had high motivation.

Motivation not only affects academic performance, but also affects the desire of students to continue learning mathematics. Milne (1992) investigated the attitude of students who enrolled in a year-long bridging mathematics course in Australia. This course was provided to the students who could not attain the minimum required score in mathematics to enter university science courses. The Fennema-Sherman Mathematics Attitude Scales were used to study students’ attitudes. The researcher found that the mean scores for Effectance Motivation of students was high at the beginning of semester; however, all the students who left the course at the end of the first semester had less motivation than the fourteen students who finished and completed the course.

Chiu and Xihua (2008) reviewed the data of 107,975 students across 41 countries using PISA mathematics test scores to examine the impact of motivation
on students’ mathematics achievement. Researchers found that there was a
significant positive relationship between students’ intrinsic motivation and their
achievement. They did not find any effect of students’ extrinsic motivation on their
achievement. Students learn more when their teachers try to increase their students’
internal motivation to learn and help them to enjoy working in classroom activities.

The Effect of Students’ Demographic Characteristics on Their Attitudes

As mentioned before, it is most important and useful for educators,
teachers, and parents to measure and determine the factors that form students’
attitudes. This measurement provides the causes of the negative attitudes, which
helps the educators know how to improve them. A person who keeps looking at the
educational research and relevant articles will find that there are two ways to find
those factors that influence and shape students’ attitudes toward mathematics. First,
some researchers focused on the factors that affect students’ performance and
achievement in mathematics. These factors also influence the attitudes of students
in mathematics. According to Ernest (2003) as mentioned previously, success
establishes positive attitudes and failure establishes negative attitudes. Second,
other researchers focused directly on the factors that impact and form students’
attitudes. Both approaches have confirmed that students’ demographic
characteristics, including their nationality, geographical region, school type,
parents’ education level, and parents’ career type, were one of the main factors that
affect students’ attitudes toward mathematics.
**Students’ nationality.** The importance of studying the nationality of students is that it reflects the role of their culture in their education and achievement. Stevenson and Lee (1990) investigated the causes of academic superiority of Japanese and Chinese children over American children. Researchers tested 1,440 Japanese and Chinese students with achievement tests in mathematics and interviewed the students and their mothers. The results indicated that their mothers focus on hard work, which caused the higher performance of their children in mathematics. On the contrary, Henderson and Landesman (1992) examined the attitudes of Mexican-American students toward mathematics and the effects of some variables on those attitudes. Researchers used MANOVA to analyze the data of 103 middle school students. The result of this study showed that Hispanic students recorded quite low achievement in mathematics. Most students had difficulty with simple mathematical skills that should have been mastered in elementary school.

**Geographical region.** Some research has mentioned the impact of geographical region of students on their attitudes and performance. Yasar et al. (2014) studied the attitude of students in Turkey toward mathematics and the variables that influence their attitudes. Researchers used survey methods to collect the data from 30,170 high school students in seven different geographic regions. Their findings showed that there is a statistical impact of geographic regions on students’ attitudes toward mathematics. Students from poor regions had more negative attitudes towards mathematics.
Furthermore, the geographic region affects not only student attitudes but also the graduation time of students. Falch, Lujala and Strom (2013) investigated the impact of travel time between students’ homes and their schools on their graduation. The sample of this study was 95% of high school students who were enrolled in 2002 in Norway. Researchers found a positive effect between lower travel time and graduation. Decreasing travel time from students’ homes to their school increases their propensity to graduate on time. On the contrary, Camello (2014) tested the factors that influence the performance of engineering students in the mathematical assessment examination in Philippines. Researcher used survey models to collect data from 131 students. The finding of the study showed that distance from students’ residence to school appeared to not be significantly related to students’ assessment examination in mathematics, which means this variable did not have a statistical impact on students’ performance.

**School type.** Some researchers claim school type can play a role on student’s performance and others believe that there is no evidence that the type of school affects students’ performance. Deraney and Abdelsalam (2012) used school type as a predictor for success of 178 graduating female university students in Saudi Arabia. Their result demonstrated that 63% of students who got direct admission were from private high schools. However, analyzing the GPA of students after graduating showed that public school students outperformed their peers during the study time and had better scores. In contrast, Camello (2014) measured the factors that impact the performance of engineering students in the
mathematical assessment examination in Philippines. The sample of this study was 131 students from the first and second year using a questionnaire to collect the data. The researcher concluded that there was no significant difference between public school students and private school students. This variable, school type, had no influence on engineering students’ performance on a mathematical assessment examination.

**Parents’ educational level.** Many researchers, such as Mbugua et al. (2012), and Visser, Juan and Feza (2015), have studied the influence of parents’ educational level on their children’s performance and attitudes. Mbugua et al. (2012) studied the factors causing poor performance in mathematics in Kenya. Researchers used a descriptive survey design with 1,876 high school students and 132 mathematics teachers. They concluded that one of the main reasons for the prevalence of poor performance in mathematics among Kenyan high school students was the level of parental education. 6.2% of parents had a university education and 66.3% of them had just a high school education. Therefore, these parents may not be perfect role models for the students in academic matters. Similarly, Visser et al. (2015) analyzed the result of TIMSS in 2011 using a multiple regression procedure to determine the factors that affect South African students’ performance in mathematics. Researchers found that higher educational level of parents had a significant positive impact on the mathematical performance of students.
Many other researchers, such as Hijazi and Naqvi (2006), Akhtar (2012), and Dimakos, Tyrlis and Spyros (2012), emphasized that the mothers’ educational levels have more influence on students’ performance and attitude than the educational level of the father. Akhtar (2012) examined the effect of socio-economic variables on high school students’ achievement in Pakistan, by using linear regression to analyze the completed questionnaire of 1,580 participants. The results showed that the mother’s education had a positive effect on her children’s achievement. The reason this happens may be because the mother traditionally spends more time with her children at home, so understandably the mother’s background will affect her children more than the father’s. Hijazi and Naqvi (2006) studied the factors that affect college students’ performance in Pakistan, by using a survey to collect data from 300 students (225 are males and 75 are female) enrolled at Punjab University of Pakistan. The researchers found that there was a positive relationship between mothers’ education and their children’s performance. Educated mothers had a positive influence on their students’ performance as compared to illiterate mothers.

On the other hand, Camello (2014) investigated the factors that influence the performance of engineering students in the local mathematical assessment examination in the Philippines. A questionnaire was used to collect data from 131 first and second year students, leading to the discovery that there was no significant impact of the parents’ educational level on students’ performance in mathematics.
Parents’ career type. Not only is studying the educational level of parents important to predict the educational performance of their children, but also studying the impact of the parents’ careers on students’ performance is most important (Barry, 2006). Mbugua et al. (2012) studied the factors causing poor performance in mathematics in Kenya. A survey was administered to 1,876 high school students and 132 mathematics teachers, which concluded that one of the main reasons for the prevalence of poor performance in mathematics among Kenyan high school students was the careers of the students’ parents. The result showed that 39.9% of parents worked in farming, and 16.8% of them worked in small business, and therefore, these parents may not provide the essential support for their children’s learning. However, there is insufficient evidence that a parent’s career causes a student’s poor or good performance in mathematics. Perhaps a farmer’s offspring spends too little time studying mathematics because they help their parents by working on the farm, thus neglecting their study of mathematics. Clearly, we do not have enough evidence to state that parents’ career type is a main cause for poor or great performance in mathematics.

Reardon (2011) investigated the relationship between socioeconomic characteristics of families and the academic performance of their children over fifty years using nineteen representative studies in the United States. Reardon found that there is a 40% gap between the achievements of students from high- and low-income families, which is twice as large as the gap in achievement between white and black students. The effect of economic status affected students’ achievement
just as much as the parents' education. Checchi (2000) focused on the reasons for the low educational achievement of university students in Italy. The participants of this study were the students at the State University of Milan in the academic year of 1995-1996. The results showed that there was positive correlation between family income and students’ achievement; parents with a high-income provide an incentive for better academic performance. This finding is also confirmed in the study of Dahl and Lochner (2012).

Nevertheless, Camello (2014) examined the factors that affect the performance of engineering students in the local mathematical assessment examination in the Philippines. The sample of this study was 131 students from the first and second year using a questionnaire to collect the data, and found that there was no significant impact of parents’ income on students’ performance in mathematics. Additionally, Akhtar (2012) tested the effect of socio-economic variables on high school students’ achievement in Pakistan using linear regression to analyze the completed questionnaire of 1,580 participants. The results showed that the mother’s career had a positive effect on her children’s achievement, but the effects are negligible. Hijazi and Naqvi (2006) studied the factors that affect college students’ performance in Pakistan, utilizing a survey to collect data from 300 students (225 are males and 75 are female) enrolled in Punjab University of Pakistan. They found that there was a negative relationship between the parents’ income and their children’s performance. Students from affluent families do not work as hard in schooling as poorer students.
Summary

Studying the factors that affect the attitudes of students toward mathematics is very important because their attitudes impact their mathematical achievement. Therefore, much research has studied the relationship between students’ demographic characteristics and their attitudes.

Mbugua et al. (2012) studied the factors causing poor performance in mathematics in Kenya. A survey was used with 1,876 high school students and 132 mathematics teachers. Researchers concluded that the main reasons for the prevalence of poor performance in mathematics among Kenyan high school students were the level of parental education and the career of the students’ parents. The results showed that 6.2% of parents had a university education and 66.3% of them had just a high school education. Also, 39.9% of the parents worked in farming and 16.8% of them were businessmen. Therefore, most parents may not provide the essential requirements for their children’s learning.

Yasar et al. (2014) investigated the attitude of students toward mathematics and the variables that influence their attitudes in Turkey. A survey was used to collect data from 30,170 high school students in seven different geographic regions. Researchers found that there was a statistical impact of geographic regions on students’ attitudes toward mathematics. Students from poor regions had more negative attitudes in mathematics than students from prosperous regions.

Deraney and Abdelsalam (2012) used school type as a predictor for success of 178 graduating female university students in Saudi Arabia. The result of the
study showed that 63% of students who got direct admission were from private high schools. However, analyzing the GPA of students after graduating demonstrated that public school students outperformed their peers during the study time and had better scores.

As reviewed previously, studying the factors that affect students’ attitudes toward mathematics, such as students’ demographic characteristics, is important to help students improve their attitudes in order to enhance their performance. Furthermore, there is a need to check and measure Saudi students’ attitude toward mathematics at the university level because almost all of the samples of previous studies were from countries other than Saudi Arabia. This reason pushed the researcher to focus more on studying this specific population. Additionally, engineering students need more focus because they have to take many mathematics classes in their program. Therefore, studying their attitude toward mathematics and the factors that influence their attitude is also necessary.
Chapter Three
Methodology

This chapter separates into the following sections: the research questions, research hypotheses, type of design, population and sample, power analysis, instrumentation, pilot study, data collection procedures, independent and dependent variables, statistical analysis, interview protocol, and summary.

This study used mixed methods to measure the relationship between freshman engineering students’ demographic characteristics and their attitudes toward mathematics. The dependent variable was freshman engineering students’ attitudes, which were the attitude toward success in mathematics, confidence in learning mathematics, mathematics anxiety, usefulness of mathematics, and effectance motivation in mathematics. The independent variables; students’ demographic characteristics; included were nationality, geographical region, school type, fathers’ educational levels, mothers’ educational levels, fathers’ career types, and mothers’ career types. A survey was used to collect data from 157 freshmen engineering students. Twenty-six of the participants were interviewed to validate the findings from the survey and obtain deep and detailed explanations about their attitudes.

Research Questions

The main research question of this study was: what is the relationship between the freshman engineering students’ attitudes toward mathematics and their
demographic characteristics enrolled at Imam Abdulrahman Bin Faisal University (IAU)? The study addressed the following questions:

1. What is the relationship between students’ demographic characteristics and their attitude toward success in mathematics?

2. What is the relationship between students’ demographic characteristics and their confidence in learning mathematics?

3. What is the relationship between students’ demographic characteristics and their anxiety over mathematics?

4. What is the relationship between students’ demographic characteristics and their awareness of the usefulness of mathematics?

5. What is the relationship between students’ demographic characteristics and their effectance motivation in mathematics?

**Research Hypotheses**

The following hypotheses were formulated for this study:

\[ H_{01} \]: There is no significant relationship between students’ demographic characteristics and their attitude toward success in mathematics.

\[ H_{a1} \]: There is a significant relationship between students’ demographic characteristics and their attitude toward success in mathematics.

\[ H_{02} \]: There is no significant relationship between students’ demographic characteristics and their confidence in learning mathematics.

\[ H_{a2} \]: There is a significant relationship between students’ demographic characteristics and their confidence in learning mathematics.
H₀₃: There is no significant relationship between students’ demographic characteristics and their anxiety over mathematics.

Hₐ₃: There is a significant relationship between students’ demographic characteristics and their anxiety over mathematics.

H₀₄: There is no significant relationship between students’ demographic characteristics and their awareness of the usefulness of mathematics.

Hₐ₄: There is a significant relationship between students’ demographic characteristics and their awareness of the usefulness of mathematics.

H₀₅: There is no significant relationship between students’ demographic characteristics and their effectance motivation in mathematics.

Hₐ₅: There is a significant relationship between students’ demographic characteristics and their effectance motivation in mathematics.

**Type of Design**

Mixed methods were used in this investigation to measure the relationship among the seven independent variables: students’ nationality, geographical region, school type, fathers’ educational levels, mothers’ educational levels, fathers’ career types, and mothers’ career types. The five dependent variables include attitude toward success in mathematics, confidence in learning mathematics, mathematics anxiety, usefulness of mathematics, and effectance motivation in mathematics. This type of design involves both quantitative and qualitative data in a single research study. A survey design collected quantitative data, which was also helpful for this study. According to Gay, Mills and Airasian (2012), survey research involves
testing hypotheses or answering questions about people’s attitudes, behaviors, opinions, and perceptions of the individuals regarding a certain object or phenomenon through collecting data. An interview collected qualitative data. According to Gallo (2014), interview questions help the researcher to better understand quantitative results. The mixed methods research design gave the researcher the opportunity to understand deeply the relationship between freshman engineering students' demographic characteristics and their attitudes toward mathematics.

**Population and Sample**

**Population**

The population of this study consisted of engineering students enrolled in first year mathematics classes offered at Imam Abdulrahman Bin Faisal University (IAU) located in the eastern region of Saudi Arabia. The sample was chosen because of the availability of the students, the enrollment size of the classes, and the requirement for the students to enroll in the classes. The population contained similar age groups, ethnic backgrounds, and academic majors.

**Sample**

Participants in this study are over 18 years old and enrolled in IAU in Saudi Arabia. The IAU is one of the public Saudi universities that was established in 1975 with just two colleges, which were the College of Medicine and the College of Architecture. The College of Architecture is one of the three colleges that are
provided now to engineering students. Each student had the freedom whether or not to participate in this study. The student participants completed a computerized questionnaire. Participants were informed that their answers and information were confidential. The approval to collect the data was received from the Institutional Review Board (IRB) at IAU, and also at Florida Institute of Technology (see Appendix E & F).

The total number of participants was 157 freshman engineering students who studied at IAU. The students were selected via random sampling method to represent the population. Participants’ demographic characteristics were collected for nationality, region of residency, school type, parents’ educational level, and parents’ career type. Their demographic information showed that 91.7% of them are Saudi, 89.8% live in the eastern region, and 70.7% graduated from public high school. Additional demographic characteristics and sample data are provided in Chapter 4.

**Power Analysis**

The aim of the statistical power analysis technique is that it helps the quantitative researchers to decide both how large a sample is needed in order to have accurate and reliable statistical judgments, and second, how likely the chosen statistical tests are to identify the impacts of a given size in a specific situation (Hill & Lewicki, 2007). To conduct the power analysis, a G*Power program was used to determine the minimum number of participants needed in this study. The power that the researcher aimed to have for the multiple linear regression was 0.8; the
effect size was 0.15; and the alpha level was 0.05. There were seven independent
variables, and it was determined that at least 103 participants were needed in this
study.

**Instrumentation**

The survey for this study was designed in two parts. The first part
concerned the students’ demographical questions and the second part concerned the
students’ attitudes toward mathematics (see Appendix B).

The first part outlined the following information: participants’ nationality
(Saudi or Non-Saudi), geographical region (Central Region, Northern Region,
Southern Region, Eastern Region, or Western Region), school type (Public School
or Private School), fathers’ educational levels (Elementary School, Middle School,
High School, Bachelor Degree, Masters Degree, PhD Degree, or None), mothers’
educational levels (Elementary School, Middle School, High School, Bachelor
Degree, Masters Degree, PhD Degree, or None), fathers’ career types (Health Care,
Law, Engineering, Education, Military, Self-Employed, Company Employees, or
Other), and mothers’ career types (Health Care, Law, Engineering, Education,
Military, Self-Employed, Company Employees, Housewife, or Other). The option
*Other* in career type's questions refers to any other career that was not listed, such
as government jobs. Also, the researcher included the *Housewife* as a mother’s
career type for two reasons. First, Saudi’s culture, as well as in Islamic thought,
believes that the fundamental career for all mothers is to become a housewife.
Nurturing of the new generations through taking care of them and helping them to
make their way is an essential job for mothers even without gaining any salary. This is because the husband is the only one responsible for supporting his children and his wife in Saudi’s culture and in Islamic beliefs. After the husband passes away or cannot work, his sons are responsible for supporting their parents and their sisters. Second, most Saudi mothers are housewives, as you will see in Chapter 4. For this reason, the researcher became interested in studying the relationship between this kind of career and their children’s attitudes toward mathematics.

Furthermore, a set of options was combined in the first part of the survey because there was such a small number of exceptions. For example, in mothers’ career types, frequency of Self-Employed was 1, frequency of Company Employees was 2, and frequency of Health Care was 3. All these options were merged with the option Other to became the total 11.

For the second part of the instrument, which is the attitude instrument, a permission to adopt the instruments of the “Fennema-Sherman Mathematics Attitude Scales” (Fennema & Sherman, 1976) was obtained from the author (see Appendix G).

**Attitude Instruments**

There are many different instruments which can help the researcher to measure students’ attitudes toward mathematics, such as these cited by Askar (1986), Baykul (1990), Camello (2014), Tapia and Marsh (2004), Marchis (2011), and Fennema and Sherman (1976). Askar (1986) developed a questionnaire with 20 questions to examine student attitudes toward mathematics. It contains questions in
a five-point Likert format, from “completely agree” to “completely disagree” in which there is a mix of positive and negative items. Baykul (1990) developed a questionnaire with 30 questions to measure the attitudes toward mathematics of students from fifth graders to high-school seniors. It contains questions in a five-point Likert format, from “strongly agree” to “strongly disagree”, in which there is a mix of positive and negative questions. Camello (2014) developed a questionnaire with 13 questions to assess the attitudes of engineering students toward mathematics. It contains questions in a five-point Likert format, from “strongly agree” to “strongly disagree”.

Tapia and Marsh (2004) developed a questionnaire with 40 items to measure high school students’ attitudes toward mathematics. It contains questions in a five-point Likert format, from “strongly don't agree” to “strongly agree”. The questionnaires are distributed as follows: (a) 15 items related to self-confidence, (b) 10 items related to value of mathematics, (c) 10 items related to enjoyment and (d) 10 items related to motivation.

Marchis (2011) developed a questionnaire with 28 items: five items related to demographic information and 22 questions formulated to test the attitudes of high school students toward mathematics. It contains questions in a five-point Likert format, from “strongly don't agree” to “strongly agree”. The questionnaires are distributed as follows: (a) three questions measuring self-efficacy, (b) three questions measuring help-seeking, (c) three questions measuring self-judgment, (d) two questions measuring self-reaction, (e) three questions measuring utility of
mathematics, (f) two questions measuring anxiety, and (g) six questions measuring mathematics teacher.

Most of the previous studies were designed to show the overall attitude of students toward mathematics with the exception of Tapia and Marsh (2004), and Marchis (2011); although these two exceptions include subscales that focus on different factors, these subscales cannot be used individually to investigate a specific factor. The most comprehensive study was conducted by Fennema and Sherman (1976) who developed a questionnaire that contains nine scales: attitude toward success in mathematics, mathematics as a male domain, mother scale, father scale, teacher scale, confidence in learning mathematics, mathematics anxiety, effectance motivation in mathematics, and usefulness of mathematics. The researcher can use these scales individually or as sets of two or more, which help to measure specific factors. More details about the Fennema and Sherman scales are discussed next.

The Fennema-Sherman Mathematics Attitude Scales (FSMA)

The major data collection tool that was used in this study is the Arabic translation of the Fennema-Sherman Mathematics Attitude Scales (FSMA). The FSMA were created in 1976 to test mathematics attitudes of high school students. At the university level, the FSMA has been used in research to focus on females and freshman students. For example, Frazier-Kouassi (1999) used the Fennema-Sherman Mathematics Attitude Scale to investigate 140 female students' attitude
toward mathematics in the Ivory Coast. On the other hand, Bramlett (2007) used
the Fennema-Sherman Mathematics Attitude Scale to study the factors that affect
mathematics attitudes of 224 freshmen African-American students enrolled in
college algebra classes in Mississippi. Furthermore, according to Metsämuuronen
(2012), the FSMA is considered one of the most important and popular instruments
that is used in many international comparisons and assessments, such as Trends in
International Mathematics and Science Study (TIMSS) and Program for
International Student Assessment (PISA).

The domains of the FSMA are (1) Attitude Towards Success in
Mathematics Scale, (2) Mathematics as a Male Domain Scale, (3) Mother Scale, (4)
Father Scale, (5) Teacher Scale, (6) Confidence in Learning Mathematics Scale, (7)
Mathematics Anxiety Scale, (8) Effectance Motivation Scale, and (9) Usefulness of
Mathematics Scale. Five of the nine domains of the FSMA were used to measure
student attitudes toward mathematics, which were attitude towards success in
mathematics, confidence in learning mathematics, mathematics anxiety, usefulness
of mathematics, and effectance motivation (see Appendix B). The male, teacher,
father and mother subscales are excluded.

The FSMA Scale contains items in a five-point Likert format, in which
there are a mix of positive and negative statements, in order to receive more
accurate responses. Each scale in the FSMA consists of twelve (12) questions. Six
questions are stated positively and six questions are stated negatively. The whole
FSMA scale consists of 60 questions in this study. Opinions were indicated as
follows: 1 = strongly disagree; 2 = disagree; 3 = not sure; 4 = agree; and 5 = strongly agree for the positively stated questions. The statistical ratings for the statements are 1, 2, 3, 4, and 5.

The researcher has made four modifications on the original instrument. The first and second modifications were within the Attitude Towards Success in Mathematics Scale, where the word “kids” was changed to the word “students” in items 8 and 12. The third modification was within the Usefulness of Mathematics Scale, where the word “school” was changed to “university” in item 12. These modifications make the instrument more specific so it could be used with university students. The final modification was the translation of the instrument into the Arabic language (see Appendix C).

**Validity and Reliability**

The instrument that was used in this study, the FSMA, has been used in many studies, and the reliability and validity of the FSMA has been well established. Fennema and Sherman (1976) showed the reliability of all the nine scales by calculating split-half reliabilities values. Liau et al. (2007) established the validity and reliability of a Malay version of the FSMA in a Malaysian context. Their study administered the FSMA to 2,380 high school students. The reliabilities for all scales in the FSMA were sufficient. Confirmatory Factor Analysis (CFA) was used and pointed out that the nine scales constitute nine separate factors. The results of their study added empirical evidence to support the theoretical structure of the FSMA. Dogbey (2010) also conducted a study on American students from
six community colleges in midwestern states using seven of the nine scales of the FSMA and demonstrated the reliability by calculating CronBach alphas for the seven scales. The reliability results for the Fennema and Sherman (1976), Liau et al. (2007) and Dogbey (2010) are found in Tables 1, 2, and 3. Additionally, the researcher established the validity and reliability of the translated instrument by conducting a pilot study. All of the details of the pilot study are provided in the next section.

Table 1

*Split-Half Reliabilities of the Fennema-Sherman Mathematics Attitude Scales*

<table>
<thead>
<tr>
<th>Scale</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Attitude Toward Success in Mathematics (AS)</td>
<td>.87</td>
</tr>
<tr>
<td>2. Mathematics as a Male Domain (MD)</td>
<td>.87</td>
</tr>
<tr>
<td>3. Teacher (T)</td>
<td>.88</td>
</tr>
<tr>
<td>4. Confidence in Learning Mathematics (C)</td>
<td>.93</td>
</tr>
<tr>
<td>5. Mathematics Anxiety (A)</td>
<td>.89</td>
</tr>
<tr>
<td>6. Usefulness of Mathematics (U)</td>
<td>.88</td>
</tr>
<tr>
<td>7. Effectance Motivation in Mathematics (E)</td>
<td>.87</td>
</tr>
<tr>
<td>8. Father (F)</td>
<td>.91</td>
</tr>
<tr>
<td>9. Mother (M)</td>
<td>.86</td>
</tr>
</tbody>
</table>

Source: Fennema and Sherman (1976)
Table 2

*Reliability Coefficients for the Mathematics Attitudes Scales*

<table>
<thead>
<tr>
<th>Scale</th>
<th>CronBach α</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Attitude Toward Success in Mathematics (Success)</td>
<td>.65</td>
</tr>
<tr>
<td>2. Confidence in Learning Mathematics (Confidence)</td>
<td>.91</td>
</tr>
<tr>
<td>3. Effectance Motivation</td>
<td>.76</td>
</tr>
<tr>
<td>4. Father Attitude</td>
<td>.88</td>
</tr>
<tr>
<td>5. Mathematics as a Male Domain (Male Domain)</td>
<td>.80</td>
</tr>
<tr>
<td>6. Mathematics Anxiety</td>
<td>.89</td>
</tr>
<tr>
<td>7. Mother Attitude</td>
<td>.83</td>
</tr>
<tr>
<td>8. Teacher Attitude</td>
<td>.83</td>
</tr>
<tr>
<td>9. Usefulness of Mathematics (Usefulness)</td>
<td>.92</td>
</tr>
</tbody>
</table>

Source: Liau, Kassim and Loke (2007)
### Table 3

*Cronbach’s Alpha Reliability of the Adapted FSMA Items by Subcomponent Attitude*

<table>
<thead>
<tr>
<th>Subcomponent Attitude</th>
<th>Complete Responses (n)</th>
<th>Number of Items</th>
<th>Reliability $\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Success</td>
<td>297</td>
<td>12</td>
<td>.88</td>
</tr>
<tr>
<td>2. Male Domain</td>
<td>295</td>
<td>12</td>
<td>.87</td>
</tr>
<tr>
<td>3. Teacher</td>
<td>294</td>
<td>12</td>
<td>.87</td>
</tr>
<tr>
<td>4. Confidence</td>
<td>286</td>
<td>11</td>
<td>.94</td>
</tr>
<tr>
<td>5. Anxiety</td>
<td>287</td>
<td>11</td>
<td>.94</td>
</tr>
<tr>
<td>6. Usefulness</td>
<td>276</td>
<td>12</td>
<td>.95</td>
</tr>
<tr>
<td>7. Effectance Motivation</td>
<td>280</td>
<td>12</td>
<td>.91</td>
</tr>
<tr>
<td>All Items</td>
<td>226</td>
<td>82</td>
<td>.96</td>
</tr>
</tbody>
</table>

*Source: Dogbey (2010)*

In this current study, the researcher demonstrated reliability by calculating Cronbach’s alphas of the five chosen scales of the Fennema-Sherman Mathematics Attitude Scales after collecting data. The reliability results for the survey are found in Table 4.
<table>
<thead>
<tr>
<th>Subcomponent Attitude</th>
<th>Complete Responses (n)</th>
<th>Number of Items</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Success</td>
<td>157</td>
<td>12</td>
<td>.76</td>
</tr>
<tr>
<td>2. Confidence</td>
<td>157</td>
<td>12</td>
<td>.93</td>
</tr>
<tr>
<td>3. Anxiety</td>
<td>157</td>
<td>12</td>
<td>.93</td>
</tr>
<tr>
<td>4. Usefulness</td>
<td>157</td>
<td>12</td>
<td>.92</td>
</tr>
<tr>
<td>5. Motivation</td>
<td>157</td>
<td>12</td>
<td>.86</td>
</tr>
<tr>
<td>All Items</td>
<td>157</td>
<td>60</td>
<td>.96</td>
</tr>
</tbody>
</table>

The results of calculating Cronbach’s alphas for the current study were consistent with the results of Cronbach’s alphas for the pilot study (see Table 5).

**Pilot Study of Instruments**

A pilot study of the survey and the interview protocol was conducted during the Spring 2018 semester in order to identify and reduce the unexpected issues, weaknesses, and flaws of the instrument before collecting data and conducting the actual study (Gay & Airasian, 2003). The sample of this study was Saudi undergraduate students enrolled in the Florida Institute of Technology (FIT). Participants were male and female students from different regions in Saudi Arabia, and they studied a variety of majors at FIT. After getting the approval to collect the data from the Institutional Review Board (IRB) (see Appendix G), the researcher
reached participants through the social media of the Saudi Students Union. The purpose of the research study was explained to the participants, and all of them participated voluntarily to pilot test the instruments. According to Hill (1998), a pilot study sample size should be from 10 to 30 participants in survey research. All parts of the pilot study were completed by 49 participants.

**Instrument validity.** The survey statements were translated into the Arabic language and then presented to four individuals from Saudi Arabia who are proficient in both English and Arabic in order to evaluate the statements and provide feedback for the translation. They recommended minor changes regarding the clarity and language level. After that, the survey was sent to an expert for proofreading and assistance in identifying the statements’ clarity. All recommendations and suggestions were taken into consideration after evaluating all the statements in order to ensure their appropriateness to the objectives of the study.

**Instrument reliability.** Forty-nine Saudi undergraduate male and female students enrolled at FIT and living in the United States participated in the survey. The researcher met and interviewed six participants to discuss and obtain a better idea of students’ reactions to the survey items. This meeting provided the researcher with some questions, comments, and suggestions about the survey’s statements to enhance the translated instrument. Then minor revisions were made, and a few more changes were taken into consideration. The reliability results for the survey of the pilot study are found in Table 5.
Table 5

*Pilot Study's Reliability Statistics for the FSMA*

<table>
<thead>
<tr>
<th>Subcomponent Attitude</th>
<th>Complete Responses (n)</th>
<th>Number of Items</th>
<th>Cronbach’s $\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Success</td>
<td>49</td>
<td>12</td>
<td>.72</td>
</tr>
<tr>
<td>2. Confidence</td>
<td>49</td>
<td>12</td>
<td>.93</td>
</tr>
<tr>
<td>3. Anxiety</td>
<td>49</td>
<td>12</td>
<td>.93</td>
</tr>
<tr>
<td>4. Usefulness</td>
<td>49</td>
<td>12</td>
<td>.91</td>
</tr>
<tr>
<td>5. Motivation</td>
<td>49</td>
<td>12</td>
<td>.94</td>
</tr>
<tr>
<td>All Items</td>
<td>49</td>
<td>60</td>
<td>.96</td>
</tr>
</tbody>
</table>

**Data Collection Procedures**

During Spring 2018, permission to conduct the study was secured from the Institutional Review Board (IRB) at Florida Institute of Technology and from the Institutional Review Board (IRB) at Imam Abdulrahman Bin Faisal University (see Appendix E & F). After receiving permission, the researcher traveled to Saudi Arabia to collect the data. In Fall 2018, the researcher administered the survey to the freshmen engineering students after appropriate instructions were given. The students were asked to reply honestly to all the items and not to leave any item empty to eliminate non-responses.

Google’s online survey service was used to design the electronic version of the survey. Participants were informed that their participation would be voluntary,
they would not be asked their names, and their IP addresses would not be collected. The hyperlink was sent to the participants through their emails as listed in the Imam Abdulrahman Bin Faisal University. The expected time for participants to complete the survey was 10-15 minutes. One of the advantages of an online survey is that missing answers can be avoided by making all questions required. All completed instruments were logged and examined for non-responses and errors.

**Independent and Dependent Variables**

The independent variables were freshmen engineering students’ demographic information, which were students’ nationality, geographical region, school type, fathers’ educational levels, mothers’ educational levels, fathers’ career types, and mothers’ career types. These variables were assumed in some way to affect the dependent variables, which are attitude toward success in mathematics, confidence in learning mathematics, mathematics anxiety, usefulness of mathematics, and effectance motivation in mathematics.

**Statistical Analysis**

This study examined the relationship of seven independent variables, analyzing the freshmen engineering students’ attitudes toward mathematics, using a multiple linear regression (MR) procedure that uses SPSS software. This kind of statistical procedure estimates the relationship between sets of independent variables and a dependent variable. According to Hill and Lewicki (2007), the main goal of the multiple regression is to provide more information about the
relationship between many independent variables and a dependent variable. Also, the MR can work with both types of independent variables, the continuous and the categorical (Keith, 2014). Thus, it was a well-suited procedure for this study because the main purpose was to measure the relationship between the demographic characteristics of the freshman engineering students and their attitude toward mathematics, and also because all of the independent variables in this study were categorical variables. A multiple linear regression also helped the researcher predict the possible effects and forecast the interaction between independent and dependent variables (Orndorff, 2017). This procedure indicated the level of variance shared by several variables. All hypotheses were tested at the .05 alpha level or better.

**Interview Protocol**

Qualitative data was collected from 26 participants. These participants were asked seven open-ended questions in a face-to-face interview to understand their attitudes toward mathematics and explore the factors that shaped these attitudes. Analysis processes of the qualitative data in this study tend to be concurrent because the qualitative data was collected immediately after interviews and before quantitative data was analyzed. Participants’ responses to the interview questions helped to validate the findings from the survey and to obtain deep and detailed explanations about their attitudes toward mathematics. Participants had an opportunity to share their opinions, feelings, and attitudes toward mathematics. The researcher coded and examined the recorded responses. All the responses were
organized based on the question number and then presented to two other researchers to review and validate them. The interview questions were as follows:

1. 
   a) In general, how would you describe your current attitude toward mathematics?
   b) What factors do you feel most influence your current attitude towards mathematics and why?

2. 
   a) In general, how would you describe your current attitude toward success in mathematics?
   b) What factors do you think most contributed to your attitude toward success in mathematics? Please explain why.

3. 
   a) In general, do you think you have confidence in learning mathematics?
   b) What factors do you think best contributed to your current confidence in learning mathematics? Please explain why.

4. 
   a) Do you feel anxiety about taking a course in mathematics?
   b) What factors do you think best contributed to your current anxiety about mathematics? Please explain why.

5. 
   a) Do you feel that mathematics is useful to know?
b) Overall, what factors do you think most contributed to your current awareness of the usefulness of mathematics? Please explain why.

6.  
a) In general, do you think you have a motivation in mathematics? 
b) What factors do you think most contributed to your motivation in mathematics? Please explain why.

7. Answer the following questions from your personal point of view: 
a) Overall, do you believe that your geographical region has influenced your current attitude toward mathematics? (Clarify your answer). 
b) Overall, do you believe that the type of your high school has influenced your current attitude toward mathematics? (Clarify your answer). 
c) Overall, do you believe that your parents’ educational levels have influenced your current attitude toward mathematics? (Clarify your answer). 
d) Overall, do you believe that your parents’ career types have influenced your current attitude toward mathematics? (Clarify your answer).

Summary  
The relationship between freshman engineering students’ demographic characteristics and their attitude toward mathematics was measured in this study. A survey that was developed and validated by Fennema and Sherman (1976) was used in this study to answer the research questions. This survey included two parts, which were seven items about the demographic characteristics and 60 items about
students’ attitudes toward mathematics. This design helped the researcher to determine if there was a significant relationship between the demographic characteristics and the students’ attitudes toward mathematics among the selected population of students. Also, there was an interview to collect qualitative data from 26 participants in order to validate the findings from the survey and obtain deep and detailed explanations about participants’ attitudes. The results of this study can provide teachers and other educators with information concerning methods that should be included in instruction in order to help students succeed in mathematics.
Chapter Four
Results

Introduction

The purpose of this research was to provide quantitative and qualitative data that could help measure and understand the relationship between the attitudes toward mathematics among freshman engineering students and their demographic characteristics at Imam Abdulrahman Bin Faisal University (IAU) in Saudi Arabia. As a result, parents, other researchers, educators, and administrators may have a better understanding of their students’ learning style, and also be able to determine and meet the engineering students’ needs in learning mathematics through improving their programs of study.

In this study, five of the nine domain scales of the Fennema-Sherman Mathematics Attitude scales (FSMA) were used. Each scale contains twelve statements in a five-point Likert format. Six statements’ words were designated positively and six other statements used words designated negatively. Opinions were indicated as follows: 1 = strongly disagree; 2 = disagree; 3 = not sure; 4 = agree; and 5 = strongly agree for the positively stated statements, and 5 = strongly disagree; 4 = disagree; 3 = not sure; 2 = agree; and 1 = strongly agree, for the negatively stated statements. A total of 157 surveys were administered to engineering students who enrolled in calculus 1 classes at the IAU. All surveys were completed to make a sample size of a hundred and fifty seven (N = 157).
This chapter is organized into the following sections: description of sample, descriptive statistics, preparing the data sets, analysis of research questions, interview protocol, and chapter summary.

**Description of Sample**

Table 6 indicates the information regarding the students’ nationality in the current study. All of the participants were over 18 years old. The students were 157 participants, 91.7% of them Saudi and 8.3% of them non-Saudi. All the students that participated in this study were undergraduate male students in the first year of an engineering major.

<table>
<thead>
<tr>
<th>Nationality</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saudi</td>
<td>144</td>
<td>91.7%</td>
</tr>
<tr>
<td>Non-Saudi</td>
<td>13</td>
<td>8.3%</td>
</tr>
<tr>
<td>Total</td>
<td>157</td>
<td>100%</td>
</tr>
</tbody>
</table>

Listed in Table 7 are the geographical regions for participants’ residence in Saudi Arabia, and the type of high school from which they graduated. Eighty-nine point eight percent (89.8%) of the students were from the eastern region, and 10.2% were from outside of the eastern region. The majority of the students,
70.7%, indicated that they had attended public school, while the other students, 29.3%, indicated that they attended a private high school.

Table 7

*Geographical Region, School Type*

<table>
<thead>
<tr>
<th>Geographical region</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern region</td>
<td>141</td>
<td>89.8%</td>
</tr>
<tr>
<td>Non-Eastern region</td>
<td>16</td>
<td>10.2%</td>
</tr>
<tr>
<td>School type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public school</td>
<td>111</td>
<td>70.7%</td>
</tr>
<tr>
<td>Private school</td>
<td>46</td>
<td>29.3%</td>
</tr>
</tbody>
</table>

Table 8 displays the educational level of the parents. The majority of the fathers’ educational level, 47.1%, was indicated as undergraduate, followed by high school (29.3%), less than high school (15.3%), and graduate (8.3%). The majority of the mothers, 47.7%, had undergraduate degrees, followed by high school (35.7%), and less than high school (16.6%), which was very much in the minority.
### Table 8

*Parents’ Educational Levels*

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fathers’ educational levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>24</td>
<td>15.3%</td>
</tr>
<tr>
<td>High school</td>
<td>46</td>
<td>29.3%</td>
</tr>
<tr>
<td>Undergraduate</td>
<td>74</td>
<td>47.1%</td>
</tr>
<tr>
<td>Graduate</td>
<td>13</td>
<td>8.3%</td>
</tr>
<tr>
<td>Mothers’ educational levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>26</td>
<td>16.6%</td>
</tr>
<tr>
<td>High school</td>
<td>56</td>
<td>35.7%</td>
</tr>
<tr>
<td>Undergraduate</td>
<td>75</td>
<td>47.7%</td>
</tr>
</tbody>
</table>

Table 9 describes the career types of the parents. The majority of the fathers’ career types, 32.5%, indicated that they worked for companies, followed by the field of education (17.2%), other (16.6%), engineering (11.5%), self-employed (11.5%), and military (10.7%). At the same time, the majority of the mothers’ career types, 54.8%, indicated that they were housewives, followed by education (38.2%), and other (7%), which was the lowest percentage of mothers’ careers.
Table 9

Parent’s career types

<table>
<thead>
<tr>
<th></th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fathers’ career types</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td>18</td>
<td>11.5%</td>
</tr>
<tr>
<td>Education</td>
<td>27</td>
<td>17.2%</td>
</tr>
<tr>
<td>Military</td>
<td>17</td>
<td>10.7%</td>
</tr>
<tr>
<td>Self-employed</td>
<td>18</td>
<td>11.5%</td>
</tr>
<tr>
<td>Company employees</td>
<td>51</td>
<td>32.5%</td>
</tr>
<tr>
<td>Other</td>
<td>26</td>
<td>16.6%</td>
</tr>
<tr>
<td><strong>Mothers’ career types</strong></td>
<td></td>
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<tr>
<td>Education</td>
<td>60</td>
<td>38.2%</td>
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<tr>
<td>Housewife</td>
<td>86</td>
<td>54.8%</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
<td>7%</td>
</tr>
</tbody>
</table>

Descriptive Statistics

Table 10 provides descriptive statistics for the mean scores for the five attitude scales (The Attitude Toward Success in Mathematics Scale (Success), The Confidence in Learning Mathematics Scale (Confidence), The Mathematics Anxiety Scale (Anxiety), The Mathematics Usefulness Scale (Usefulness), and The Effectance Motivation Scale in Mathematics (Motivation)). The maximum possible mean score is 60, and the minimum possible mean score is 12. A higher score is considered a more positive attitude toward mathematics, and a lower score is considered a more negative attitude. The results showed that Usefulness (M = 51.15) received the highest score, followed by Success (M = 51.10), Confidence
(M = 45.32), Motivation (M = 43.08), and Anxiety (M = 39.92), which received the lowest score.

Table 10

The Descriptive Statistics of Scales

<table>
<thead>
<tr>
<th>Scale</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success</td>
<td>157</td>
<td>51.10</td>
<td>5.504</td>
<td>35</td>
<td>60</td>
</tr>
<tr>
<td>Confidence</td>
<td>157</td>
<td>45.32</td>
<td>8.49</td>
<td>22</td>
<td>60</td>
</tr>
<tr>
<td>Anxiety</td>
<td>157</td>
<td>39.92</td>
<td>10.223</td>
<td>14</td>
<td>60</td>
</tr>
<tr>
<td>Usefulness</td>
<td>157</td>
<td>51.15</td>
<td>7.586</td>
<td>28</td>
<td>60</td>
</tr>
<tr>
<td>Motivation</td>
<td>157</td>
<td>43.08</td>
<td>7.604</td>
<td>21</td>
<td>60</td>
</tr>
</tbody>
</table>

For more details, Table 10 indicates that the freshman engineering students at IAU reported the highest mean with reference to their awareness of the usefulness of mathematics (M=51.15), and their attitudes toward success in mathematics (M=51.10). This table also illustrates that the participants showed a high mean with reference to their confidence in learning mathematics (M=45.32), and their motivation (M=45.32). Additionally, results shown on Table 10 revealed that the freshman engineering students felt less positive with reference to their mathematics anxiety (M=39.92).
Preparing The Data Sets

Encoding the Nominal Variables

There were seven demographic factors (nationality, geographical region, school type, fathers’ educational levels, mothers’ educational levels, fathers’ career types, and mothers’ career types) that were collected using nominal scales in the current study. All these factors were coded using dummy coding to convert the nominal variables to a numerical data suitable for multiple leaner regression (MR) analysis. This kind of coding assigns each factor a new value, either zero or one (0, 1), for each coded variable. The new number of the variables will be transfer to the number of categorical variables minus one (K-1). For example, nationality represented two categories, either Saudi or Non-Saudi. Therefore, there was only one new coded variable was created, as follows: 1= Saudi and 0 = Non-Saudi. Even though the geographical region had five possible categories (Northern, Southern, Eastern, Western, Central), four geographical groups were combined because of their small size, and the new group was named Non-Eastern region. Similarly, mothers’ career types contained nine possible categories (heath care, law, engineering, education, military, self-employed, company employees, housewife, and other); however, only three new coded variables were created because three categories were empty, and four more categories were combined because of their small size. Table 11 shows the final dummy coding for all nominal variables.
Table 11

The final Dummy Coding Scheme for Nominal Variables Included in MR Analyses

<table>
<thead>
<tr>
<th>Variables</th>
<th>N</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4a</th>
<th>X4b</th>
<th>X4c</th>
<th>X5a</th>
<th>X5b</th>
<th>X6a</th>
<th>X6b</th>
<th>X6c</th>
<th>X6d</th>
<th>X6e</th>
<th>X7a</th>
<th>X7b</th>
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<td>1. Nationality</td>
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<td></td>
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<tr>
<td>Non-Saudi</td>
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<td>2. Geographic Regions</td>
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<tr>
<td>Eastern region</td>
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<td>3. School Type</td>
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<td>X6c</td>
<td>X6d</td>
<td>X6e</td>
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<td><strong>5. Mother’s Education</strong></td>
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<tr>
<td><strong>6. Father’s Career</strong></td>
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</tr>
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<td>Education</td>
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</tr>
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<td>Self-employed</td>
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</tr>
<tr>
<td>Company employees</td>
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<td>1</td>
<td>0</td>
<td></td>
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<tr>
<td><strong>7. Mother’s Career</strong></td>
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<td>Education</td>
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<tr>
<td>Housewife</td>
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</tr>
</tbody>
</table>
**Outlier Analysis**

Outliers in statistics are a set of points that do not fit the rest of the points. In order to diagnose data problems regarding outliers, it is necessary to test the following values: the value of the Studentized Residual (Stud. Residual) to check the distance; the Leverage Value to check the leverage; and the value of Cook’s D to check the influence (Cohen et al., 2003). According to Cohen et al. (2003), the value of the Stud. Residual must be between – 3 to + 3 for a large N. The value of the leverage must not be greater than $\frac{2k}{N}$ for a large N. The value of the Cook’s D must not be greater than 1. The existence of outliers in regression analysis causes erroneous results and analysis. Thus, researchers should take appropriate remedial actions in order to predict the right regression results. This study revealed that all the Research Questions did not have any outliers except Research Question 2.

Table 12 shows the outlier analysis of Research Question 2 based on the Studentized Residual. These outliers were removed from the dataset before running the multiple linear regression analysis.

Table 12

*Outlier Analyses for Research Question 2 (N =157)*

<table>
<thead>
<tr>
<th>Value of Stud. Residual</th>
<th>Number of Outliers</th>
<th>Outliers’ IDs Removed</th>
<th>Final (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>–3.464</td>
<td>2</td>
<td>50, 103</td>
<td>155</td>
</tr>
</tbody>
</table>
Regression Assumptions

A multiple linear regression (MR) was used to test the research questions in the current study. According to Cohen et al. (2003) and Keith (2014), there are some important assumptions that must be met in order to get correct results for the relationship between the independent variables (IVs) and the dependent variable (DV) when using MR. The following MR’s assumptions were checked in this study before running the MR procedure: (1) Linearity (linear relationships between each DVs and IVs) was met by checking the Scatterplot; (2) Normality (the DV is normally distributed) was met by checking the histogram; (3) absence of Outliers was checked and met (see the previous section) by using the Studentized Residual, Cook’s D, and the Leverage Value; (4) absence of the high Multicollinearity was met by checking Tolerance and VIF; (5) Homoscedasticity was met by checking the Scatterplot; (6) Independent errors (residuals are independent of one another) were met by checking the Durbin-Waston; (7) Normality of residuals was met by checking the Scatterplot. Hence, all the MR’s assumptions were satisfied in this study.

Analysis of Research Questions

Research data was collected from the two-part survey: the demographic characteristics, and the attitude toward mathematics scales. Additionally, 26 freshman engineering students who responded to the survey were interviewed in this study.
**Research Question 1**

Research Question 1 states: “What is the relationship between students’ demographic characteristics and their attitude toward success in mathematics?”

Multiple linear regression is a common method used to describe the relationship between a set of independent variables (e.g., demographic factors) and a dependent variable. The results of this multiple regression analysis illustrated that the model was statistically significant, as shown in Table 13. The overall $R^2$ value for this model was $0.192$, $F(15, 141) = 2.234$, $p < .05$. Thus, the null hypothesis was rejected ($H_{o1} = 0$), and the alternative hypothesis was accepted indicating that there is a significant relationship between students’ demographic characteristics and their attitude toward success in mathematics ($H_{a1} \neq 0$).

<table>
<thead>
<tr>
<th>Table 13</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall Result for Research Question 1 ($N = 157$)</strong></td>
</tr>
<tr>
<td>$R^2$</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>$0.192$</td>
</tr>
</tbody>
</table>

Within this model, fifteen independent variables explained only $19.2\%$ ($R^2 = 0.192$) of the variance in freshman engineering students’ attitudes toward success in mathematics ($DV_1$). Of those 15 variables, three variables made a statistically significant contribution to this model. One was the Saudi nationality ($t = -2.266$, $p = 0.025$). Two were in the fathers’ career types: Education ($t = 2.999$, $p = 0.003$) and
Company Employees ($t = 2.468, p = .015$). See Table 14 for more details. Hence, the prediction equation for Research Question 1 was:

$$\hat{Y}_1 = 51.503 - 3.724X1 + .734X2 - .252X3 + 1.781X4a - 1.129X4b + .057X4c + 1.615X5a + .529X5b + 3.286X6a + 5.309X6b + 2.866X6c + 3.690X6d + .817X6e + .478X7a - 2.564X7b.$$

Table 14

*Results of Multiple Regression Analysis for Research Question 1 (N = 157)*

<table>
<thead>
<tr>
<th>IVs</th>
<th>B</th>
<th>$\beta$</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>51.503</td>
<td>14.433</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td><strong>Nationality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi (X1)</td>
<td>-3.724</td>
<td>-.187</td>
<td>-2.266</td>
<td>.025*</td>
</tr>
<tr>
<td><strong>Geographical region</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Eastern region (X2)</td>
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<td>.040</td>
<td>.501</td>
<td>.617</td>
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<td><strong>School type</strong></td>
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</tr>
<tr>
<td>Public school (X3)</td>
<td>- .252</td>
<td>-.021</td>
<td>- .256</td>
<td>.799</td>
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<tr>
<td><strong>Fathers’ educational levels</strong></td>
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<tr>
<td>Fathers’ Less than high school (X4a)</td>
<td>1.781</td>
<td>.117</td>
<td>.880</td>
<td>.380</td>
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<tr>
<td>Fathers’ High school (X4b)</td>
<td>-1.129</td>
<td>-.094</td>
<td>-.615</td>
<td>.540</td>
</tr>
<tr>
<td>Fathers’ Undergraduate (X4c)</td>
<td>.057</td>
<td>.005</td>
<td>.035</td>
<td>.972</td>
</tr>
<tr>
<td><strong>Mothers’ educational levels</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mothers’ High school (X5a)</td>
<td>1.615</td>
<td>.141</td>
<td>1.242</td>
<td>.216</td>
</tr>
</tbody>
</table>
## Mothers’ Career Types

<table>
<thead>
<tr>
<th>Mother's Career Type</th>
<th>Mean</th>
<th>SD 1</th>
<th>SD 2</th>
<th>SD 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate (X5b)</td>
<td>0.529</td>
<td>0.048</td>
<td>0.322</td>
<td>0.748</td>
</tr>
</tbody>
</table>

## Fathers’ Career Types

<table>
<thead>
<tr>
<th>Father's Career Type</th>
<th>Mean</th>
<th>SD 1</th>
<th>SD 2</th>
<th>SD 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering (X6a)</td>
<td>3.286</td>
<td>0.191</td>
<td>1.676</td>
<td>0.096</td>
</tr>
<tr>
<td>Education (X6b)</td>
<td>5.309</td>
<td>0.365</td>
<td>2.999</td>
<td>0.003**</td>
</tr>
<tr>
<td>Self-employed (X6c)</td>
<td>2.866</td>
<td>0.166</td>
<td>1.557</td>
<td>0.122</td>
</tr>
<tr>
<td>Company employees (X6d)</td>
<td>3.690</td>
<td>0.315</td>
<td>2.468</td>
<td>0.015*</td>
</tr>
<tr>
<td>Other (X6e)</td>
<td>0.817</td>
<td>0.055</td>
<td>0.473</td>
<td>0.637</td>
</tr>
</tbody>
</table>

## Mothers’ Career Types

<table>
<thead>
<tr>
<th>Mother’s Career Type</th>
<th>Mean</th>
<th>SD 1</th>
<th>SD 2</th>
<th>SD 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education (X7a)</td>
<td>0.478</td>
<td>0.042</td>
<td>0.262</td>
<td>0.794</td>
</tr>
<tr>
<td>Housewife (X7b)</td>
<td>-2.564</td>
<td>-0.233</td>
<td>-1.493</td>
<td>0.138</td>
</tr>
</tbody>
</table>

*Note.* *p*<.05, **p**<.005. The variables that coded as 0 were: Nationality (Non-Saudi = 0), Geographical Region (Non-Eastern region = 0), School Type (Private School = 0), Fathers’ Educational Levels (Graduate = 0), Mothers’ Educational Levels (Less than high school = 0), Fathers’ Career Types (Military = 0), and Mothers’ Career Types (Other = 0).

According to the multiple regression analysis, the Saudi nationality (X1) indicated that there is a negative relationship with attitude toward success in mathematics. In other words, Saudi freshman engineering students’ attitudes toward success in mathematics were 3.724 points lower than Non-Saudi freshman engineering students. Also, from the regression analysis results there is a positive relationship between the freshman engineering students’ attitudes toward success in mathematics and their fathers’ career type (Education). The effect of students whose fathers work in the educational field (X6b) on their children’s attitude...
toward success in mathematics was 5.309 points higher than students whose fathers work in the military, which is also 1.619 points higher than students whose fathers work in companies. Additionally, the results illustrated that there is a positive relationship between the freshman engineering students’ attitudes toward success in mathematics and their fathers’ career type (Company employees). The effect on their children’s attitude toward success in mathematics of fathers working in the company field ($X6d$) was 3.690 points higher than for students whose fathers work in the military; however, it was 1.619 points lower than for students whose fathers work in the education.

**Research Question 2**

Research Question 2 states: “What is the relationship between students’ demographic characteristics and their confidence in learning mathematics?”

Multiple linear regression was used to describe the relationship between a set of independent variables (students’ demographic factors) and a dependent variable. The results of this multiple regression analysis indicated that the model was statistically significant, as shown in Table 15. The overall $R^2$ value for this model was .268, $F(15,139) = 3.401, p < .001$. Thus, the null hypothesis was rejected ($H_{02} = 0$), and the alternative hypothesis was accepted, revealing that there is a significant relationship between students’ demographic characteristics and their confidence in learning mathematics ($H_{a2} 
eq 0$).
Within this model, fifteen independent variables explained only 26.8% \( (R^2 = .268) \) of the variance in freshman engineering students’ confidence in learning mathematics \( (DV_2) \). Of those 15 variables, six variables were found to be statistically significant. One was the Eastern geographical region \( (t = 2.474, p = .015) \). One was the mothers’ educational levels: Undergraduate \( (t = -3.289, p = .001) \). Three were in the fathers’ career types: Engineering \( (t = 2.657, p = .009) \), Education \( (t = 2.969, p = .004) \), and Self-employed \( (t = 2.354, p = .02) \). Finally, one was in the mothers’ career types: Education \( (t = 2.069, p = .04) \). See Table 16 for more details. Therefore, the prediction equation for Research Question 2 was:

\[
\hat{Y}_2 = 45.469 - 2.466X1 + 5.151X2 + 1.343X3 - 3.653X4a - 4.532X4b - 2.526X4c - 1.491X5a - 7.663X5b + 7.494X6a + 7.508X6b + 6.148X6c + 1.495X6d + 2.766X6e + 5.371X7a - 3.106X7b.
\]
### Table 16

**Results of Multiple Regression Analysis for Research Question 2 (N =155)**

<table>
<thead>
<tr>
<th>IVs</th>
<th>B</th>
<th>β</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant</strong></td>
<td>45.469</td>
<td>8.962</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td><strong>Nationality</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi (X1)</td>
<td>–2.466</td>
<td>–.084</td>
<td>–1.056</td>
<td>.293</td>
</tr>
<tr>
<td><strong>Geographical region</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern region (X2)</td>
<td>5.151</td>
<td>.192</td>
<td>2.474</td>
<td>.015*</td>
</tr>
<tr>
<td><strong>School type</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public school (X3)</td>
<td>1.343</td>
<td>.075</td>
<td>.955</td>
<td>.341</td>
</tr>
<tr>
<td><strong>Fathers’ educational levels</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fathers’ Less than high school (X4a)</td>
<td>–3.653</td>
<td>–.162</td>
<td>–1.271</td>
<td>.206</td>
</tr>
<tr>
<td>Fathers’ High school (X4b)</td>
<td>–4.532</td>
<td>–.253</td>
<td>–1.739</td>
<td>.084</td>
</tr>
<tr>
<td>Fathers’ Undergraduate (X4c)</td>
<td>–2.526</td>
<td>–.154</td>
<td>–1.084</td>
<td>.280</td>
</tr>
<tr>
<td><strong>Mothers’ educational levels</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mothers’ High school (X5a)</td>
<td>–1.491</td>
<td>–.088</td>
<td>–.808</td>
<td>.420</td>
</tr>
<tr>
<td>Mothers’ Undergraduate (X5b)</td>
<td>–7.663</td>
<td>–.468</td>
<td>–3.289</td>
<td>.001**</td>
</tr>
<tr>
<td><strong>Fathers’ career types</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fathers’ Engineering (X6a)</td>
<td>7.494</td>
<td>.287</td>
<td>2.657</td>
<td>.009*</td>
</tr>
<tr>
<td>Fathers’ Education (X6b)</td>
<td>7.508</td>
<td>.343</td>
<td>2.969</td>
<td>.004**</td>
</tr>
<tr>
<td>Fathers’ Self-employed (X6c)</td>
<td>6.148</td>
<td>.241</td>
<td>2.354</td>
<td>.020*</td>
</tr>
<tr>
<td>Fathers’ Company employees (X6d)</td>
<td>1.495</td>
<td>.086</td>
<td>.705</td>
<td>.482</td>
</tr>
</tbody>
</table>
According to the multiple regression analysis, the Eastern region (X2) indicated that there is a positive relationship with confidence in learning mathematics. In other words, confidence in learning mathematics of the freshman engineering students who belong to the Eastern region was 5.151 points higher than for the freshman engineering students who belong to other regions. Also, from the regression analysis results there is a negative relationship between the freshman engineering students’ confidence in learning mathematics and their mothers’ educational levels (Undergraduate). The effect of students whose mothers had a bachelor’s degree (X5b) on their children’s confidence in learning mathematics was 7.663 points lower than students whose mothers had less than a high school education. Additionally, the results illustrated that there is a positive relationship between the freshman engineering students’ confidence in learning mathematics and their fathers’ career type (Engineering, Education, and Self-employed). The effect on the confidence of students whose fathers work in the engineering field
(X6a) was 7.494 points higher than for students whose fathers work in the military.
Also, the effect on the confidence in learning mathematics of students whose fathers work in educational field (X6b) was 7.508 points higher than that of students whose fathers work in the military. Furthermore, the effect on the confidence of students whose fathers were self-employed (X6c) was 6.148 points higher than for students whose fathers work in the military. Finally, the findings of regression analysis showed that there is a positive relationship between the freshman engineering students’ confidence in learning mathematics and their mothers’ career type (Education). The effect on the confidence in learning mathematics of students whose mothers work in the educational field (X7a) was 5.371 points higher than that of students whose mothers work in another field but was not a housewife.

**Research Question 3**

Research Question 3 states: “What is the relationship between students’ demographic characteristics and their anxiety over mathematics?” Multiple linear regression was run to describe the relationship between a set of independent variables (students’ demographic factors) and a dependent variable. The results of this multiple regression analysis showed that the model was statistically significant, as shown in Table 17. The overall R² value for this model was .157, F (15,141) = 1.746, p < .05. Thus, the null hypothesis was rejected (H₀₃ = 0), and the alternative hypothesis was accepted, revealing that there is a significant relationship between students’ demographic characteristics and their anxiety over mathematics (Hₐ₃ ≠ 0).
Table 17

Overall Result for Research Question 3 (N = 157)

<table>
<thead>
<tr>
<th>R²</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>.157</td>
<td>1.746</td>
<td>.049</td>
</tr>
</tbody>
</table>

Within this model, fifteen independent variables explained only 15.7% (R² = .157) of the variance in freshman engineering students’ anxiety over mathematics (DV3). Of those 15 variables, two variables were found to be statistically significant. One was in the mothers’ educational levels: Undergraduate (t = −2.434, p = .016). One was in the fathers’ career types: Education (t = 2.591, p = .011). See Table 18 for more details. Therefore, the prediction equation for Research Question 3 was:

\[
\hat{Y}_3 = 39.299 - 2.595X1 + 3.257X2 + 3.460X3 - 1.954X4a - 1.924X4b + .051X4c - 1.480X5a - 7.584X5b + 6.843X6a + 8.705X6b + 4.492X6c + 2.759X6d + 2.906X6e + 1.859X7a - 4.143X7b.
\]
Table 18

*Results of Multiple Regression Analysis for Research Question 3 (N = 157)*

<table>
<thead>
<tr>
<th>IVs</th>
<th>B</th>
<th>β</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>39.299</td>
<td>5.804</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>Nationality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi (X1)</td>
<td>− 2.595</td>
<td>− .070</td>
<td>− .832</td>
<td>.407</td>
</tr>
<tr>
<td>Geographical region</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern region (X2)</td>
<td>3.257</td>
<td>.097</td>
<td>1.171</td>
<td>.243</td>
</tr>
<tr>
<td>School type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public school (X3)</td>
<td>3.460</td>
<td>.155</td>
<td>1.849</td>
<td>.066</td>
</tr>
<tr>
<td>Fathers’ educational levels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fathers’ Less than high school (X4a)</td>
<td>− 1.954</td>
<td>− .069</td>
<td>− .509</td>
<td>.612</td>
</tr>
<tr>
<td>Fathers’ high school (X4b)</td>
<td>− 1.924</td>
<td>− .086</td>
<td>− .552</td>
<td>.582</td>
</tr>
<tr>
<td>Fathers’ Undergraduate (X4c)</td>
<td>.051</td>
<td>.003</td>
<td>.016</td>
<td>.987</td>
</tr>
<tr>
<td>Mothers’ educational levels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mothers’ High school (X5a)</td>
<td>− 1.480</td>
<td>− .070</td>
<td>− .600</td>
<td>.550</td>
</tr>
<tr>
<td>Mothers’ Undergraduate (X5b)</td>
<td>− 7.584</td>
<td>− .372</td>
<td>− 2.434</td>
<td>.016*</td>
</tr>
<tr>
<td>Fathers’ career types</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fathers’ Engineering (X6a)</td>
<td>6.843</td>
<td>.214</td>
<td>1.839</td>
<td>.068</td>
</tr>
<tr>
<td>Fathers’ Education (X6b)</td>
<td>8.705</td>
<td>.322</td>
<td>2.591</td>
<td>.011*</td>
</tr>
<tr>
<td>Fathers’ Self-employed (X6c)</td>
<td>4.492</td>
<td>.140</td>
<td>1.286</td>
<td>.201</td>
</tr>
<tr>
<td>Fathers’ Company employees (X6d)</td>
<td>2.759</td>
<td>.127</td>
<td>.973</td>
<td>.332</td>
</tr>
</tbody>
</table>
Fathers’ Other \((X6e)\) & 2.906 & .106 & .887 & .377 \\

**Mothers’ career types** \\
Mothers’ Education \((X7a)\) & 1.859 & .089 & .537 & .592 \\
Mothers’ Housewife \((X7b)\) & -4.143 & -.202 & -1.272 & .206 \\

*Note. \(*p<.05. \) The variables that coded as 0 were: Nationality (Non-Saudi = 0), Geographical Region (Non-Eastern region = 0), School Type (Private School = 0), Fathers’ Educational Levels (Graduate = 0), Mothers’ Educational Levels (Less than high school = 0), Fathers’ Career Types (Military = 0), and Mothers’ Career Types (Other = 0).*

According to the multiple regression analysis, there is a negative relationship between the freshman engineering students’ anxiety over mathematics and their mothers’ educational level (Undergraduate). The effect on students’ mathematics anxiety of mothers holding a bachelor’s degree \((X5b)\) was 7.584 points lower than students whose mothers had less than high school education. Also, the results of regression analysis reported there is a positive relationship between the freshman engineering students’ anxiety over mathematics and their fathers’ career type (Education). The effect on students’ mathematics anxiety of fathers who work in the educational field \((X6b)\) was 8.705 points higher than for students whose fathers work in the military.

**Research Question 4**

Research Question 4 states: “What is the relationship between students’ demographic characteristics and their awareness of the usefulness of mathematics?” Multiple linear regression was used to study the relationship between a set of
independent variables (students’ demographic factors) and a dependent variable. The results of this multiple regression analysis confirmed that the model was statistically significant, as shown in Table 19. The overall $R^2$ value for this model was .17, $F(15,141) = 1.928$, $p < .05$. Thus, the null hypothesis was rejected ($H_{04} = 0$), and the alternative hypothesis was accepted, revealing that there is a significant relationship between students’ demographic characteristics and the usefulness of mathematics to the students ($H_{a4} \neq 0$).

Table 19

| Overall Result for Research Question 4 ($N = 157$) |
|------|------|------|
| $R^2$ | F    | P    |
| .17  | 1.928| .025 |

Within this model, fifteen independent variables explained only 17% ($R^2 = .17$) of the variance in freshman engineering students’ awareness of the usefulness of mathematics (DV$_4$). Of those 15 variables, three variables were found to be statistically significant. Three were in the fathers’ career types: Engineering ($t = 3.089$, $p = .002$), Education ($t = 2.000$, $p = .047$), and Self-employed ($t = 2.135$, $p = .035$). See Table 20 for more details. Therefore, the prediction equation for Research Question 4 was:

$$\hat{Y}_4 = 48.927 - 1.323X1 + 3.970X2 + .248X3 - 3.178X4a - 2.359X4b - 2.140X4c - .483X5a - 3.150X5b + 8.462X6a + 4.946X6b + 5.489X6c + 2.907X6d + 2.850X6e + 2.659X7a - 2.410X7b.$$
Table 20

Results of Multiple Regression Analysis for Research Question 4 (N = 157)

<table>
<thead>
<tr>
<th>IVs</th>
<th>B</th>
<th>β</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>48.927</td>
<td>9.815</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>Nationality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saudi (X1)</td>
<td>−1.323</td>
<td>−.048</td>
<td>−.576</td>
<td>.565</td>
</tr>
<tr>
<td>Geographical region</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern region (X2)</td>
<td>3.970</td>
<td>.159</td>
<td>1.940</td>
<td>.054</td>
</tr>
<tr>
<td>School type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public school (X3)</td>
<td>.248</td>
<td>.015</td>
<td>.180</td>
<td>.858</td>
</tr>
<tr>
<td>Fathers’ educational levels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fathers’ Less than high school (X4a)</td>
<td>−3.178</td>
<td>−.151</td>
<td>−1.124</td>
<td>.263</td>
</tr>
<tr>
<td>Fathers’ High school (X4b)</td>
<td>−2.359</td>
<td>−.142</td>
<td>−.919</td>
<td>.359</td>
</tr>
<tr>
<td>Fathers’ Undergraduate (X4c)</td>
<td>−2.140</td>
<td>−.141</td>
<td>−.934</td>
<td>.352</td>
</tr>
<tr>
<td>Mothers’ educational levels</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mothers’ High school (X5a)</td>
<td>−.483</td>
<td>−.031</td>
<td>−.266</td>
<td>.791</td>
</tr>
<tr>
<td>Mothers’ Undergraduate (X5b)</td>
<td>−3.150</td>
<td>−.208</td>
<td>−1.373</td>
<td>.172</td>
</tr>
<tr>
<td>Fathers’ career types</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fathers’ Engineering (X6a)</td>
<td>8.462</td>
<td>.357</td>
<td>3.089</td>
<td>.002**</td>
</tr>
<tr>
<td>Fathers’ Education (X6b)</td>
<td>4.946</td>
<td>.247</td>
<td>2.000</td>
<td>.047*</td>
</tr>
<tr>
<td>Fathers’ Self-employed (X6c)</td>
<td>5.489</td>
<td>.231</td>
<td>2.135</td>
<td>.035*</td>
</tr>
<tr>
<td>Fathers’ Company employees (X6d)</td>
<td>2.907</td>
<td>.180</td>
<td>1.392</td>
<td>.166</td>
</tr>
</tbody>
</table>
According to the multiple regression analysis, there is a positive relationship between the freshman engineering students’ awareness of the usefulness of mathematics and their fathers’ career type (Engineering, Education, and Self-employed). The effect on students’ awareness of the usefulness of mathematics was 8.462 points higher if their fathers work in the engineering field \((X6a)\) than if their fathers work in the military. Also, the effect on students’ understanding of the usefulness of mathematics was 4.946 points higher for those with fathers working in the educational field \((X6b)\) than for students whose fathers work in the military. Furthermore, the effect on students’ realization of the usefulness of mathematics was 5.489 points higher for those whose fathers were self-employed \((X6c)\) than for students whose fathers work in the military.

**Research Question 5**

Research Question 5 states: “What is the relationship between students’ demographic characteristics and their effectance motivation in mathematics?”
Multiple linear regression was run to investigate the relationship between a set of independent variables (students’ demographic factors) and a dependent variable. The results of this multiple regression analysis showed that the model was statistically significant, as shown in Table 21. The overall $R^2$ value for this model was .223, $F(15,141) = 2.698, p < .005$. Thus, the null hypothesis was rejected ($H_{o5}= 0$), and the alternative hypothesis was accepted, revealing that there is a significant relationship between students’ demographic characteristics and their effectance motivation in mathematics ($H_{a5}≠ 0$).

Table 21

<table>
<thead>
<tr>
<th>Overall Result for Research Question 5 (N =157)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R^2$</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>.223</td>
</tr>
</tbody>
</table>

Within this model, fifteen independent variables explained only 22.3% ($R^2 = .223$) of the variance in freshman engineering students’ effectance motivation in mathematics ($DV_5$). Of those 15 variables, three variables were found to be statistically significant. Three were in the fathers’ career types: Engineering ($t = 3.018, p = .003$), Education ($t = 3.415, p = .001$), and Self-employed ($t = 3.274, p = .001$). See Table 22 for more details. Thus, the prediction equation for Research Question 5 was:
\[
Y_5 = 39.928 + .556X1 + .905X2 + 2.438X3 - 4.048X4a - 2.430X4b - \\
1.730X4c + 1.475X5a - 2.721X5b + 8.017X6a + 8.191X6b + 8.164X6c + 3.738X6d \\
+ 1.947X6e + .507X7a - 3.589X7b. 
\]

Table 22

*Results of Multiple Regression Analysis for Research Question 5 (N = 157)*

<table>
<thead>
<tr>
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**Fathers’ career types**

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**Mothers’ career types**

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*Note. **p < .005. The variables that coded as 0 were: Nationality (Non-Saudi = 0), Geographical Region (Non-Eastern region = 0), School Type (Private School = 0), Fathers’ Educational Levels (Graduate = 0), Mothers’ Educational Levels (Less than high school = 0), Fathers’ Career Types (Military = 0), and Mothers’ Career Types (Other = 0).*

According to the multiple regression analysis, there is a positive relationship between the freshman engineering students’ motivation in mathematics and their fathers’ career types (Engineering, Education, and Self-employed). The effect on students’ motivation was 8.017 points higher for those whose fathers work in the engineering field (X6a) than for students whose fathers work in the military. Also, the effect on students’ motivation in mathematics was 8.191 points higher for those whose fathers work in the educational field (X6b) than for students whose fathers work in the military. Furthermore, the effect on students’ motivation
was 8.164 points higher for those whose fathers were self-employed ($X6c$) than for students whose fathers work in the military.

**Findings of the Interviews**

Once the survey was collected, the researcher contacted the students for an open-ended interview. After three rounds of tries to convince the students to participate, only 26 of the freshman engineering students who completed the survey agreed to meet and answer the interview questions. All the participants were over 18 years old and enrolled at Imam Abdulrahman Bin Faisal University (IAU). Audio recording was used to save each interview in order to help the researcher to analyze the data. Fictional names were used when referencing students. Any quotes that were recorded in this study regarding the results of the interviews were taken verbatim from the audio recording in order to provide the reader the most accurate answer of each student. The researcher created a matrix of open coding from keywords attached to each answer of the interviewers (see Appendix I). The matrix contains 26 rows to represent the participants, and 7 columns to represent the questions in the interview. Additionally, in order to establish credibility, the analyzed interview data was reviewed by two professors from Saudi Arabia, and they recommended a few minor amendments. All their recommendations were taken into consideration.
**Interview Question 1: Factors and Current Attitude**

The interview discussions helped the researcher to explore the students’ ideas about the survey’s questions in greater depth. Analysis of the responses to the first interview question revealed that all students had either positive or neutral attitudes toward mathematics. The reasons for their positive attitudes revolved around three major themes: (1) Teacher’s positive characteristics, (2) Parental support, (3) Practice and preparation. One student answered that his teacher had the strongest impact on his attitude toward mathematics. He was very glad that his high school mathematics teacher was patient and helpful and always used a joke in teaching.

At the same time, the reasons for their neutral attitudes revolved around four major themes: (1) Teacher’s negative characteristics, (2) Assessments and grades, (3) English language effect, and (4) Time management. Some participants answered that exam grades were one major reason why they were afraid of mathematics. One of them confirmed that he used to love mathematics and complained that mathematics assessments caused him to waste his time and efforts in high school. Figure 2 and Figure 3 show the justification for the opinions provided by the participants based on their attitudes.
Figure 2: Themes and factors that contribute to the positive attitude

Teacher’s positive characteristics
Parental support
Practice and preparation

Positive Attitude

Figure 3: Themes and factors that contribute to the neutral attitude

Teacher’s negative characteristics
Assessments and grades
English language effect
Time management

Neutral Attitude
Factors of positive attitude

Teacher’s positive characteristics. Even though this factor was not listed among those used to analyze the survey results, it has shed light on how students believed their attitudes toward mathematics are shaped, and who they feel forms their attitudes. Thirteen participants mentioned that teacher characteristics had a strong influence on their attitudes toward mathematics. They indicated that their attitudes toward mathematics could change with different teachers. Student comments used some personal characteristics of the teacher (nice, strict, funny, willing to help, caring) to illustrate how these characteristics increase their positive attitudes. For example, Mohammed had always struggled with mathematics in elementary school and felt his middle school mathematics teacher played a major role in his positive attitude.

Mohammed stated that:

I had thought I never understood mathematics when I was in elementary school. Until I met a nice math teacher in middle school who changed my mind and made me feel that I could learn. The first time I took the full mark in mathematics exam was in his class. He was credited with my love of mathematics and my trust in myself (Mohammed A., personal interview, September 12, 2018).

Also, Sultan recalled his experience with his mathematics teachers, and explained how his mathematics attitude has been changed because of his teachers.
Sultan said that:
In elementary school, I loved mathematics because I had a teacher that really tried to make me understand. His class was so fun and active. But, in middle school, I had a boring teacher who taught me for three years. He just stood at the board and kept writing, and at the end of the class he gave us many questions as homework. I hate mathematics because of him. Fortunately, my mathematics teachers in high school were really helpful. I was so lucky they were very supportive for the whole year. They always opened the discussion, listened to my questions, and were patient with my mistakes. I can’t work when the teachers are not nice. It is very difficult (Sultan W., personal interview, November 29, 2018).

**Parental support.** The second major reason for the positive attitudes of freshman engineering students toward mathematics was parental support. Nine participants explained that parents, especially fathers, had a direct influence in their love of mathematics. The father’s discussion with his children and showing how much he liked mathematics had a great impact on the children’s attitudes. One student claimed that his father had to quit school because of physical conditions; however, he always shows his love and knowledge of mathematics. His father remembered a multiplication table up to 99. So the student believes that his love for mathematics was influenced by his father’s love (Anwar G., personal interview, October 3, 2018).
The influence of the father’s work and his practice of mathematics also reflected on his children because this influence will appear in his daily life.

One participant mentioned that,

My father is an engineer and he always uses mathematics even at home. Guess what? He has written the value of $\pi$ on the wall of our living room. I dream of being an engineer like my father and using mathematics everywhere (Mustafa A., personal interview, September 17, 2018).

**Practice and preparation.** Seven participants agreed that continuous training in solving mathematics problems and giving sufficient time to study the subject was an important element in their confidence in their mathematics abilities, and it caused an improvement in their positive attitudes. Jafar stated that mathematics is a subject that needs paper and pencil. When you give it enough time to solve many different ideas for a concept, it gives you a sense of comfort and enjoyment (Jafar A., personal interview, October 3, 2018). Jafar’s thought was supported by his colleague Ali. Ali claimed that spending enough time to practice and solve mathematical problems, even if these problems were easy, will make you feel that you are able to solve the difficult ones as well, which leads you to accept mathematics and not to fear it (Ali M., personal interview, October 10, 2018).
Factors of neutral attitude

Teacher’s negative characteristics. Eleven participants discussed negative characteristics of the teacher that they felt affected their attitudes toward mathematics, such as boring, angry, impatient, and frustrated. They believed the teachers’ negative characteristics were the most important factor in their neutral attitude toward the subject. Seven of the eleven students who had neutral attitudes focused on the personal demeanor of the teacher and how it impacts their attitudes. One participant stated, “I began to hate class time because the teacher was always angry. He could not bear to see a student who did not understand the lesson” (Abdullah R., personal interview, October 9, 2018). Nine of the eleven students who had neutral attitudes emphasized the professional demeanor of the teacher. One of the participants stated, “My teacher did not help me to learn mathematics correctly. He had used simple examples in class, but he had written hard questions on the test. Really, I do not know where his questions came from” (Waleed S., personal interview, September 26, 2018).

In addition, the importance of the interaction and relationship between the teachers and their students was one of the main points that was mentioned by five of the eleven students who had neutral attitudes. The students felt that relaxed interaction with the teacher had more impact on their attitudes than other factors. One student discussed that:

I remember how my high school mathematics teacher thought that the only subject we were studying was mathematics. When we tried
to tell him that we have tasks in other subjects, he would just get
mad and give our class more homework. Imagine that he gave us
more homework every Thursday because we had the weekend. He
never respected or felt for us (Faisal R., personal interview, October
15, 2018).

**Assessments and grades.** Nine participants expressed that the grades on
the mathematics test were the cause of their current neutral attitude toward
mathematics. Mathematics has the greatest weight in an engineering major;
therefore, low grades in mathematics courses affect the student’s academic GPA.
Abdullah, along with Muslim and Nayef, conveyed this feeling. When Abdullah
was asked to describe his current attitude toward mathematics, he said, “I really
would like to say it is positive but my grades in mathematics exam makes me say
it’s a neutral attitude” (Abdullah R., personal interview, October 9, 2018).
Similarly, Mohammed said, “my attitude is neutral not because of the subject but
because of my grades in mathematics” (Muslim A., personal interview, September
12, 2018). Nayef echoed their thoughts when talking about his attitude toward
mathematics.

I do not hate mathematics but also do not love it. When I solve
problems of mathematics at home, I feel it is the most beautiful
subject. I can see the developing of my abilities. However, when the
time of the test come, I feel it a little hard to remember what I
learned. It makes me lose some points on the test, which affects my GPA (Nayef O., personal interview, October 10, 2018).

Thus, engineering students are under the pressure of maintaining good grades in mathematics.

*English language effect.* The educational system in the Kingdom of Saudi Arabia uses the Arabic language for teaching all subjects, except English. Students use the Arabic language to learn from elementary to high school in all types of schools that follow the Saudi system, whether public or private. International schools, in some cities of Saudi Arabia, have a different structure because they follow the system of countries that they originated in and use their curricula. Most Saudi students are graduating from Saudi schools. The Arabic language is used to teach from Grade 1 to Grade 12. Many of them indicated language barriers created more problems than mathematics. Students spend most of their time studying the English mathematical vocabulary instead of studying the mathematical concepts. Ten students agreed that English was an obstacle for understanding of mathematics.

One of them stated:

I spend a lot of time studying mathematics because I do not understand what the professor says in the lecture. He uses English and speaks very fast. I feel disappointed. I cannot ask any questions during the class because I did not understand what he was saying.

(Saud T., personal interview, October 11, 2018).
Some students indicated studying mathematics in Arabic would be easier. Abdulrahman said, “I wish I were studying mathematics in Arabic. I will not lose some points in the test because I did not understand the question” (Abdulrahman T., personal interview, October 3, 2018).

**Time management.** Undergraduate students must take many courses in one semester at the university, and that is one of the challenges that face new students. Learning time management skills is one of the most important skills of the university students that many universities seek to develop and teach to their students. Eight students explained that they do not designate enough time to mathematics because there are many courses they have to study for.

One student said that:

> Actually, I don’t practice to solve enough mathematical problems because I leave my college at 5 pm everyday, and I have many of the tasks in different courses that I have to finish. I do not find enough time to sit with my family, so how can I find enough time to solve many mathematical exercises? (Rashed M., personal interview, October 9, 2018).

Another student believed that the pressure of other courses affected his understanding of mathematics. Every professor considers his subject to be the most important subject. Thus, professors compete by giving many tasks and homework assignments to solve, and this affects students’ learning of mathematics (Salman N., personal interview, October 5, 2018).
Interview Question 2: Attitude Toward Success in Mathematics

All participants agreed that their attitude towards success in mathematics was positive. The reasons for their positive attitude toward success were (1) pride in themselves, followed by (2) competition with their colleagues, and (3) respect from their fathers, as shown in Figure 4. Eleven students believed that their success in mathematics made them proud of themselves. One student said, “it is a nice feeling to be mentioned in class that you have the highest score in mathematics. This makes me proud of myself” (Ibrahim A., personal interview, October 30, 2018). Additionally, success in mathematics makes a person feel intelligent. Another student mentioned that, “mathematics is a difficult subject and if you get high marks, everyone thinks you are intelligent” (Adel I., personal interview, October 22, 2018).

Figure 4: Factors that contribute to the attitude toward success in mathematics
Eight participants focused on the competition posed by success in mathematics. The student needs a strong competitor that gives him a greater incentive to continue to succeed. This competition among students makes the learning process livelier. Students compete with knowledge acquisition and demonstrate their understanding of mathematical concepts.

One participant said:

The sense of victory in the competition is the most important motivation for me to succeed in mathematics. I remember in grade 11 we were four superior students in one class. We were fighting to get the highest score. I cannot forget when I took the full mark in a mathematics test. The sense of victory was indescribable. (Abed I., personal interview, November 12, 2018).

Seven participants considered the feeling of respect from their parents, especially their fathers, to be the most important reason for their positive attitude toward success in mathematics. One participant stated that, “My main reason for me to become an engineer and to succeed in mathematics with a high grade is to see my father respect me and being proud in front of my family” (Abdul Razzaq K., personal interview, September 27, 2018).

**Interview Question 3: Confidence in Learning Mathematics**

The freshman engineering students at IAU had a high level of confidence for learning mathematics. There were only six students who did not show high confidence levels for learning mathematics, five of them saying that they had
experienced neutral confidence and only one saying that he had a low confidence level. The reasons for their different confidence levels were limited to four reasons: (1) practice and preparation, (2) assessments and grades, (3) teachers, and (4) weak mathematical foundation (see Figure 5).

![Confidence in Learning Diagram]

*Figure 5:* Factors that contribute to the confidence in learning mathematics

Twenty students suggested that their continuous practice in solving mathematical problems and sufficient time spent studying in their class resulted in their high confidence level in learning mathematics. One student of them said, “I have positive confidence for learning mathematics because I solve a lot of different problems, and these exercises increases my confidence in myself” (Shaker M., personal interview, November 27, 2018). However, five other students showed neutral confidence level in learning mathematics, blaming this on the lack of
practice. Students claimed that there was a positive relationship between practice and confidence in mathematics. If the student decreased his practicing hours, he experienced lower confidence.

One of the participants stated:

Honestly, I have a neutral confidence in learning mathematics and I am personally responsible for this imbalance because I am not diligent enough in mathematics. I only study mathematics for the exam, which reduces my confidence (Majid O., personal interview, November 16, 2018).

Twelve of the twenty students who had high confidence levels associated with mathematics believed that their high scores on mathematics tests were a second reason for their high confidence levels in regard to learning mathematics. One student said, “I usually get good grades in the mathematics test and that increases my confidence” (Fahd O., personal interview, November 29, 2018). On the contrary, four of the five students reported that mathematical test scores were the reason for neutral confidence levels. One student stated, “I study mathematics as much as I can, but my grades in mathematics testing are the cause of my current neutral confidence” (Safwan R., personal interview, December 3, 2018).

The teacher played a pivotal role in the students’ confidence level for their learning of mathematics. Nine of the twenty students who had high confidence levels associated with mathematics thought that their teachers had a positive impact on their confidence levels for the learning of mathematics.
One participant stated:

I have high confidence in learning mathematics from middle school until now because of my wonderful teacher, Jamil Albasri. In his class, I saw mathematics as an easy subject. He increased my confidence by his way of teaching and his ethics (Hassan R., personal interview, November 2, 2018).

In contrast, three of the five students who had neutral confidence levels associated with mathematics reported that the teacher was the cause of their neutral confidence levels. One student said, “I think the reason for my current confidence is my professor. He does not explain well and this makes me consume more time in understanding the curriculum” (Abdul eIlah H., personal interview, December 3, 2018).

Of the 26 students interviewed, there was only one student with a low confidence level for learning mathematics. His confidence level was based on a weak mathematical foundation. This weakness makes him less involved in the classroom and weak in problem solving. Because of that weakness, he always checks his answers from many websites and always asks his classmates to see their solutions (Mutaeib S., personal interview, November 1, 2018).

**Interview Question 4: Mathematics Anxiety**

The freshman engineering students were divided into two groups when they were asked about their anxiety in mathematics. Thirteen students believed they had mathematical anxiety, while thirteen other students believed they did not have
mathematical anxiety. The interview showed that the reasons for their belief were as follows: (1) assessments and grades in mathematics test, (2) enough time to practice and preparation, (3) pressure of other courses, and (4) consideration of mathematics as their favorite subject, as shown in Figure 6.

![Diagram of factors contributing to mathematics anxiety]

*Figure 6: Factors that contribute to the mathematics anxiety*

Ten of the thirteen students who felt anxiety showed the effect of mathematics test scores were the main cause of their mathematics anxiety.

One participant stated:

Mathematics has the highest academic hours. It is normal to have mathematics anxiety. It greatly affects the engineering student’s GPA. I am concerned about the grades in mathematics more than mathematics itself (Nayef O., personal interview, October 10, 2018).
Nevertheless, eight of the thirteen students who did not have anxiety indicated that high scores on mathematics tests were one reason why they did not have mathematics anxiety. One student stated, “I used to have mathematics anxiety in middle school, but now I do not because my grades are always high in mathematics exams” (Fahd O., personal interview, November 29, 2018).

Not devoting enough time to study and practice mathematics was the second reason for engineering students’ anxiety regarding mathematics. Seven of the thirteen students who felt anxiety affirmed that not being able or having time to practice resolving the many different mathematical problems caused them mathematics anxiety. One student said, “I have anxiety in mathematics because I did not give the subject the time and effort required. I want a high score on the test but I did not do the required study. I know my level in mathematics, so I feel anxiety” (Waleed S., personal interview, September 26, 2018).

On the other hand, there were ten other students who did not feel anxiety in mathematics who claimed that studying mathematics continuously and trying to solve many mathematical exercises increased their self-confidence thereby eliminating the anxiety about mathematics. One participant said, “I think I do not feel anxiety of math because I study and solve many of the ideas throughout the academic year, so I feel confident in my abilities” (Abed I., personal interview, November 12, 2018).

Five of the thirteen students who felt anxiety considered that other subjects had an impact on their increased anxiety in mathematics. One participant stated,
“definitely, I feel anxiety in mathematics. There is no sufficient time to study it because I have many courses that I have to study, too” (Muslim A., personal interview, September 12, 2018). Also, they thought the homework in other subjects does not allow enough time to practice mathematics, which increased their anxiety. Another participant stated, “I do not have time to review mathematics materials because my time just goes away in finishing the homework of other courses and then I go to sleep” (Saud T., personal interview, October 11, 2018).

The impact of loving mathematics on many students was present in their answers about the mathematics anxiety question. Seven students confirmed that seeing mathematics as their favorite subject helps them not feel anxiety. One student said, “I do not feel anxiety because I love mathematics” (Jafar A., personal interview, October 3, 2018).

**Interview Question 5: Usefulness of Mathematics**

All the participants agreed that mathematics is very useful. They attributed their belief to three reasons: (1) their awareness of the relationship between mathematics and everyday life and other scientific subjects, (2) their awareness of the correlation of mathematics and their engineering major, and (3) their awareness of the benefit of mathematics in their future careers (see Figure 7).
Figure 7: Factors that contribute to the awareness of the usefulness of mathematics

Twenty students who participated in the interview indicated that the reason for their awareness of the usefulness of mathematics was their knowledge of the relationships between mathematics and daily life. One student said, “I can find mathematics everywhere by measuring distance, calculating the price of a purchase, and even using the GPS in the car” (Mutaeib S., personal interview, November 1, 2018). They also mentioned the relationship between mathematics and various sciences as the reason for their understanding. Other student said, “I believed mathematics is the mother of science. Physics, chemistry, and other disciplines require mathematics” (Abdul eIlah H., personal interview, December 3, 2018).

Fifteen students considered mathematics to be important in their discipline, and this is the second reason for their awareness of the usefulness of mathematics. One participant stated that, “engineering students have to take many mathematics
courses in their field so this is enough to know the usefulness of mathematics” (Hassan R., personal interview, November 2, 2018).

Thirteen participants thought that one factor that illustrates the usefulness of mathematics was its effect on their future career. One participant said, “Mathematics is useful to me in the future because companies are focused on hiring engineers with high grades in mathematics” (Majid O., personal interview, November 16, 2018). Furthermore, they considered the effect of mathematics on their future income as a factor that shows the usefulness of mathematics.

Another participant stated:

Every person seeks to have a high income. We, as engineers, consider mathematics as the door through which we get job offers with high salaries. Everyone sees the engineer with high grades in mathematics is as an intelligent engineer and he will become asset for the company in which he works. (Safwan R., personal interview, December 3, 2018).

Interview Question 6: Effectance Motivation in Mathematics

The freshman engineering students at IAU agreed that they have sufficient motivation in mathematics. They reported three factors that formulated their motivations, which were (1) their future, (2) their major, and (3) their families, as shown in Figure 8.
Eighteen students indicated that their future was their first motivation in mathematics. One participant said, “the competition in the labor market, and the previous engineering students, where they work now, are the motivation for me to work harder in mathematics” (Abed I., personal interview, November 12, 2018). Additionally, fifteen students added that their major, engineering, was their motivation in mathematics. Another participant stated, “my major is the biggest motivator for me. I am enrolling in engineering college, and if I want to be an engineer, I need to take care of mathematics” (Shaker M., personal interview, November 27, 2018). Eleven students consider that their family was their motivation in learning mathematics.
One of them said,

I think my family is the motivation for me to learn mathematics. My father is an engineer, my mother is a teacher, and my sister is a doctor. They always support me and stand with me during my studying (Abdul Razzaq K., personal interview, September 27, 2018).

Other participants mentioned their father specifically as their motivator in mathematics. One participant said, “for me, I believe my father is my biggest motivation in mathematics. He always makes me feel that I am able to skip all the obstacles” (Abdul Razzaq K., personal interview, September 27, 2018).

**Interview Question 7: Students’ Opinions for Demographic Factors**

The last question was about the participants’ thought concerning the impact of their demographic characteristics on their attitudes toward mathematics. Did participants see any relationship between their demographic factors (geographical region, school type, parents’ educational level, and parents’ career type) and their attitudes toward mathematics? The interview showed a disparity in responses among participants.

**Geographical region.** Twelve of the participants did not agree that their geographical region has influenced their current attitude toward mathematics. One of them said, “Whoever says that the city has an effect, he tries to blame his failure on any reason. Honestly, this is personal, and you are the only one who build his future” (Adel I., personal interview, October 22, 2018). Some of them mentioned
that the teacher is influential rather than the city. One participant stated, “I do not think that the city has an impact on my mathematical attitude but the teacher has” (Rashed M., personal interview, October 9, 2018). Even so, fourteen participants agreed that the region they belonged to had an impact on their attitude toward mathematics. One student stated, “The people around me, affect me. I have friends who study at King Fahd University of Petroleum and Minerals. They are my motivation to learn mathematics” (Salman N., personal interview, October 5, 2018). Additionally, some of them considered that belonging to a large city which contains many companies would help them understand the usefulness of mathematics. Another participant stated, “Because I belong to the Eastern Region, I know the largest companies in Saudi Arabia such as Saudi Aramco, SABIC and other big companies. I know if I want to work in one of these big companies, I have to get high grades in mathematics” (Ibrahim A., personal interview, October 30, 2018).

**School type.** Fifteen students did not believe that the status of their high school had influenced their current attitude toward mathematics. One participant said, “I do not think that the type of high school has an impact, but rather the teachers have the biggest influence” (Abdulrahman T., personal interview, October 3, 2018). Nevertheless, eleven participants indicated that the type of high school did affect their attitudes. Ten considered that public schools were better while one was in favor of private schools. One participant said, “I agree that school types affect attitudes. I graduated from public high school, and I think if I graduated from
a private school, my attitude toward mathematics would be negative” (Faisal R., personal interview, October 15, 2018). Additionally, one participant revealed that he believed that the output of private schools is not good because his friends who graduated from private schools had a problem with mathematics (Faisal R., personal interview, October 15, 2018). Another participant mentioned that teachers in private schools are very lenient because the students pay money to attend. Thus, the students do not work hard because they know they will succeed at the end of the year (Abdullah R., personal interview, October 9, 2018).

On the other hand, one participant had a different point of view. He believes that private schools are best because he graduated from a private high school, and also he heard that public schools are worse.

He stated that:

Yes, the school type has an impact on my attitude toward mathematics. I graduated from private high school, where staff provided extra lessons for scientific subjects and mathematics. I think that private schools are better than public because I have heard that public school is bad regarding education. Public schools do not use new modern methods of teaching, which affects the learning (Ali M., personal interview, October 10, 2018).

**Parents’ educational levels.** Seventeen participants rejected the idea that their parents’ educational level has influenced their current attitude toward mathematics. Twelve indicated that teachers were their influence, not their parents’
education. One student said, “I think my teachers are the direct influence, not my parents’ educational level because students are always impacted by the people from whom they learned” (Mohammed A., personal interview, September 12, 2018).

However, nine participants agreed that the level of their parents’ education had an impact on their attitudes. Four considered that the educational level of both parents impacted their attitudes toward mathematics. One participant said, “My father and my mother are my perfect role models. Both were university students, and I am trying to become like them” (Sultan W., personal interview, November 29, 2018). Furthermore, three of the nine participants indicated that their fathers’ educational levels had influence. One of them stated, “My father has a PhD, and I hope to be like him one day” (Mustafa A., personal interview, September 17, 2018). Two students considered that the effect was from their mothers’ education level. One student mentioned that when he felt pressure at his university, his mother knew how to help him to overcome the obstacles because she had the same experience previously (Anwar G., personal interview, October 3, 2018).

**Parents’ career types.** Eighteen participants did not agree that their parents’ career types have influenced their current attitude toward mathematics. One of the participants said, “I do not think there is a relationship between my mathematical attitude and my parents’ jobs” (Nayef O., personal interview, October 10, 2018). He indicated that teachers formulate students’ attitudes. He stated, “Students spend more time at school than with their parents, so I think teachers and
their jobs are more influential on the students’ attitudes toward mathematics”
(Nayef O., personal interview, October 10, 2018).

At the same time, eight participants believed that their parents’ career
affected their attitudes. Five of the participants identified with their fathers’ careers.
One of them said, “My father is a contractor, and he is the reason for me to choose engineering. Hopefully, I will graduate very fast to work with him in the field of construction” (Rashed M., personal interview, October 9, 2018). Three of the eight participants identified that their mothers’ careers were influential. One of them said, “My mother is a school principal, and she is very interested in teaching methods. I have never found any concept difficult to learn” (Abed I., personal interview, November 12, 2018).

Chapter Summary
This chapter presented the results from a survey and interviews to help answer the research questions. The study used mixed methods to investigate the results of the quantitative part and added deep details from the qualitative part to the body of the research. The results of the survey were reported as descriptive data and verbal and written responses for the interview part.

Results of the survey part revealed that there was a positive relationship between the fathers’ career type of the freshman engineering students and their attitudes toward mathematics while there was a negative relationship between the mothers’ educational level of the freshman engineering students and their attitudes toward mathematics, especially in their confidence and anxiety about mathematics.
The Saudi nationality of students was found to have a negative relationship with students’ attitudes toward success in mathematics. Also, the geographical region and mothers’ career types were found to have a positive relationship with students’ confidence in learning mathematics. However, the school type and fathers’ educational level did not have a significant relationship with the freshman engineering students’ attitudes toward mathematics.

Results of the interview part revealed that the large number of freshman engineering students at IAU had a positive attitude toward mathematics, and the rest of them had a neutral attitude toward mathematics. The results of the interviews agreed with the results of the survey that the fathers’ career type had a positive impact on their children’s attitudes. Many students mentioned the influence of their fathers and their career type on the students’ attitudes toward mathematics.

In addition, the interview part reported other factors that have a strong influence on the freshman engineering students’ attitudes towards mathematics positively or negatively, which were (1) the impact of teachers’ characteristics on their students’ attitudes toward mathematics, (2) the influence of tests and grades on students’ attitudes toward mathematics, and (3) the effect of practice and preparation on students’ attitudes toward mathematics.
Chapter Five
Discussions and Conclusions

In this study, the researcher tried to find the reasons for students’ actions and performance in mathematics courses. The research focuses on providing quantitative and qualitative data that can help to identify the attitudes toward mathematics of the freshman engineering students at Imam Abdulrahman Bin Faisal University (IAU) in Saudi Arabia and the factors that influence their attitudes. The quantitative data indicated the relationship between freshman engineering students’ demographic characteristics and their attitudes toward mathematics, and the qualitative data determined the factors affecting their attitudes. The results of the study may present other researchers, administrators, and educators with a better understanding of their students’ attitudes and how to improve students’ abilities and learning.

This chapter contains five main parts. The first part summarizes the study, which includes an overview of the purpose, methodology, research design, and statistical strategy. The second part expounds upon findings for each research question and each interview question. The third part provides the conclusion and inferences for research questions and discusses the implications relative to prior research and practice. The fourth part reviews the limitations and delimitations of the study. The final part provides the recommendations for future research.
Summary of the Study

The purpose of the research study was to measure the relationship between freshman engineering students’ demographic characteristics and their attitudes toward mathematics. The study was based on many previous studies that examined this relationship, such as Huang (2010), Mohamed and Waheed (2011), Deraney and Abdelsalam (2012), Mbugua et al. (2012), Yasar et al. (2014), and Siebers (2015). The findings of these studies identified some demographic factors (e.g., parents’ educational level and parents’ career type) that impacted students’ attitudes. By taking a closer look at the freshman students’ attitudes while they were in engineering college, this study seeks to have a better understanding of the influence of the demographic factors on their attitudes toward mathematics.

The research used mixed methods, including surveys and interviews, to measure the relationship between students’ demographic characteristics and their attitudes toward mathematics. In the quantitative study, the researcher distributed the survey to the participants; in the qualitative study, the researcher interviewed some of them. The study population was engineering students enrolled in first year mathematics classes offered at Imam Abdulrahman Bin Faisal University (IAU) in Saudi Arabia. The sample size of the study was 157 students \((N = 157)\) who completed the survey, and 26 students \((N = 26)\) who were interviewed.

The main dependent variable of the quantitative study was freshman engineering students’ attitudes toward mathematics, which was divided into five dependent variables (DV s), one for each research question: (1) attitude toward
success in mathematics, (2) confidence in learning mathematics, (3) mathematics anxiety, (4) usefulness of mathematics, and (5) effectance motivation in mathematics. Seven independent variables (IVs) were included in this investigation, which were students’ nationality, geographical region, school type, fathers’ educational levels, mothers’ educational levels, fathers’ career types, and mothers’ career types. The categorical factors in these seven independent variables were dummy coded, resulting in 15 variables for the five Research Questions.

An interview was used to examine the students’ attitudes toward mathematics and to explore the factors that influence their attitudes by using open-ended questions to make more space for the participants to express their opinions. The instrument that was used in the quantitative study to test students’ attitudes towards mathematics was the Arabic translation of the short version of the Fennema-Sherman Mathematics Attitude Scales (FSMA), a reliable instrument used to measure mathematics attitudes of students at different school levels. The FSMA survey that was used in this study consists of 5 scales: (1) Attitude Towards Success in Mathematics Scale, (2) Confidence in Learning Mathematics Scale, (3) Mathematics Anxiety Scale, (4) Usefulness of Mathematics Scale, and (5) Effectance Motivation Scale. Each scale consists of twelve questions. The FSMA Scale contains items in a five-point Likert format, in which there are a mix of positive and negative statements (Liau et al., 2007). In summary, the FSMA survey is a reliable measure and is valid to use (Dogbey, 2010).
After receiving IRB approval from both universities, Florida Institute of Technology (FIT) and Imam Abdulrahman Bin Faisal University (IAU), the research data were obtained using surveys and interviews. Then, the data was ready to analyze after coding the nominal variables for quantitative study. The researcher found only two outliers within the data for Research Question 2, which were removed. Multiple linear regression (MR) was used to analyze survey data for all research questions after the assumptions of the MR were satisfied. In addition, in the qualitative study, the coding process was used to collect the important information from the participants’ answers. The researcher created a matrix of open coding from keywords to analyze each interview question.

**Summary of Findings**

This study investigated the relationship between freshmen engineering students’ demographic characteristics and their attitudes toward mathematics. The study’s accessible population included all IAU undergraduate freshman engineering students who enrolled in Calculus 1 in Fall 2018. The study sample included students who participated in the FSMA survey \((N = 157)\) and who were interviewed \((N = 26)\).

**Findings of the research questions**

Multiple linear regression (MR) analysis was used to investigate the relationship between the 15 IVs and a DV for Research Questions 1 through 5. All
six assumptions of the MR were satisfied. Outliers analysis was conducted for Research Question 2, and two outliers were removed (N = 155).

For Research Question 1, the MR analysis was conducted to determine the relationship of the 15 independent variables with the students’ attitudes toward success in mathematics. The model was statistically significant, and the variables: Saudi nationality (X1), fathers’ education career (X6b), and fathers’ company employment (X6d) made a significant contribution to their $R^2 = .192$, $F(15, 141) = 2.234$, $p < .05$.

The same analysis was conducted for Research Question 2 to determine the relationship of the 15 independent variables with the students’ confidence in learning mathematics. The model was statistically significant, and the variables: Eastern geographical region (X2), mothers’ undergraduate level (X5b), fathers’ engineering career (X6a), fathers’ education career (X6b), fathers’ self-employed status (X6c), and mothers’ education career (X7a) made a significant contribution to their $R^2 = .268$, $F(15, 139) = 3.401$, $p < .001$.

The same analysis was conducted for Research Question 3 to determine the relationship of the 15 independent variables with the students’ anxiety over mathematics. The model was statistically significant, and the variables: mothers’ undergraduate level (X5b) and fathers’ education career (X6b) made a significant contribution to their $R^2 = .157$, $F(15, 141) = 1.746$, $p < .05$.

For Research Question 4, the MR analysis was conducted to determine the relationship of the 15 independent variables with the students’ awareness of the
usefulness of mathematics. The model was statistically significant, and the variables: fathers’ engineering career (X6a), fathers’ education career (X6b), and fathers’ self-employed status (X6c) made a significant contribution to their $R^2 = .17$, $F (15,141) = 1.928$, $p < .05$.

Finally, the same analysis was conducted for Research Question 5 to determine the relationship of the 15 IVs on the students’ effectance motivation in mathematics (DV). The regression model was statistically significant; $R^2 = .223$, $F (15, 141) = 2.698$, $p < .005$, and three IVs made a statistically significant contribution to this model. All three of these variables were in the fathers’ career types: Engineering (X6a), Education (X6b), and Self-employed (X6c).

**Findings of the interview questions**

An interview was used to investigate students’ attitudes toward mathematics for Interview Questions 1 through 7 and also to explore the factors that impacted their attitudes.

Interview Question 1 indicated that the freshman engineering students showed positive and neutral attitudes toward mathematics. Participants credited their positive attitudes to three main themes, which were teacher’s positive characteristics, parental support, and practice and preparation. Major reasons that participants used to justify their neutral attitudes were teacher’s negative characteristics, assessments and grades, English language effect, and time management.
Interview Question 2 indicated that all participants showed positive attitudes toward success in mathematics. Students justified their positive attitudes by citing pride in themselves, competition with their colleagues, and a desire for respect from their fathers.

Interview Question 3 indicated that all students showed high levels of confidence for learning mathematics except six students. Participants justified the reasons for their different confidence levels by mentioning their practices, grades, teachers, and weak mathematical foundation.

Interview Question 4 indicated that half of the participants had mathematical anxiety and the rest did not. The reasons for participants’ beliefs were based on insufficient time to practice, pressure of other courses, grades on mathematics tests, and consideration of mathematics as their favorite subject.

Interview Question 5 indicated that all participants showed their understanding of the usefulness of mathematics and stated the reasons for their understanding as being due to three main themes, which were their awareness of the relationship between mathematics and everyday life and other scientific subjects, their awareness of the correlation of mathematics and their engineering major, and their awareness of the benefit of mathematics in their future careers.

Interview Question 6 indicated that all students had sufficient motivation in mathematics. Participants gave the reasons for their motivations as being due to three factors, which were their future, their major, and their families.
Finally, the interview indicated a disparity in responses among participants for Interview Question 7. Twelve of the participants did not believe that the geographical region had influenced their current attitude toward mathematics while fourteen of them did. Fifteen students did not agree that the type of their high school had influenced their current attitudes; however, eleven students agreed. Seventeen participants rejected the idea that their parents’ educational level had influenced their current attitudes, but nine students accepted this as an influence. Eighteen participants did not agree that their parents’ career type has influenced their current attitudes while eight did.

Conclusion, Inferences, and Implications

This part of the study includes the findings of the multiple linear regression analyses for Research Questions 1 through 5 and also includes the findings of the interviews for Interview Questions 1 through 7. Each question presents the interpretations and possible explanations for the results.

Research Question 1

“What is the relationship between students’ demographic characteristics and their attitude toward success in mathematics?”

The results reveal that freshman engineering students’ attitudes toward success in mathematics reported a second highest mean score (M = 51.10), which indicates that the students had a positive attitude toward success in mathematics. In other words, the freshman engineering students see the importance and the value of
being successful in mathematics courses. Multiple linear regression analysis was conducted to examine the contribution of 15 independent variables (IVs) to predict the freshman engineering students’ attitudes toward success in mathematics (DV₁). Results of the analysis indicate that this model was statistically significant, $F(15, 141) = 2.234, p < .05$, and explained 19.2% ($R^2 = .192$) of a variance in this DV₁. Of these 15 IVs, only three were significant in predicting students’ attitudes toward success. The first variable was in the nationality: Saudi (X₁); $t = -2.266, p = .025$. The two other variables were in the fathers’ career types: Education (X₆b); $t = 2.999, p = .003$, and Company Employees (X₆d); $t = 2.468, p = .015$.

The findings of this question indicated that there was a relationship between students’ demographic characteristics, especially students’ nationality and fathers’ career types, and their attitudes toward success in mathematics. The findings align with many prior studies (Barry, 2006; Checchi, 2000; Dahl & Lochner, 2012; Gegbe et al., 2015; Henderson & Landesman, 1992; Huntsinger et al., 2000; Mbugua et al., 2012; N. Ali et al., 2009; Reardon, 2011; Stevenson & Lee, 1990).

The results of the study indicate that there is a positive relationship between the freshman engineering students’ attitudes toward success in mathematics and their fathers’ career type, especially fathers who work in education and fathers who work in companies. This finding is supported by other studies’ results that also showed there was a positive correlation between parents’ career type and their children’s achievement (Checchi, 2000; Dahl & Lochner, 2012). Checchi (2000) focused on the reasons for the low educational achievement of university students
in Italy. The results showed that there was a positive correlation between family income and students’ achievement; parents who gain a high income from their jobs provide an incentive for better academic performance.

However, other studies contradict the results because they did not see any relationship or showed a negative relationship (Akhtar, 2012; Camello, 2014; Hijazi & Naqvi, 2006). Hijazi and Naqvi (2006) studied the factors that affect college students’ performance in Pakistan. The researchers found that there was a negative relationship between the parents’ career type and their children’s performance. Students from affluent families do not work as hard in school as poorer students.

A plausible explanation for the result of the current study is that the fathers’ work in education makes them realize the usefulness of increasing and improving their children’s attitudes toward success in mathematics for their children’s future lives. Also, those fathers may be perfect role models for their children in academic study because the profession of education is prestigious, and the children are proud of their fathers’ careers.

Additionally, of the many fathers’ career types, the highest percentage, 32.5%, was company employees. The fathers who work in companies are more knowledgeable about the benefit of being successful in mathematics. Since acquiring a job with a high salary depends on the engineers’ skills and proficiency, fathers know that having high grades in mathematics is very important to hiring companies.
Even though the results of the study indicated that there is a negative relationship between the freshman engineering students’ attitudes toward success in mathematics and Saudi nationality, the result likely does not depend on nationality specifically but on other factors such as language problems. The students indicated that they have English language problems, causing them weakness in mathematics as will be shown in the results of Interview Question 1. The explanation of the result is consistent with the outcome of prior studies of Neville-Barton and Barton (2005) and Yonson (2017), who found that the biggest problem that nonnative English students faced in mathematics learning was the language difficulties.

**Research Question 2**

“What is the relationship between students’ demographic characteristics and their confidence in learning mathematics?”

The results revealed that freshman engineering students’ confidence in learning mathematics was reported at an overall high mean score (M = 45.32), which indicates that the students had a positive attitude. In other words, the freshman engineering students had enough self-confidence to learn mathematics. Multiple linear regression analysis was conducted to measure the contribution of 15 independent variables (IVs) to predict the freshman engineering students’ confidence in learning mathematics (DV₂). Results of this analysis indicated that this model was statistically significant ($F (15,139) = 3.401, p < .001$) and explained 26.8% ($R^2 = .268$) of a variance in this DV₂. Of these 15 IVs, only six variables were significant in predicting students’ confidence in learning mathematics. The
first variable was in the geographical region: Eastern \( (X2); t = 2.474, p = .015 \). The second variable was in the mothers’ educational levels: Undergraduate \( (X5b); t = -3.289, p = .001 \). The third variable was in the mothers’ career types: Education \( (X7a); t = 2.069, p = .04 \). The last three variables were in the fathers’ career types: Engineering \( (X6a); t = 2.657, p = .009 \), Education \( (X6b); t = 2.969, p = .004 \), and Self-employed \( (X6c); t = 2.354, p = .02 \).

The findings indicated that there was a relationship between students’ demographic characteristics; especially students’ geographical region, mothers’ educational levels, mothers’ career types, and fathers’ career types; and their confidence in learning mathematics. The findings mentioned above align with many prior studies (Akhtar, 2012; Barry, 2006; Checchi, 2000; Dahl & Lochner, 2012; Deraney & Abdelsalam, 2012; Dimakos et al., 2012; Falch et al., 2013; Hijazi & Naqvi, 2006; Mbugua et al., 2012; Strutchens & Silver, 2000; Signer et al., 1996; Reardon, 2011; Visser et al., 2015; Yasar et al., 2014).

The results of the current study indicated that there is a positive relationship between the freshman engineering students’ confidence in learning mathematics and their geographical region, especially students who belong to the Eastern region. This finding is supported by other studies’ results that showed there was a positive correlation between students’ geographical region and their attitudes (Strom, 2013; Yasar et al., 2014). Yasar et al. (2014) studied the attitude of students in Turkey toward mathematics and the variables that influence their attitudes. Their findings showed that geographic regions statistically impacted students’ attitudes toward
mathematics. Students from poor regions had more negative attitudes towards mathematics.

A plausible explanation for the result is that because of the discovering of the oil fields in the Eastern Province of Saudi Arabia in earlier times, many of the biggest Saudi companies, such as Saudi Aramco, worked there since 1933. As a result, education received great attention in the Eastern Province at an early date and established many schools where the Eastern children enrolled. Hence, it is not surprising that students who belong to the Eastern region have more confidence in learning mathematics compared to others. One of the Eastern schools, Dhahran Ahliyya Schools, is considered one of the most important schools in the Kingdom of Saudi Arabia. The students of this school represent the Kingdom in many international forums such as the International Mathematical Olympiad (IMO) and Gulf Mathematical Olympiad (GMO).

In addition, the results of Research Question 2 indicated that there is a positive relationship between the freshman engineering students’ confidence in learning mathematics and their parents’ career type, especially mothers who work in education, fathers who work in the engineering field, fathers who work in education, and fathers who are self-employed. This finding is supported by other studies’ results that also showed there was a positive relationship between parents’ career type and their children’s achievement (Barry, 2006; Checchi, 2000; Dahl & Lochner, 2012; Mbugua et al., 2012; Reardon, 2011). Mbugua et al. (2012) studied the factors causing poor performance in mathematics in Kenya. The result showed
that one of the main reasons for the prevalence of poor performance in mathematics among Kenyan high school students was the career of students’ parents.

A plausible explanation for this result is that the parents’ work in education makes them realize the usefulness of increasing and improving their children’s confidence in learning mathematics for their children’s future lives. Also, those parents who work in education may have the experiences and teaching methods to qualify them to deal with the problems facing their children in learning, which causes an increase in their children’s confidence in learning mathematics.

The accepted interpretation of the positive relationship between the job of the fathers in engineering and their children’s confidence is that these fathers are the first supporters of their children because they are more knowledgeable about what the future engineers need. Supporting fathers to become perfect role models for their children in learning mathematics may increase the confidence of their children.

In the case of the fathers who are self-employed, a plausible explanation for this result is that usually self-employed people have highly developed arithmetic skills because they need these abilities in their professions to buy and sell. Also, self-employed fathers have expedient methods to get the output of mathematical calculations. Teaching these skills and methods to children undoubtedly increases their confidence in learning mathematics.

The very interesting result of Research Question 2 was that there is a negative relationship between the freshman engineering students’ confidence in
learning mathematics and their mothers’ educational level, especially mothers who have a bachelor’s degree. The answer to the question is contrary to expectations because the survey results indicated that 47.7% of mothers have a bachelor’s degree, and 38.2% work in education. Also, the findings indicated that there is a positive relationship between the mothers’ career type (Education) and their children’s confidence in learning mathematics. As a result, the relationship between the level of the mothers’ education and their children’s confidence was expected to be positive rather than negative.

Research Question 3

“What is the relationship between students’ demographic characteristics and their anxiety over mathematics?”

The results revealed that freshman engineering students’ anxiety over mathematics was reported at the lowest overall mean score (M = 39.92), which means the freshman engineering students had less anxiety over mathematics. Multiple linear regression analysis was conducted to investigate the contribution of 15 independent variables (IVs) to predict the freshman engineering students’ anxiety over mathematics (DV3). Results of this analysis indicated that this model was statistically significant ($F(15,141) = 1.746, p < .05$) and explained 15.7% ($R^2 = .157$) of a variance in this DV3. Of these 15 IVs, only two variables were significant in predicting students’ anxiety over mathematics. The first variable was in the mothers’ educational levels: Undergraduate ($X5b$); $t = –2.434, p = .016$. The
second variable was in the fathers’ career types: Education (X6b); $t = 2.591, p = .011$.

The findings of this question indicated that there was a relationship between students’ demographic characteristics; especially the mothers’ educational levels and fathers’ career types; and their anxiety over mathematics. The findings mentioned above align with some prior studies (Mbugua et al., 2012; Yasar et al., 2014; and Deraney & Abdelsalam, 2012).

The results of the study indicated that there is a positive relationship between the freshman engineering students who have less anxiety over mathematics and their fathers’ career type, especially fathers who work in education. This finding is supported by other studies’ results that showed there was a positive relationship between parents’ career types and their children’s attitudes and academic performances (Gegbe et al., 2015; Liau et al., 2007; Mbugua et al., 2012; N. Ali et al., 2009; Reardon, 2011). N. Ali et al. (2009) surveyed 418 Malaysian university students to identify the factors that influence students’ performance. Researchers found that students’ demographic characteristics, such as parents’ career types, had a strong positive impact on their performance. Students whose parents had good jobs with higher income have better GPAs.

A plausible explanation for this result is that the nature of working in education makes the fathers more knowledgeable than others in how to deal with and decrease their children’s anxiety in mathematics. Additionally, the fathers who work in education had a positive relationship with their children’s attitudes toward
success and their confidence in learning mathematics. Hence, it would naturally
cause their children to be less anxious in mathematics. A study of Liau et al. (2007)
confirmed the results of the current study that when confidence and attitude toward
success in mathematics increase in students, anxiety decreases clearly.

The very interesting result of Research Question 3 was that there is a
negative relationship between the freshman engineering students who have less
anxiety over mathematics and their mothers’ educational level, especially mothers
who have a bachelor’s degree. This result is contrary to expectations because the
experiences of mothers in university studies should have made them better able to
deal with the anxiety of their children, which should help to decrease the anxiety,
not increase it. Also, other studies contradict this result. For instance, Akhtar
(2012) examined the effect of socio-economic variables on high school students’
achievement in Pakistan. The results showed that the mothers’ education had a
positive effect on the children’s achievement. The researcher attributed the reason a
positive effect happens may be because the mother traditionally spends more time
with her children at home, so understandably, the mothers’ backgrounds will affect
the children more than the fathers’.

**Research Question 4**

“What is the relationship between students’ demographic characteristics
and their awareness of the usefulness of mathematics?”

The results revealed that freshman engineering students’ awareness of the
usefulness of mathematics was reported at the highest mean score (M = 51.15),
which indicates that the students had a positive attitude. In other words, the freshman engineering students realize the usefulness of mathematics for their lives, study, and future employment. Multiple linear regression analysis was conducted to test the contribution of 15 independent variables (IVs) to predict the freshman engineering students’ awareness of the usefulness of mathematics (DV). Results of this analysis indicate that this model was statistically significant \( (F (15,141) = 1.928, p < .05) \) and explained 17% \( (R^2 = .17) \) of a variance in this DV. Of these 15 IVs, only three variables were significant in predicting students’ awareness of the usefulness of mathematics. All three variables were in the fathers’ career types: Engineering \((X6a); t = 3.089, p = .002, \) Education \((X6b); t = 2.000, p = .047, \) and Self-employed \((X6c); t = 2.135, p = .035.\)

The findings for this question indicated that there was a relationship between students’ demographic characteristics, especially the fathers’ career types, and their awareness of the usefulness of mathematics. The findings mentioned above align with many prior studies (Chouinard et al., 1999; Deraney & Abdelsalam, 2012; Frazier-Kouassi, 1999; Hackett & Betz, 1989; Lofland, 1992; Mbugua et al., 2012; Yasar et al., 2014; Walker & McCoy, 1997).

The results of the study indicated that there is a positive relationship between the freshman engineering students’ awareness of the usefulness of mathematics and their fathers’ career types, especially fathers who work in the engineering field, fathers who work in education, and fathers who are self-employed. This finding is supported by other studies’ results that also showed there
was a positive relationship between parents’ career type and their children’s attitudes and performance (Gegbe et al., 2015; Liau et al., 2007; Mbugua et al., 2012; N. Ali et al., 2009; Reardon, 2011). Gegbe et al. (2015) used three questionnaires with 100 high school students and 15 mathematics teachers in Sierra Leone to determine the demographic factors that impact students’ mathematical performance. Researchers found that the parents’ career type had a significant impact on students’ performance. The results of the study demonstrated that 40% of the parents were farmers, which explained the low performance of their children in mathematics.

A plausible interpretation of the positive relationship between the job of the fathers in engineering and their children’s awareness of the usefulness of mathematics is that the fathers realize the usefulness of mathematics in engineering because they work in the field, so they, more than others, can help their children to realize the usefulness of mathematics.

In addition, fathers who work in education realize the usefulness of mathematics for their children’s future lives, for engineering and mathematics courses are very important for their major. These courses have a great impact on their children’s academic GPA. Therefore, parents can help their children recognize the usefulness of mathematics.

Furthermore, because some fathers who are self-employed need mathematics in their work, their children may realize the usefulness of mathematics, not only for an engineering major but also for all aspects of life.
Research Question 5

“What is the relationship between students’ demographic characteristics and their effectance motivation in mathematics?”

The results revealed that freshman engineering students’ effectance motivation in mathematics was reported at high mean score (M = 43.08), which indicates that the students had a positive attitude. In other words, the freshman engineering students have motivation to enjoy solving mathematical problems and keep trying to solve hard problems until finding solutions. Multiple linear regression analysis was conducted to measure the contribution of 15 independent variables (IVs) to predict the freshman engineering students’ effectance motivation in mathematics (DV5). Results of this analysis indicated that this model was statistically significant (F (15,141) = 2.698, p < .005) and explained 22.3% (R² = .223) of a variance in the DVs. Of the 15 IVs, only three variables were significant in predicting students’ effectance motivation in mathematics. All three variables were in the fathers’ career types: Engineering (X6a); t = 3.018, p = .003, Education (X6b); t = 3.415, p = .001, and Self-employed (X6c); t = 3.274, p = .001.

The findings for this question indicated that there was a relationship between students’ demographic characteristics, especially the fathers’ career types, and their effectance motivation in mathematics. The findings mentioned above align with some prior studies (Abdurrahman & Garba, 2014; Chiu & Xihua, 2008; Frazier-Kouassi, 1999; Mata et al., 2012; Milne, 1992; Tella, 2007).
The results of the study indicated that there is a positive relationship between the freshman engineering students’ effectance motivation in mathematics and their fathers’ career types, especially fathers who work in the engineering field, fathers who work in education, and fathers who are self-employed. This finding is supported by other studies’ results that also showed there was a positive relationship between parents’ career types and their children’s attitudes and achievements (Gegbe et al., 2015; Liau et al., 2007; Mbugua et al., 2012; N. Ali et al., 2009; Reardon, 2011). Reardon (2011) investigated the relationship between socioeconomic characteristics of families and the academic performance of their children over fifty years using nineteen representative studies in the United States and found that there is a 40% gap between the achievements of students from high- and low-income families, which is twice as large as the gap in achievement between white and black students.

However, other studies contradict these results because they did not see any relationship or showed a negative relationship (Akhtar, 2012; Camello, 2014; Hijazi & Naqvi, 2006). Camello (2014) examined the factors that affect the performance of engineering students in the local mathematical assessment examination in the Philippines. The researcher found that there was no significant impact of parents’ income on students’ performance in mathematics.

A plausible explanation for the result of the current study is that the fathers who work in education can motivate their children in learning mathematics because those fathers may be perfect role models for their children in academic study, and
also, the nature of working in education makes the fathers more familiar with ways to motivate children for learning.

Additionally, a plausible interpretation of the positive relationship between the job of the fathers in engineering and their children’s effectance motivation in mathematics is that fathers who work in the engineering field may become a motivation to their children for learning mathematics because the children usually aspire to become like their fathers.

Moreover, fathers who are self-employed may motivate their children to learn mathematics more than others because the fathers know how mathematics is important for their work, more so for engineering students who consider mathematics an essential part of their studies.

**Notes from Research Questions 1 through 5.** Even though there is a claim that many of the freshmen engineering students at IAU received low grades in mathematics, the freshmen engineering students appeared to have an overall positive attitude toward mathematics. The mean values of the five scales were above the average attitude. The Usefulness of Mathematics Scale received the highest mean score (M = 51.15), followed by the Attitude Towards Success in Mathematics Scale (M = 51.10), the Confidence in Learning Mathematics Scale (M = 45.32), the Effectance Motivation Scale (M = 43.08), and the Mathematics Anxiety Scale (M = 39.92), which received the lowest mean score. The findings align with results of Bramlett’s study (2007) that over half of the African-American students did not achieve high scores in mathematics; however, most of the students
stated that mathematics is one of their favorite subjects in which they always receive good grades. The finding raises an important question as to why positive attitudes toward mathematics did not cause high-test scores. Is it possible that other factors have caused positive attitudes but did not help students earn higher grades?

As mentioned earlier, the study, like a few other studies (e.g., Mbugua et al., 2012; Yasar et al., 2014; and Deraney & Abdelsalam, 2012), focuses on investigating the relationship between students’ demographic characteristics and their attitudes towards mathematics. Thus, the present study might add new findings in educational research. The results indicated that the fathers’ career types had a positive and clear relationship to the five attitudes of their children toward mathematics: attitudes toward success in mathematics, confidence in learning mathematics, mathematics anxiety, usefulness of mathematics, and effectance motivation in mathematics. Additionally, the striking result is that mothers’ educational level, especially undergraduate, had a negative relationship with their children’s attitudes: confidence in learning mathematics, and mathematics anxiety. Furthermore, two factors did not show any relationship with the freshman engineering students’ attitudes, which were school type and fathers’ educational levels.

**Interview Question 1**

“a) In general, how would you describe your current attitude toward mathematics?”
b) What factors do you feel most influence your current attitude towards mathematics and why?"

The results of the interview showed that 58% of participants have a positive attitude toward mathematics, while 42% have a neutral attitude. The percentages support the finding of the survey that IAU freshman engineering students showed a positive attitude toward mathematics.

The participants identified three main reasons for their positive attitudes, which are teacher’s positive characteristics, parental support, and practice and preparation. The rest of the students identified four major reasons for their neutral attitudes, which are teacher’s negative characteristics, assessments and grades, English language effect, and time management. Regarding parental support, the participants focus more on their fathers’ impact. According to one participant in the interview, his father’s work in engineering had a big influence on his desire to study engineering and also in learning mathematics. This result supports the finding of the survey that the fathers’ career types had a strong and positive relationship with their children’s attitude toward mathematics. Also, the English language effect supports the researcher's explanation for the result of Research Question 1. The English language problem was the cause of the weakness of students in mathematics, not the effect of their nationality.

Several participants noted that the positive or negative characteristics of the teachers influenced their attitudes toward mathematics. Participants used some vocabulary such as *nice, cooperative, nervous, or boring* to describe the
characteristics of their teachers. Positive characteristics were associated with increasing positive attitudes in students, and negative characteristics were associated with decreasing students’ positive attitudes. In addition, some participants reported the impact of parental support on increasing their positive attitudes. They thought that parents, especially their fathers, had a direct impact on their love of mathematics. Furthermore, the practice of students in solving mathematical problems was no less important in shaping the attitudes of students toward mathematics. Most participants stated that spending enough time to solve mathematics problems makes them trust their mathematics abilities and improve their positive attitudes. Moreover, many participants expressed that the low grades on the mathematics exams and the inability to allot and manage the time to study mathematics and other subjects were important causes of decreasing their positive attitudes towards mathematics. Similarly, the weakness of students in English and lack of understanding what the professor says in the lecture were reasons to reduce their positive attitudes.

In an in-depth look at the reasons cited by the participants, the observer can see that the reasons are either internal, depending on a student himself, or external, depending on other factors than a student. The internal reasons include practice and preparation, assessments and grades, English language effect, and time management. The external reasons include teachers’ characteristics and parental support. The assessments and grades usually depend on the time that students spent on studying the material and practicing different mathematical problems. The
English language effect also depends on the students’ attempts to develop their language skills. Hence, it is possible to find clearly that the internal reasons are the greatest influences on their attitudes toward mathematics.

**Interview Question 2:**

“a) *In general, how would you describe your current attitude toward success in mathematics?*

*b) What factors do you think most contributed to your attitude toward success in mathematics? Please justify why.*”

All participants made clear that their attitudes toward success in mathematics are positive. They identified three reasons for these attitudes, which were pride in themselves, competition with their colleagues, and respect from their fathers. The results showed that 29% of the participants believed that being successful in mathematics makes them proud of themselves and trust their abilities. One participant stressed that success in mathematics increases students’ confidence in their abilities. Additionally, 73% of students mentioned the effect of the competition posed by success in mathematics. One student illustrates that the rivalry between peers and the sense of victory in competition is the strongest motivation for success. Finally, 29% of them focus on their fathers’ respect, considering one of the most important reasons for wanting to succeed. One participant showed more interest and determination to make his father proud of him, and he thought that the source of this pride is excellence in mathematics.
The results of Interview Question 2 support the findings of the survey that IAU freshman engineering students had a high positive attitude toward success in mathematics (M = 51.10). In addition, the results of this question clearly indicate the degree to which the freshman engineering students were affected by their fathers. The finding supports the results of the survey and proves the role of the fathers in particular for their children’s attitudes toward mathematics. Also, the outcome not only shows the effect of the fathers but also demonstrates the positive effect of the fathers in their children’s attitudes.

As mentioned in the first interview question, the observer can see that most of the reasons are related to students themselves. The pride in themselves and competition with their colleagues can be named the internal reasons because they are produced and associated with the students alone, while the pride of their fathers can be called the external reasons because they result from others. Therefore, it is clear that the reasons that relate to the students, the internal reasons, are the most influential reasons for the students’ attitudes toward mathematics.

**Interview Question 3:**

“a) In general, do you think you have confidence in learning mathematics?

b) What factors do you think best contributed to your current confidence in learning mathematics? Please justify why.”

The results of the interview showed that all the participants have a high level of confidence in learning mathematics except six students. Five of these six students showed neutral confidence, and the last remaining student showed a low
confidence level. The results of Interview Question 3 support the findings of the survey that IAU freshman engineering students had overall high confidence in learning mathematics (M = 45.32).

The participants determined four major reasons for their confidence level, which are practice and preparation, assessments and grades, teachers, and weak mathematical foundation. The effect of practicing to solve mathematical problems increases the students’ confidence; 77% of the participants expressed that practice caused their high confidence while 19% of other participants reported that low levels of practice to solve and review mathematics issues caused their neutral confidence in learning mathematics. Additionally, the results indicated that 46% of the students consider their high grades in mathematics tests to be the cause of their high confidence while 15% of other students consider their low grades in mathematics tests to be the cause of their neutral confidence. Moreover, the results revealed that 35% of the students believed that their high confidence in mathematics was the result of the positive influence of their mathematics teachers. According to one participant, the teaching methods of his mathematics teacher in middle school made mathematics an easy subject, which increased his confidence in learning mathematics. However, 12% of other students stated that their mathematics teachers are the cause of their neutral confidence in mathematics. On the other hand, only one participant mentioned that he is afraid of mathematics and does not trust his abilities because his weak mathematical foundation causes his low confidence in learning mathematics.
It should be noted that not all of the factors that students mentioned above, which caused the formation of their current confidence in learning mathematics, are linked to the results of the survey. The factors do not include any demographic factors. Also, the reasons may be divided into internal reasons, which are practice and preparation, assessments and grades, and weak mathematical foundation, related to the students themselves, and an external reason, which is the teacher, which is not related to the students.

**Interview Question 4:**

“a) Do you feel anxiety about taking a course in mathematics?

b) What factors do you think best contributed to your current anxiety over mathematics? Please justify why.”

Half of the participants who were interviewed showed anxiety about taking mathematics courses, and the rest of the participants did not feel anxiety. The participants identified four reasons for their levels of mathematics anxiety, which are assessments and grades in mathematics tests, enough time to practice and preparation, pressure of other courses, and seeing mathematics as their favorite subject. The findings revealed that 38% of students believed their low grades on mathematics exams increased their anxiety over mathematics, and 31% of students affirmed that their high grades in mathematics decreased their anxiety. In addition, the results indicated that 27% of the participants claimed that they did not devote enough time to solving many mathematical problems, which caused them more anxiety over mathematics while 38% of students emphasized that the more time
spent practicing solving different ideas of mathematics problem, the less anxiety over the subject. Furthermore, five students believed that the pressure of other courses and losing time finishing their homework gave them less time to review and study mathematics, which caused increased anxiety. On the other hand, 37% of participants considered mathematics as their favorite subject, so they enjoyed studying and did not feel anxiety over it.

The results of Interview Question 4 could support the findings of the survey that the IAU freshman engineering students had overall less anxiety over mathematics (M = 39.92). However, not all of the reasons that participants stated above caused the formation of their current anxiety over mathematics, are related to the results of the survey. These reasons do not include any demographic factors. Also, these reasons, which are assessments and grades, practice and preparation, and seeing mathematics as their favorite subject, can be named internal reasons, which are a result of the students themselves. Even the pressure of other courses can be considered an internal reason because it results from an inability to allot and manage time.

**Interview Question 5:**

“a) Do you feel that mathematics is useful to know?

b) Overall, what factors do you think most contributed to your current awareness of the usefulness of mathematics? Please justify why.”

In the view of all the participants, mathematics is a very useful subject now and in the future. They identified three factors for their attitudes, which are their
awareness of the relationship of mathematics to their daily lives, and mathematics and other scientific subjects; their awareness of the relationship between mathematics and their engineering major; and their awareness of the benefits of mathematics in their future jobs. The results showed that 77% of the participants believed that they need mathematics everywhere in their lives by using mathematical calculations and in school by using mathematics in other scientific subjects. All these needs could explain how mathematics is useful and important. Additionally, 58% of the students expressed that their need for mathematics in engineering made them aware of the usefulness of mathematics. Furthermore, 50% of the students mentioned how mathematics is important for their future. One participant affirmed that the utility of mathematics might be seen clearly when engineering students know that mathematics is one of the essential requirements for the best career offers.

The results of Interview Question 5 support the findings of the survey that the IAU freshman engineering students had a high awareness of the usefulness of mathematics (M = 51.15). As well, it is clearly noted that not all of the factors that students stated above, which caused the formation of their awareness of the usefulness of mathematics, are related to the results of the survey. The factors do not include any demographic factors. Also, the reasons, which are their awareness of the relationship of mathematics to their daily lives, and mathematics and other scientific subjects; their awareness of the relationship between mathematics and
their major; and their awareness of the benefits of mathematics in their future jobs can be named internal reasons, which are a result of the students themselves.

Interview Question 6:

“a) In general, do you think you have a motivation in mathematics?

b) What factors do you think most contributed to your motivation in mathematics? Please justify why.”

All students who participated in the interview stated that they have sufficient motivation in mathematics. In their views, their motivations come from their futures, their majors, and their families. The results revealed that 69% of participants claimed that their future prospects were their first motivation in mathematics. According to a participant, obtaining a prestigious job requires high grades in mathematics. In addition, 58% of students mentioned that engineering students realize that the way to graduate from engineering college is through success in mathematics courses. Moreover, 42% of participants indicated their families, especially their fathers, are their motivations. One participant suggested that he had the motivation to solve mathematics problems and not stop working on issues until he found solutions because he saw how his father deeply focused and solved any mathematics question his father had.

The results of Interview Question 6 support the findings of the survey that IAU freshman engineering students had an overall high positive effectance motivation in mathematics (M = 43.08). Additionally, the results of this question clearly indicate the degree to which the freshman engineering students were
affected by their fathers. The findings support the results of the survey and prove the role of the fathers in particular for their children’s effectance motivation in mathematics. Also, the findings not only show the effect of the fathers but also demonstrate the positive effect of the fathers in their children’s attitudes.

As mentioned previously, observers can see that most of the reasons are related to students themselves. The effect of students’ futures, and students’ majors can be named the internal reasons because they are produced and associated with the students alone while the effect of students’ families can be called the external reason because they result from others. Therefore, internal reasons prove to be the most influential for the students’ effectance motivation in mathematics.

**Interview Question 7:**

“Answer the following questions from your personal point of view:

a) Overall, do you believe that your geographical region has influenced your current attitude toward mathematics? (Clarify your answer).

b) Overall, do you believe that the type of your high school has influenced your current attitude toward mathematics? (Clarify your answer).

c) Overall, do you believe that your parents’ educational levels have influenced your current attitude toward mathematics? (Clarify your answer).

d) Overall, do you believe that your parents’ career types have influenced your current attitude toward mathematics? (Clarify your answer).”

The results indicated that there is a difference in the views between the IAU freshman engineering students on the extent of the impact of their demographic
factors on their attitudes toward mathematics. Most participants agreed to the impact of their geographical region on their current attitudes while 46% disagreed. In addition, most participants did not support the influence of the school type on their current attitudes while 42% of participants supported its impact. Furthermore, most students rejected the effect of the parents’ educational levels on their current attitudes while 35% accepted this effect. Finally, most students disagreed about the impact of their parents’ career types on their current attitudes while 31% of students agreed. Although there are some demographics impacts on the students’ attitudes raised by the participants in the current question, many participants did not agree with the impact of the demographic characteristics and believed that their teachers are the strongest influential factors in their attitudes.

The results of Interview Question 7 support the findings of the survey that students’ geographical region had a positive relationship with their attitudes toward mathematics. Additionally, the results of this question support the results of the survey that students’ school types and fathers’ educational levels not have a relationship with their attitudes.

Anyone who carefully observes the results of Interview Question 7 finds that most students do not see the effect of demographic factors on their attitudes towards mathematics. The finding is supported by the results of Interview Questions 1 through 6. The participants did not mention the impact of demographic factors when they were asked a general question about their thoughts regarding the factors that form their attitudes. Therefore, the researcher believes that even if some
participants said demographic factors impacted them, this effect is not significant. Also, the largest number of students expressed their rejection of the influence of demographic factors when asked specifically, which led to support the idea of the weak impact of these factors.

**Notes from Interview Questions 1 through 7.** The results of the interview showed that the teacher has a great influence on students’ attitudes toward mathematics. Also, the fathers had clear and influential roles in their children’s attitudes. Moreover, two factors did not show any relationship with the IAU freshman engineering students’ attitudes, which were school type and fathers’ educational levels.

The striking result is that most of the reasons and factors (e.g., practice and preparation, assessments and grades, and time management) that participants consider as contributing to shaping their attitudes towards mathematics are reasons that relate to the students themselves and are produce by them, which means that the students are the cause of their own positive or negative attitudes toward mathematics. Spending more time in practice and training to solve different ideas of mathematical concepts increases the probability of obtaining high grades on mathematics tests. Earning high grades in mathematics increases positive attitudes towards mathematics. Therefore, most factors that affect students’ attitudes came from the students so the solutions should be from the students as well. As a result, the present study confirms that the majority of the reasons that affect freshman engineering students’ attitudes stem from the students themselves.
Implications

The results of the current study provide some useful findings and insights into the freshman engineering students’ attitudes toward mathematics. These results can contribute to the efforts of Imam Abdulrahman Bin Faisal University (IAU) to enhance its mathematics courses and overcome the challenges that engineering students might face. In addition, the results might contribute to the efforts of the IAU and other Saudi universities to improve the positive attitude toward mathematics of their engineering students. The freshman engineering students also provided the reasons that they believe are shaping their current attitudes, which may help IAU and other Saudi universities to create ways to improve their students’ attitudes in order to increase the achievement levels of their engineering students in mathematics.

Limitation and Delimitations

Limitation

There are several limitations to this study:

1. The study focused on freshman engineering students in one Saudi university. Thus, the findings may not be generalized to fit all Saudi universities.

2. The study included freshman engineering students in Fall 2018 only, which means the reports are limited to students in one academic semester.

3. The study was undertaken at the beginning of Fall 2018; therefore, if it were undertaken over a longer period of time, such as at the beginning of the semester and at the end of the semester, the results would be more accurate.
4. The lecturer was present during the survey, which may have affected students' responses.

5. Students took only ten to fifteen minutes for the limited survey due to time constraints of these student participants.

6. Some participants may not show their actual opinion when they answered the interview questions because they thought their professors would listen or read their responses. Some participants did not take enough time to reflect properly in order to answer the interview questions. Also, some students overly praised their professors and smiled while answering. Hence, the participants may have had more negative attitudes toward mathematics than what they described.

7. The study is limited to male freshman engineering students and did not include any female participants.

8. The study is subject to the limitations recognized in the data collection by surveys and interviews.

**Delimitations**

Three major delimitations relate to this study. Firstly, the data that was used in the current study were limited to students who enrolled in Fall 2018 at Imam Abdulrahman Bin Faisal University (IAU), a public, scientific, and not-for-profit university located in the eastern province of the Kingdom of Saudi Arabia. Secondly, the data was also limited to those collected from freshman engineering students who enrolled at engineering college during that semester. Finally, the current study includes only data about attitudes, demographics, and interviews that
were given through those freshman engineering students’ responses of the surveys and the interviews.

**Recommendation for Future Studies**

Educational researchers concerned with examining the mathematics attitudes of engineering students may consider one the following suggestions for further research:

1. For future studies, it is recommended to replicate this study in different populations in Saudi Arabia to understand cross-cultural applications of the findings so that Saudi universities can develop and help their engineering students to increase their positive attitudes toward mathematics; which, in turn leads to improved students’ performances.

2. The current study found that the mothers’ educational level, especially undergraduate level, have a negative relationship with the attitudes of their children, and this result was interesting and contrary to the researcher’s expectations. Therefore, re-examining the relationship between the mothers’ educational level and their children’s attitudes toward mathematics with a different and larger sample, or with a different population may help to discover the causes of the relationship and confirm the results of this study.

3. The current study reveals that the teachers have a large and clear impact on the attitudes of their students more than other variables. Consequently, it is necessary to study the teachers’ personal characteristics, their practical skills, and
their influences on their students’ attitudes toward mathematics and the students’ performance.

4. This study found that the English language effect was one reason of the neutral mathematics attitudes among freshman engineering students. Considering this factor, studying the relationship between language effect and students’ achievement in mathematics may help to understand the causes of their failure in mathematics courses. However, it is not certain that students do not suffer from weakness in mathematical skills. Therefore, their mathematics abilities must also be measured along with their language skills.

5. Most of the reasons mentioned by the participants in the interviews were reasons from the students themselves. As a result, many more interviews should be conducted to identify more reasons that students believe have influenced their attitudes. The reasons may support the results of this study and may also draw the attention of researchers to focus on students’ needs and the ways to help students to address the problems.

6. The study could be expanded to investigate the effects of other factors, such as teachers’ methods and peers’ effects, on freshman engineering students’ attitudes toward mathematics.

7. The study focused on testing the attitudes of engineering students in one university only. Researchers are suggested to compare the attitudes of IAU freshman engineering students with the engineering students’ attitudes of prestigious universities such as King Fahd University of Petroleum and Minerals.
This comparison may help to provide more accurate and useful information on the causes of these attitudes and the methods of development.

**Summary**

Findings from the study indicate that IAU freshman engineering students have positive attitudes toward mathematics, and their attitudes are more affected by their fathers and their teachers. Furthermore, the results of the survey indicate that there are positive relationships (1) between the fathers’ career types and all the five attitudes of the students toward mathematics, (2) between the mothers’ career types and students’ confidence in learning mathematics, and (3) between geographical regions and students’ confidence in learning mathematics. In contrast, there are negative relationships (1) between the mothers’ educational levels and two students’ attitudes (confidence in learning mathematics and mathematics anxiety), and (2) between students’ nationalities and their attitudes toward success in mathematics.

In addition, the results of the interview indicate that the reasons that shape freshman engineering students’ attitudes can be divided into two parts, which are internal reasons resulting from the students themselves, and external reasons resulting from others. The internal reasons are (1) practice and preparation, (2) assessments and grades, (3) English language effect, (4) time management, (5) pride in themselves, (6) competition with their colleagues, (7) weak mathematical foundation, (8) consideration of mathematics as a favorite subject, (9) pressure of other courses, (10) awareness of the relationship between mathematics in their daily
lives and mathematics with other scientific subjects, (11) awareness of the relationship between mathematics and their majors, (12) and awareness of the benefit of mathematics in their future career. The external reasons are (1) teachers’ characteristics, (2) parental support, and (3) respect from their fathers.

This study may help the Saudi Ministry of Education, other researchers, administrators, and faculty members to have a better understanding of the freshman engineering students’ attitudes and the factors that shape their views. This may allow them to create the programs that would better serve the engineering students to be academically successful.
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Appendix A

Confirmation From The King Fahd National Library That This Topic Did Not Researched Before
Appendix B

The Survey Instrument (English Version)

Part 1: Demographic Characteristic

Please choose the appropriate response from the following:

1. Nationality
   a) Saudi
   b) Non-Saudi

2. From what region did you come from in Saudi Arabia?
   a) Central Region
   b) Eastern Region
   c) Western Region
   d) Northern Region
   e) Southern Region

3. From what type of high school did you graduate?
   a) Public School
   b) Private School

4. Fathers’ educational levels
   a) Elementary school
   b) Middle school
   c) High School
   d) Undergraduate
   e) Graduate
   f) None

5. Mothers’ educational levels
   a) Elementary school
   b) Middle school
   c) High School
   d) Undergraduate
   e) Graduate
   f) None
6. Fathers’ career types
   a) Health care
   b) Law
   c) Engineering
   d) Education
   e) Military
   f) Self-employed
   g) Company employees
   h) Other

7. Mothers’ career types
   a) Health care
   b) Law
   c) Engineering
   d) Education
   e) Military
   f) Self-employed
   g) Company employees
   h) Housewife
   i) Other

Part 2: The Fennema-Sherman Mathematics Attitude Scales
   Indicate how much you agree with each of the following statement:

   | N | I like math. | Strongly agree | Agree | Not sure | Disagree | Strongly disagree |
---|---|-------------|-------------|--------|-----------|----------|-------------------|
1  |   |             |             |        |           |          |                   |
2  |   | I’d be proud to be the outstanding math student. |             |        |           |          |                   |
3  |   | I am happy to get good grades in math. |             |        |           |          |                   |
4  |   | It would be great to win a prize in math. |             |        |           |          |                   |
5  |   | Being first in a math competition would make me happy. |             |        |           |          |                   |
6  |   | Being thought of as smart in math would be a great thing. |             |        |           |          |                   |
7  |   | Winning a prize in math would make me feel embarrassed. |             |        |           |          |                   |
8  |   | Other students will think I’m weird if I get good grades in math. |             |        |           |          |                   |
9  |   | If I get good grades in math, I would try to hide it. |             |        |           |          |                   |
10 |   | If I got the highest grade in math, I’d prefer no one knew. |             |        |           |          |                   |
11 |   | It would make people like me less if I were a really good math student. |             |        |           |          |                   |
I don’t like students to think I’m smart in math.

### Confidence in Learning Math

<table>
<thead>
<tr>
<th>N</th>
<th>Item</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Not sure</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I feel confident trying math.</td>
<td></td>
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<td>2</td>
<td>I am sure that I could do advanced work in math.</td>
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<tr>
<td>3</td>
<td>I am sure that I can learn math.</td>
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<td>4</td>
<td>I think I could handle more difficult math.</td>
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<tr>
<td>5</td>
<td>I can get good grades in math.</td>
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<tr>
<td>6</td>
<td>I have a lot of self-confidence when it comes to math.</td>
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<tr>
<td>7</td>
<td>I am no good at math.</td>
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<td>8</td>
<td>I do not think I could do advanced math.</td>
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<td>9</td>
<td>I am not the type to do well in math.</td>
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<tr>
<td>10</td>
<td>For some reason, even though I study, math is really hard for me.</td>
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<td>11</td>
<td>I do fine in most subjects, but when it comes to math I really mess up.</td>
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<tr>
<td>12</td>
<td>Math is my worst subject.</td>
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</tbody>
</table>

### Math Anxiety

<table>
<thead>
<tr>
<th>N</th>
<th>Item</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Not sure</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Math does not scare me at all.</td>
<td></td>
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<tr>
<td>2</td>
<td>It wouldn’t bother me at all to take more math courses.</td>
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<tr>
<td>3</td>
<td>I don’t usually worry about being able to solve math problems.</td>
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<tr>
<td>4</td>
<td>I almost never get nervous during a math test.</td>
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<tr>
<td>5</td>
<td>I am usually calm during math tests.</td>
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<tr>
<td>6</td>
<td>I am usually calm in math class.</td>
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<tr>
<td>7</td>
<td>Math usually makes me feel uncomfortable and nervous.</td>
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<tr>
<td>8</td>
<td>Math makes me feel uncomfortable, restless, irritable, and impatient.</td>
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<tr>
<td>9</td>
<td>I get a sick feeling when I think of trying to do math problems.</td>
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<tr>
<td>10</td>
<td>My mind goes blank and I am unable to think clearly when working math problems.</td>
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</tr>
<tr>
<td>11</td>
<td>A math test would scare me.</td>
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<td></td>
</tr>
<tr>
<td>12</td>
<td>Math makes me feel uneasy, confused, and nervous.</td>
<td></td>
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</tr>
</tbody>
</table>
### Usefulness of Math

<table>
<thead>
<tr>
<th>N</th>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Not sure</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I’ll need math for my career.</td>
<td></td>
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<tr>
<td>2</td>
<td>I study math because I know how useful it is.</td>
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<tr>
<td>3</td>
<td>Knowing math will help me earn a living.</td>
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<tr>
<td>4</td>
<td>Math is an important and useful subject.</td>
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<tr>
<td>5</td>
<td>I need to master math for my future work.</td>
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<tr>
<td>6</td>
<td>I will use math in many ways as an adult.</td>
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<tr>
<td>7</td>
<td>Math is not important in my life.</td>
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<tr>
<td>8</td>
<td>Math will not be important in my life’s work.</td>
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<tr>
<td>9</td>
<td>I see math as a subject that I won’t use very much in daily life as an adult.</td>
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<tr>
<td>10</td>
<td>Taking math is a waste of time.</td>
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<tr>
<td>11</td>
<td>It’s not important for me to do well in math as an adult.</td>
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<tr>
<td>12</td>
<td>I expect to have little use for math when I get out of university.</td>
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</tbody>
</table>

### Effectance Motivation

<table>
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<tr>
<th>N</th>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Not sure</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I like math puzzles.</td>
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<tr>
<td>2</td>
<td>Math is enjoyable to me.</td>
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<tr>
<td>3</td>
<td>When a math problem comes up that I cannot solve right away, I stick with it until I find the solution.</td>
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<tr>
<td>4</td>
<td>Once I start working on a math puzzle, it is hard to stop.</td>
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<tr>
<td>5</td>
<td>When I have a question that doesn’t get answered in math class, I keep thinking about it.</td>
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<td>6</td>
<td>I am challenged by math problems I cannot understand right away.</td>
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<tr>
<td>7</td>
<td>Figuring out math problems is not something I like to do.</td>
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<tr>
<td>8</td>
<td>The challenge of math problems does not appeal to me.</td>
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</tr>
<tr>
<td>9</td>
<td>Math puzzles are boring.</td>
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<tr>
<td>10</td>
<td>I do not understand how some people can spend so much time on math and seem to like it.</td>
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<tr>
<td>11</td>
<td>I would rather have someone else figure out a tough math problem than have to work it out myself.</td>
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<td></td>
</tr>
<tr>
<td>12</td>
<td>I do as little work in math as possible.</td>
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</tr>
</tbody>
</table>
Interview Questions

1. a) In general, how would you describe your current attitude toward mathematics?
b) What factors do you feel most influence your current attitude towards mathematics and why?

2. a) In general, how would you describe your current attitude toward success in mathematics?
b) What factors do you think most contributed to your attitude toward success in mathematics? Please justify why.

3. a) In general, do you think you have confidence in learning mathematics?

4. a) Do you feel anxiety about taking a course in mathematics?
b) What factors do you think best contributed to your current anxiety over mathematics? Please justify why.

5. a) Do you feel that mathematics is useful to know?
b) Overall, what factors do you think most contributed to your current awareness of the usefulness of mathematics? Please justify why.

6. a) In general, do you think you have a motivation in mathematics?
b) What factors do you think most contributed to your motivation in mathematics? Please justify why.

7. Answer the following questions from your personal point of view:
a) Overall, do you believe that your geographical region has influenced your current attitude toward mathematics? (Clarify your answer).
b) Overall, do you believe that the type of your high school has influenced your current attitude toward mathematics? (Clarify your answer).
c) Overall, do you believe that your parents’ educational levels have influenced your current attitude toward mathematics? (Clarify your answer).
d) Overall, do you believe that your parents’ career types have influenced your current attitude toward mathematics? (Clarify your answer).
Appendix C

The Survey Instrument (Arabic Version)

القسم الأول: البيانات والمعلومات العامة
الرجاء اختيار الإجابة المناسبة لما يلي:

١. الجنسية:
   أ. سعودي
   ب. غير سعودي

٢. إلى أي منطقة من مناطق المملكة تنتمي؟
   أ. المنطقة الوسطى
   ب. المنطقة الشرقية
   ج. المنطقة الغربية
   د. المنطقة الشمالية
   ه. المنطقة الجنوبية

٣. ما هي نوع المدرسة الثانوية التي تخرجت منها؟
   أ. مدرسة حكومية
   ب. مدرسة خاصة

٤. المستوى التعليمي للأب.
   أ. الابتدائية
   ب. المتوسطة
   ج. الثانوية
   د. بكالوريوس
   ه. دراسات عليا
   و. غير متعلم
5. المستوى التعليمي للأم.
   أ. الابتدائية
   ب. المتوسطة
   ج. الثانوية
   د. بكالوريوس
   ه. دراسات عليا
   و. غير متعلمة

6. القطاع الوظيفي لعمل الأب.
   أ. الصحة
   ب. القانون
   ج. الهندسة
   د. التعليم
   ه. العسكرية
   و. أعمال حرة ( التجارة )
   ز. القطاع الخاص ( شركات )
   ح. غير ذلك

7. القطاع الوظيفي لعمل الأم.
   أ. الصحة
   ب. القانون
   ج. الهندسة
   د. التعليم
   ه. العسكرية
   و. أعمال حرة ( التجارة )
   ز. القطاع الخاص ( شركات )
   ح. ربة منزل
   ط. غير ذلك
القسم الثاني: استبيان "فينما / شيرمان" لقياس اتجاهات (موافقات) الرياضيات

حدد مدى موافقتك أو عدم موافقتك على العبارات التالية:

الموقف من النجاح في الرياضيات:

<table>
<thead>
<tr>
<th>الاعتراف بالنجاح في الرياضيات</th>
<th>رقم</th>
</tr>
</thead>
<tbody>
<tr>
<td>أعارض بشدة</td>
<td>1</td>
</tr>
<tr>
<td>سأكون فخوراً عندما أصبح طالباً متميزاً في الرياضيات.</td>
<td>2</td>
</tr>
<tr>
<td>أنا سعيد للحصول على درجات جيدة في الرياضيات.</td>
<td>3</td>
</tr>
<tr>
<td>سيكون أمراً رائعًا لو فزت بجائزة في الرياضيات.</td>
<td>4</td>
</tr>
<tr>
<td>تحقيق المركز الأول في مسابقة الرياضيات سيعني لي سعيداً.</td>
<td>5</td>
</tr>
<tr>
<td>ان يعتقد أني ذكي في الرياضيات سيكون شيئاً عظيماً.</td>
<td>6</td>
</tr>
<tr>
<td>الفوز بجائزة في الرياضيات سيعنعني أشعر بالحرج.</td>
<td>7</td>
</tr>
<tr>
<td>الطلاب سيعتقدون باني غريب لو حصلت على درجات جيدة في الرياضيات.</td>
<td>8</td>
</tr>
<tr>
<td>إذا حصلت على درجات جيدة في الرياضيات، فسأحاول إخفاؤها.</td>
<td>9</td>
</tr>
<tr>
<td>إذا حصلت على أعلى درجة في الرياضيات، فأفضل أن لا يعلم أحداً بذلك.</td>
<td>10</td>
</tr>
<tr>
<td>قد يظل الأشخاص من حبهم لي لو كنت طالباً جيداً في الرياضيات.</td>
<td>11</td>
</tr>
<tr>
<td>لا أحب أن يظن الطلاب باني ذكي في الرياضيات.</td>
<td>12</td>
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</tbody>
</table>
الثقة في تعلم الرياضيات:

<table>
<thead>
<tr>
<th>رقم</th>
<th>مصطلح</th>
<th>نوعية</th>
<th>امتداد</th>
</tr>
</thead>
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<tr>
<td>1</td>
<td>أشعر بالثقة عند محاولتي لتعلم الرياضيات.</td>
<td>شدة</td>
<td>أوافق بشدة</td>
</tr>
<tr>
<td>2</td>
<td>أنا متأكد من أنه يمكنني حل مسائل صعبة في الرياضيات.</td>
<td>غير</td>
<td>أوافق</td>
</tr>
<tr>
<td>3</td>
<td>أنا متأكد من أنه يمكنني تعلم الرياضيات.</td>
<td>أرافق</td>
<td>أعارض غير متأكد</td>
</tr>
<tr>
<td>4</td>
<td>أعتقد أنه يمكنني التعامل مع مسائل الرياضيات الصعبة.</td>
<td>أرافق</td>
<td>أوافق</td>
</tr>
<tr>
<td>5</td>
<td>يمكنني الحصول على درجات جيدة في الرياضيات.</td>
<td>شدة</td>
<td>أعارض بشدة</td>
</tr>
<tr>
<td>6</td>
<td>لدي الكثير من الثقة بالنفس عندما يتعلق الأمر بالرياضيات.</td>
<td>غير</td>
<td>أعارض غير متأكد</td>
</tr>
<tr>
<td>7</td>
<td>أنا نمت متفتاً بالرياضيات بشكل جيد.</td>
<td>أرافق</td>
<td>أعارض</td>
</tr>
<tr>
<td>8</td>
<td>لا أعتقد أنه يمكنني القيام بمسائل الرياضيات الصعبة.</td>
<td>أرافق</td>
<td>أوافق</td>
</tr>
<tr>
<td>9</td>
<td>أنا لست من الطلاب الذين يؤدون بشكل جيد في الرياضيات.</td>
<td>شدة</td>
<td>أعارض بشدة</td>
</tr>
<tr>
<td>10</td>
<td>على الرغم من أنني أدرس ولكن لسبب ما فإن الرياضيات صعبة بالنسبة لي.</td>
<td>غير</td>
<td>أعارض غير متأكد</td>
</tr>
<tr>
<td>11</td>
<td>أنا جيد في معظم المواد، ولكن في الرياضيات فانني لا أؤدي بشكل جيد.</td>
<td>أرافق</td>
<td>أعارض</td>
</tr>
<tr>
<td>12</td>
<td>الرياضيات هي أسوء مادة لدي.</td>
<td>أرافق</td>
<td>أعارض</td>
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القلق من الرياضيات:

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<td>الرياضيات لا تُخيفني مطلقاً.</td>
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<td>إنه لا يزعجني مطلقاً دراسة المزيد من مواد الرياضيات.</td>
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<td>إنني لا أقلق عادةً حول قدرتي على حل مسائل الرياضيات.</td>
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<td>تقريباً لم يحدث لي أن توتر خلال اختبار الرياضيات.</td>
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<td>عادةً أكون هادئاً خلال اختبارات الرياضيات.</td>
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<td>الرياضيات عادةً تجعلني أشعر بعدم الارتياح والتوتر.</td>
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<td>الرياضيات تجعلني أشعر بعدم الارتياح، والقلق، والانفعال، وقلة الصبر.</td>
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<td>أشعر بالتعب عندما أفكر في محاولة القيام بحل مسائل الرياضيات.</td>
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<td>ذهني يكون مشوشاً وغير قادر على التفكير بوضوح عند حل مسائل الرياضيات.</td>
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<tr>
<td>اختبار الرياضيات يُخيفني.</td>
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<td>11</td>
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<td>الرياضيات تجعلني أشعر بعدم الارتياح، والارتباك، والتوتر.</td>
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فائدة الرياضيات:

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<td>سوف أحتاج للرياضيات في مهنتي.</td>
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<tr>
<td>2</td>
<td>أنا أدرس الرياضيات لأنني أعرف مدى فائدةها.</td>
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</tr>
<tr>
<td>3</td>
<td>تعلم الرياضيات سوف يساعدني على كسب لقمة العيش.</td>
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<tr>
<td>4</td>
<td>الرياضيات هي مادة مهمة ومفيدة.</td>
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</tr>
<tr>
<td>5</td>
<td>احتاج لإنفاق الرياضيات لعملي المستقبل.</td>
<td></td>
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<td>6</td>
<td>سوف أستخدم الرياضيات في مجالات كثيرة كشخص بالغ.</td>
<td></td>
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<tr>
<td>7</td>
<td>الرياضيات ليست مهمة في حياتي.</td>
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<tr>
<td>8</td>
<td>الرياضيات لن تكون مهمة في حياتي العملية.</td>
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</tr>
<tr>
<td>9</td>
<td>أرى الرياضيات كمادة لن استخدمها كثيراً في الحياة اليومية كشخص بالغ.</td>
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<td>دراسة الرياضيات هي مضيعة للوقت.</td>
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<td>11</td>
<td>ليس من المهم بالنسبة لي كشخص بالغ أن أؤدي جيداً في الرياضيات.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>12</td>
<td>أتوقع أن أستخدم القليل من الرياضيات بعد تخرجي من الجامعة.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
تأثير التحفيز:

<table>
<thead>
<tr>
<th></th>
<th>م</th>
</tr>
</thead>
<tbody>
<tr>
<td>أحب الغاز الرياضيات.</td>
<td>1</td>
</tr>
<tr>
<td>الرياضيات ممتعة بالنسبة لي.</td>
<td>2</td>
</tr>
<tr>
<td>عندما تواجهني مسألة في الرياضيات ولا استطيع حلها فوراً، فإني لا أتركها حتى أجد الحل.</td>
<td>3</td>
</tr>
<tr>
<td>أن أتوقف.</td>
<td>4</td>
</tr>
<tr>
<td>عندما يكون لدي سؤال لم يتم الإجابة عليه في حصة الرياضيات، فإني أظل أفكر فيه.</td>
<td>5</td>
</tr>
<tr>
<td>أشرح بالتحدي عندما لا استطيع فهم مسائل الرياضيات في نفس اللحظة.</td>
<td>6</td>
</tr>
<tr>
<td>إيجاد حل لمسائل الرياضيات ليس أمرًا أحب القيام به.</td>
<td>7</td>
</tr>
<tr>
<td>التحدي في مسائل الرياضيات لا يجذبني.</td>
<td>8</td>
</tr>
<tr>
<td>الغاز الرياضيات مملة.</td>
<td>9</td>
</tr>
<tr>
<td>أنا لا أفهم كيف أن بعض الأشخاص يقضون الكثير من الوقت على الرياضيات، ويبدو أنهم يحبون ذلك.</td>
<td>10</td>
</tr>
<tr>
<td>أود أن يقوم شخص آخر بحل مسائل الرياضيات الصعبة بدلاً علي.</td>
<td>11</td>
</tr>
<tr>
<td>أقوم بالقليل من العمل في الرياضيات قد المستطاع.</td>
<td>12</td>
</tr>
</tbody>
</table>

أسئلة المقابلة الشخصية

١. أ) بشكل عام، كيف تصف موقف الحالي من الرياضيات؟
   ب) ما هي العوامل التي تعتقد أن لها تأثيرًا كبيرًا على موقف الحالي من الرياضيات؟ ولماذا؟

٢. أ) بشكل عام، كيف تصف موقف الحالي من النجاح في الرياضيات؟
ب) ما هي العوامل التي تعتقد أنها ساهمت بشكل كبير في موقفك من النجاح في الرياضيات؟ الرجاء التوضيح.

٣. أ) بشكل عام، هل تعتقد أنك تمتلك الثقة لتعلم الرياضيات؟ ب) ما هي العوامل التي تعتقد أنها ساهمت بشكل أفضل في ثقتك في تعلم الرياضيات؟ الرجاء التوضيح.

٤. أ) هل تشعر بالقلق من دراسة مواد الرياضيات؟ ب) ما هي العوامل التي تعتقد أنها ساهمت بشكل كبير في قلقك من الرياضيات؟ الرجاء التوضيح.

٥. أ) هل تعتقد أن هناك فائدة من تعلم الرياضيات؟ ب) بشكل عام، ما هي العوامل التي تعتقد أنها ساهمت في استيعابك بفائدة الرياضيات؟ الرجاء التوضيح.

٦. أ) بشكل عام، هل تعتقد أنك تمتلك الحافز لتعلم الرياضيات؟ ب) ما هي العوامل التي تعتقد أنها ساهمت في تحفزك لتعلم الرياضيات؟ الرجاء التوضيح.

٧. أجب عن الأسئلة التالية من وجهة نظرك الشخصية:

أ) بشكل عام، هل تعتقد أن المنطقة التي تنتمي إليها كان لها تأثيرًا على موقفك (اتجاهك) الحالي من الرياضيات؟ (وصنح إجابتك)

ب) بشكل عام، هل تعتقد أن نوع الثانوية التي تخرجت منها كان لها تأثيرًا على موقفك (اتجاهك) الحالي من الرياضيات؟ (وصنح إجابتك)

ج) بشكل عام، هل تعتقد أن نوع وظيفة والديك كان لها تأثيرًا على موقفك (اتجاهك) الحالي من الرياضيات؟ (وصنح إجابتك)

د) بشكل عام، هل تعتقد أن نوع مستوى تعليم والديك كان لها تأثيرًا على موقفك (اتجاهك) الحالي من الرياضيات؟ (وصنح إجابتك)
Appendix D

Fennema-Sherman Mathematics Attitude Scales Key

<table>
<thead>
<tr>
<th>Code</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Attitudes Toward Success in Mathematics</td>
</tr>
<tr>
<td>C</td>
<td>Confidence in Learning Mathematics</td>
</tr>
<tr>
<td>M</td>
<td>Mathematics Anxiety</td>
</tr>
<tr>
<td>E</td>
<td>Effectance Motivation</td>
</tr>
<tr>
<td>U</td>
<td>Usefulness of Mathematics</td>
</tr>
</tbody>
</table>

| +    | A positive attitude.                     |
| –    | A negative attitude.                     |

**Scoring Directions**

Positively items get a score based on the following point scale:

Strongly agree = 5  Agree = 4  Not sure = 3  Disagree = 2  Strongly disagree = 1

Negatively items get a score based on the following point scale:

Strongly agree = 1  Agree = 2  Not sure = 3  Disagree = 4  Strongly disagree = 5

Collect the score for each group to obtain the total for that attitude.

**Note:** Represent the negatively questions by a minus sign while positively questions by a positive sign.
<table>
<thead>
<tr>
<th>Question #</th>
<th>Category</th>
<th>Attitude</th>
<th>Question #</th>
<th>Category</th>
<th>Attitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>S</td>
<td>+</td>
<td>1.</td>
<td>C</td>
<td>+</td>
</tr>
<tr>
<td>2.</td>
<td>S</td>
<td>+</td>
<td>2.</td>
<td>C</td>
<td>+</td>
</tr>
<tr>
<td>3.</td>
<td>S</td>
<td>+</td>
<td>3.</td>
<td>C</td>
<td>+</td>
</tr>
<tr>
<td>4.</td>
<td>S</td>
<td>+</td>
<td>4.</td>
<td>C</td>
<td>+</td>
</tr>
<tr>
<td>5.</td>
<td>S</td>
<td>+</td>
<td>5.</td>
<td>C</td>
<td>+</td>
</tr>
<tr>
<td>7.</td>
<td>S</td>
<td>–</td>
<td>7.</td>
<td>C</td>
<td>–</td>
</tr>
<tr>
<td>Question #</td>
<td>Category</td>
<td>Attitude</td>
<td>Question #</td>
<td>Category</td>
<td>Attitude</td>
</tr>
<tr>
<td>1.</td>
<td>M</td>
<td>+</td>
<td>1.</td>
<td>E</td>
<td>+</td>
</tr>
<tr>
<td>2.</td>
<td>M</td>
<td>+</td>
<td>2.</td>
<td>E</td>
<td>+</td>
</tr>
<tr>
<td>3.</td>
<td>M</td>
<td>+</td>
<td>3.</td>
<td>E</td>
<td>+</td>
</tr>
<tr>
<td>4.</td>
<td>M</td>
<td>+</td>
<td>4.</td>
<td>E</td>
<td>+</td>
</tr>
<tr>
<td>5.</td>
<td>M</td>
<td>+</td>
<td>5.</td>
<td>E</td>
<td>+</td>
</tr>
<tr>
<td>Question #</td>
<td>Category</td>
<td>Attitude</td>
<td>Question #</td>
<td>Category</td>
<td>Attitude</td>
</tr>
<tr>
<td>1.</td>
<td>U</td>
<td>+</td>
<td>1.</td>
<td>U</td>
<td>+</td>
</tr>
<tr>
<td>2.</td>
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<td>+</td>
<td>2.</td>
<td>U</td>
<td>+</td>
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<tr>
<td>3.</td>
<td>U</td>
<td>+</td>
<td>3.</td>
<td>U</td>
<td>+</td>
</tr>
<tr>
<td>4.</td>
<td>U</td>
<td>+</td>
<td>4.</td>
<td>U</td>
<td>+</td>
</tr>
<tr>
<td>5.</td>
<td>U</td>
<td>+</td>
<td>5.</td>
<td>U</td>
<td>+</td>
</tr>
<tr>
<td>6.</td>
<td>U</td>
<td>+</td>
<td>6.</td>
<td>U</td>
<td>+</td>
</tr>
</tbody>
</table>
## Appendix E

Institutional Review Board (IRB) Approval at Imam Abdulrahman Bin Faisal University

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Title</td>
<td>The Relationship Between The Attitude Toward Mathematics of Freshmen Engineering Students and Their Mathematics GPA at Imam Abdulrahman Bin Faisal University (IAU) in Saudi Arabia</td>
</tr>
<tr>
<td>Principal Investigator</td>
<td>Postgraduate Student / Essa Abdullah Albraheim</td>
</tr>
<tr>
<td>Supervisor</td>
<td>Dr. Ashraf Nabeel Muhammad</td>
</tr>
<tr>
<td>College / Center</td>
<td>Education Department</td>
</tr>
<tr>
<td>Curricula and Instruction</td>
<td></td>
</tr>
<tr>
<td>Approval Date</td>
<td>21/12/2017</td>
</tr>
</tbody>
</table>

The application was reviewed and approved at the University of Dammam IRB meeting on Thursday, December 21, 2017.

Approval is given for one year from the date of approval. Projects, which have not commenced within six months of the original approval, must be re-submitted to the University Institutional Review Board (IRB) Committee. If you are unable to complete your research within the validation period, you will be required to request an extension from the IRB Committee.

On completion of the research, the Principal Investigator is required to advise the Institutional Review Board if any changes are made to the protocol, a revised protocol must be submitted to the Institutional Review Board for reconsideration.

Approval is given on the understanding that the "Guidelines for Ethical Research Practice" are adhered to. Where required, a signed written consent form must be obtained from each participant in the study group.

Dean of Scientific Research

Dr. Naf Nasser Almasoud
Appendix F

Institutional Review Board (IRB) Approval at Florida Institute of Technology

Notice of Exempt Review Status
Certificate of Clearance for Human Participants Research

Principal Investigator: Essa Alitrheim
Date: June 18, 2018
IRB Number: 18-099
Study Title: Demographic factors affecting engineering students’ attitudes toward mathematics

Your research protocol was reviewed and approved by the IRB Chairperson. Per federal regulations, 45 CFR 46.101, your study has been determined to be minimal risk for human subjects and exempt from 45 CFR46 federal regulations. The Exempt determination is valid indefinitely. Substantive changes to the approved exempt research must be requested and approved prior to their initiation. Investigators may request proposed changes by submitting a Revision Request form found on the IRB website.

Acceptance of this study is based on your agreement to abide by the policies and procedures of Florida Institute of Technology’s Human Research Protection Program (http://web2.fit.edu/crm/irb) and does not replace any other approvals that may be required.

All data, which may include signed consent form documents, must be retained in a secure location for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Access to data is limited to authorized individuals listed as key study personnel.

The category for which exempt status has been determined for this protocol is as follows:

2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior so long as confidentiality is maintained.
   a. Information is recorded in such a manner that the subject cannot be identified, directly or through identifiers linked to the participant and/or
   b. Subject’s responses, if known outside the research would not reasonably place the subject at risk of criminal or civil liability or be damaging to the subject’s financial standing, employability, or reputation.
Appendix G

Institutional Review Board (IRB) Approval for Pilot Study

[Image of Florida Institute of Technology logo]

Notice of Exempt Review Status
Certificate of Clearance for Human Participants Research

Principal Investigator: Essa Albraheim
Date: December 19, 2017
IRB Number: 17-207
Study Title: A pilot study

Your research protocol was reviewed and approved by the IRB Chairperson. Per federal regulations, 45 CFR 46.101, your study has been determined to be minimal risk for human subjects and exempt from 45 CFR46 federal regulations. The Exempt determination is valid indefinitely. Substantive changes to the approved exempt research must be requested and approved prior to their initiation. Investigators may request proposed changes by submitting a Revision Request form found on the IRB website.

Acceptance of this study is based on your agreement to abide by the policies and procedures of Florida Institute of Technology’s Human Research Protection Program (http://web2.fit.edu/crm/irb) and does not replace any other approvals that may be required.

All data, which may include signed consent form documents, must be retained in a secure location for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Access to data is limited to authorized individuals listed as key study personnel.

The category for which exempt status has been determined for this protocol is as follows:

2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior so long as confidentiality is maintained.
   a. Information is recorded in such a manner that the subject cannot be identified, directly or through identifiers linked to the participant and/or
   b. Subject’s responses, if known outside the research would not reasonably place the subject at risk of criminal or civil liability or be damaging to the subject’s financial standing, employability, or reputation.
Appendix H

Permission to Use The Fennema-Sherman Instrument

You have my permission to use the Fennema Sherman scales for your research.
Elizabeth Fennema

Sent from my iPhone

On Dec 4, 2017, at 8:43 AM, Essa Alibraheim <ealibrahim2014@my.fit.edu> wrote:

Dear Prof. Fennema,
My name is Essa Alibrahim and I am a PhD student in Mathematics Education. I am currently working on my dissertation at the Florida Institute of Technology (FIT). I am planning to investigate the attitudes of freshman engineering students toward Mathematics in Saudi Arabia. I would like to have your permission to use five of the nine domains of the Fennema-Sherman Mathematics Attitude Scales, which are (1) attitude towards success in mathematics, (2) confidence in learning mathematics, (3) mathematics anxiety scale, (4) usefulness of mathematics scale, and (5) effectance motivation scale. Also, I will translate it to Arabic language.
Best regards,
Essa A. Alibrahim
## Appendix I

### Open-Coded Matrix

<table>
<thead>
<tr>
<th>N</th>
<th>Describe your current attitude and list factors that contributed it?</th>
<th>Describe your attitude toward success and list factors that contributed it?</th>
<th>Have a confidence? List factors that contributed it?</th>
<th>Have an anxiety? List factors that contributed it?</th>
<th>Is math useful? Why?</th>
<th>Have a motivation? List factors that contributed it?</th>
<th>How do you improve your mathematics attitude?</th>
</tr>
</thead>
</table>

1 Neutral.
Math courses are hard in college.
Grades.

2 Positive.
Enjoy problems.
Teachers.

3 Positive.
Good achievement.
Mother.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td>4</td>
<td>Positive.</td>
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<td>---</td>
</tr>
</tbody>
</table>
|   | **Neutral.**
|   | Math courses are hard. Other courses in university. |
| 17 | **Neutral.**
|   | In first year. |
| 18 | **Positive.**
|   | Using in future. Teachers. |
| 19 | **Neutral.**
|   | Way of teaching. |
| 20 | **Positive.**
|   | Father. |
| 21 |
|-----|-----------------------------------|-------------------------------------|------------------------------------------|------------------------------------------------|------------------------------------------|------------------------------------------|
|-----|---------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------------|---------------------------------------------------------------------------------|------------------------------------------------|------------------------------------------------|
| 26  |                     |                                               |                                               |                                               |                                                                                 |                                                                                   |                                                                                   |
Appendix J
Results of The Study (Survey & Interviews)