مجلة جامعة أم القرى للعلوم التربوية والنفسية

الموقع الإلكتروني: https://uqu.edu.sa/jep

اتجاهات الطالبات نحو الرياضيات وعلاقتها بالتحصيل في الرياضيات

Female Students' Attitudes Toward Mathematics and Their Relationships with Mathematics Achievement

منى خليفة العديل*

قسم المناهج وطرق التدريس، كلية التربية، جامعة الملك فيصل، الأحساء، المملكة العربية السعودية

Mona Khalifah Aladil*

Department of Curriculum and Instruction, King Faisal University, Al-Hasa 31982, Saudi Arabia

تاريخ التقديم: 19/1/2024 تاريخ ارسال التعديلات: 10/5/2024 تاريخ القبول:13/5/2024

Received:19/1/2024 Revised:10/5/2024 Accepted: 13/5/2024

الملخص:

هدفت هذه الدراسة لقياس اتجاهات الطالبات السعوديات نحو الرياضيات في المجالات التالية: الثقة بالنفس، إدراك القيمة، الاستمتاع، الدافعية، والقلق، ولدراسة علاقة هذه المجالات بالتحصيل في الرياضيات. ولقد تم استخدام مقياس الاتجاهات نحو الرياضيات ومقياس القلق الرياضي المكون من مكون واحد لتحديد اتجاهات 300 طالبة سعودية في السنة الأولى الجامعية نحو الرياضيات. التحصيل في الرياضيات اعتمد على التحصيل في مادة متطلبة أساسية، وهي الرياضيات العامة. استخدمت هذه الدراسة منهج البحث الكمي متضمناً الإحصاء الوصفي وتحليل ارتباط بيرسون. أظهرت نتائج الدراسة أن الطالبات لديهن اتجاهات إيجابية نحو الرياضيات في مجالات الثقة بالنفس، إدراك القيمة، الاستمتاع، الدافعية، والقلق. بالإضافة لذلك، كشفت النتائج عن علاقات ذات دلالة إحصائية بين كل مجال من مجالات الاتجاهات نحو الرياضيات والتحصيل في الرياضيات. في ضوء هذه النتائج، أوصت الدراسة المعلمين بتحديد اتجاهات الطلاب نحو الرياضيات ومن ثم السعي لتقديم الدعم المناسب لمساعدة الطالبات على تطوير اتجاهات فعالة لتحسين تحصيلهم في الرياضيات.

الكلمات المفتاحية: التحصيل، الاتجاهات، الرياضيات، الطالبات.

Abstract:

This study aimed to assess Saudi female students' attitudes toward mathematics in the following domains: self-confidence, perceived value, enjoyment, motivation, and anxiety, and examine their relationships with mathematics achievement. The Attitudes Toward Mathematics Inventory and the Single-Item Math Anxiety Scale were used to determine the attitudes of 300 Saudi first-year female students toward mathematics. Mathematics achievement was based on performance in a core subject, General Mathematics. A quantitative research approach employing descriptive statistics and Pearson correlation analysis was used in this study. The results of this study show that Saudi first-year female students have positive attitudes toward mathematics in the domains of self-confidence, perceived value, enjoyment, and anxiety. Furthermore, the results reveal significant relationships between each domain of attitudes toward mathematics and mathematics achievement. In light of these results, the study recommended that educators determine students' attitudes toward mathematics and then seek to provide suitable support to help these students develop effective attitudes to improve their mathematics achievement.

Keywords: Achievement, Attitudes, Mathematics, Students.

***المؤلف المراسل:** منى خليفة العديل

البريد الالكتروني الرسمي: maladail@kfu.edu.sa

Doi: https://doi.org/10.54940/ep54991047

1658-8177 / © 2024 by the Authors.

Published by ***J. Umm Al-Qura Univ. Educ. and Psychol. Sci.***

Introduction

Mathematics is not only a powerful tool for understanding the universe but also a essential to human knowledge and advancement. Mathematics influences how people think, so it is one of the most critical subjects for success in academics and work life (Moussa & Saali, 2022). Mathematics is the foundation of scientific inventions and discoveries, research studies, and most majors in higher education (Maass et al., 2019). It is an essential subject to study and research in many new and significant areas such as artificial intelligence algorithms, big data streams, and cloud infrastructure. In Saudi Arabia's effort to reform its educational system, mathematics—as one of the STEAM fields—has received more attention than other subjects. Hence, evolving the quality of mathematics education and investigating the factors that impact students' mathematics performance are extremely important for educators and educational institutions.

Investigating the factors that impact students' mathematics learning and achievement is an ongoing line of research in different countries, but very few of such studies have been conducted on Saudi Arabia, which has a unique culture and environment. The cognitive and affective factors that impact students' mathematics learning and achievement have been studied by mathematics education researchers around the world (Ashcraft & Krause, 2007; Giofrè et al., 2017; McLeod, 1992; Semeraro et al., 2020). Numerous research studies have concluded that attitude plays a significant role in students' learning and understanding of mathematics and their performance in mathematics (Brezavšček et al., 2020; Cerbito, 2020; ; Hagan et al., 2020; ; Jameson et al., 2022; Manalaysay, 2019; Peteros et al., 2019; Pyzdrowski et al., 2013). However, a review of the literature on the relationship between students' attitudes toward mathematics and their mathematics achievement, which comprises studies conducted in various countries, reveals inconsistent findings. There are many factors that may be responsible for the differences in the research findings, such as students' individual characteristics, culture, and environment. Despite Saudi Arabia's distinct culture and environment, there are not many research studies on the most popular domains used to measure students' attitudes toward mathematics. Therefore, studying students' attitudes toward mathematics and their relationship to mathematics achievement in a Saudi context is crucial for the mathematics education reform effort in Saudi Arabia.

Literature Review

Attitudes toward Mathematics

Attitudes toward mathematics have received notable attention since the 1960s. A review of the literature on attitudes toward mathematics shows that few researchers have defined the term clearly, and there are numerous definitions explaining the term. Attitude was defined by Eagly and Chaiken (1993) as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (p. 1). Earlier, attitude toward mathematics was defined simply by mathematics education researchers, characterizing it as an emotional disposition, either positive or negative (Haladyna et al., 1983; McLeod, 1992). Other researchers have characterized attitudes toward mathematics as reactions in terms of the importance attached, the level of difficulty, and the enjoyment derived, which could be either positive or negative (Ma, 1997). Subsequently, researchers used the term *attitudes toward mathematics* to indicate various aspects, such as liking and enjoying mathematics and having anxiety regarding the subject, as well as self-confidence, self-concept, and the perceived value of mathematics. Because of the multidimensionality of attitudes toward mathematics, Zan and Di Martino (2007) and Di Martino and Zan (2010) propose that based on three components (i.e., affective, cognitive, and behavioral components), the definitions of attitudes toward mathematics can be grouped into three categories: (1) unidimensional definitions that refer to emotional dispositions toward mathematics (i.e., the affective component), (2) bi-dimensional definitions reflecting emotions and beliefs about mathematics (i.e., affective and cognitive components), and (3) multidimensional definitions that combine affective, cognitive, and behavioral components (e.g., emotions, beliefs, and behaviors). Wen and Dubé (2022) propose a triple construct of attitudes toward mathematics in which the affective component includes anxiety and enjoyment, the cognitive component includes self-confidence and self-concept with regard to mathematics, gender roles, and the value one places on mathematics, and the behavioral component comprises behavioral intentions.

Measuring Attitudes Toward Mathematics

Mathematics education researchers recognize that attitude plays a significant role in teaching and learning mathematics (McLeod, 1992; Neale, 1969). To study students' attitudes toward mathematics, researchers have focused on developing several measuring instruments for assessing one or more of the domains of attitudes toward mathematics. In 1970, Aiken developed the Mathematics Attitude Scale, which has had a major impact on the field, to measure the enjoyment students derived from learning mathematics and the value they placed on mathematics. This was followed by many instruments that measure only one domain of attitudes to mathematics, such as the Anxiety Rating Scale (Richardson & Suinn, 1972) and the Single-Item Math Anxiety Scale (Ashcraft, 2002), which focus on anxiety, and a mathematics attitude scale (Aşkar, 1986) that measures students' enjoyment of learning mathematics. These were then followed by several instruments that assess more than one domain of attitudes toward mathematics. In 1976, the Fennema-Sherman Mathematics Attitude Scale was developed to measure anxiety, motivation, confidence, gender role, perceived value, students' attitudes toward success, and the attitudes of parents and teachers toward mathematics (Fennema & Sherman, 1976). Fennema and Sherman's scale is the most popular scale used and cited in research studies (Chamberlin, 2023). Following the contributions

of many researchers, more tools have been developed, such as the Mathematics Attitude Inventory (Sandman, 1980), which contains six attitudes toward mathematics domains: anxiety, enjoyment, motivation, teachers' perception, perceived value, and self-concept. Another tool, the Attitudes Toward Mathematics Inventory (Tapia & Marsh, 2004), contains four subdomains: enjoyment, motivation, confidence, and perceived value. A review of the literature shows that these instruments have been used extensively by many researchers to measure the attitudes toward mathematics of students from different countries around the world, but only a few of the sampled student populations are from Saudi Arabia.

Attitudes Toward Mathematics and Mathematics Achievement

Research studies on the relationship between attitudes toward mathematics and academic achievement have not yielded consistent findings. On the one hand, a range of research studies have concluded that there is a relatively strong correlation between students' attitudes toward mathematics and their achievements in mathematics (Cerbito, 2020; Dua et al., 2022; Hwang & Son, 2021; Jameson et al., 2022; Muis, 2004; Ndiaye, 2019; Pyzdrowski et al., 2013; Segarra & Julià, 2022; Sölpük, 2017). Anuar et al. (2020) found a positive correlation between Malaysian students' attitudes toward mathematics in terms of motivation, enjoyment, self-confidence, perceived value, and their mathematics achievement. In a large-scale study, Hwang and Son (2021) investigated 4,853 Singaporean students' attitudes toward mathematics using three indicators: a liking for mathematics, mathematics is highly valued, and confidence in mathematical ability. They concluded that there are statistically positive associations between these factors and the students' mathematics achievement. Jameson et al. (2022) found that US students' attitudes toward mathematics—in terms of confidence and anxiety—impacted the students' performance. Segarra and Julià (2022) emphasize that Spanish students' attitudes toward mathematics, in terms of pleasure, anxiety, usefulness, motivation, and confidence, have a positive effect on their academic achievements. Caviola et al. (2022) conducted a meta-analytic review of 177 studies and found that students' attitudes toward mathematics in the domain of *mathematics anxiety* is significantly related to their achievement in mathematics. In a recent systematic review of 95 studies, Wen and Dubé (2022) observed that students' attitudes toward mathematics in different domains (enjoyment, self-concept, confidence, perceived value, anxiety, gender roles, and behavioral intentions) impact their mathematics achievement.

On the other hand, several research studies report either no correlation or only a weak correlation between students' attitudes toward mathematics and their mathematics achievement (Aiken, 1970 &1976; Ma & Kishor, 1997; Mubeen et al., 2013; Papanastasiou, 2000; Quinn & Jadav, 1987;). A meta-analysis of 113 studies conducted by Ma and Kosher (1997) found a statistically significant association between attitudes and performance but reported that it was quite weak. They concluded that this correlation increases with age and is significant among Asian students. Recently, a study by Mubeen et al. (2013) conducted on Pakistani students and research by Papanastasiou (2000) on students from three countries (the US, Japan, and Cyprus) reported no statistically significant correlation between students' attitudes toward mathematics and their achievements in mathematics. Laranang and Bondoc (2020) found that although Filipino students exhibited positive attitudes toward mathematics, not all the domains of their attitudes are linked to student performance. They found that the value placed on mathematics is linked to mathematics performance; however, there are no significant relationships between students' mathematics performance and their self-confidence, enjoyment, or motivation. Cerbito (2020) found that students in the Philippines had a positive attitude concerning the value placed on mathematics, but their attitudes were negative with respect to self-confidence, enjoyment, and motivation. Furthermore, the results indicate that students with positive attitudes toward mathematics are highly likely to become proficient in mathematics.

In summary, various countries differ not only in mathematics achievement—as revealed by international research, such as the Trends in International Mathematics and Science Study—but also in their attitudes toward mathematics and its relationship with their mathematics performance (Askew et al., 2010; Stevenson et al., 1990). Research studies conducted in various countries report different findings on the relationship between students' attitudes toward mathematics and their mathematics achievement. Each country has its own environment and culture, which results in different attitudes among countries. In addition, there are only a few research studies on the factors that influence mathematics achievement in Saudi Arabia, which has its own unique culture and environment. Specifically, in Saudi Arabia, there is a dearth of research on the most common domains used to measure students' attitudes toward mathematics: *self-confidence regarding mathematics* (CM), *value placed on mathematics* (VM), *motivation of mathematics* (MM), *enjoyment of mathematics* (EM), and *mathematics anxiety* (MA).

Objective of the Study

This study assesses Saudi female students' attitudes toward mathematics in affective domains, including enjoyment, motivation, and anxiety, and in cognitive domains, including self-confidence and perceived value. Furthermore, this study examines the relationship between each domain of attitude toward mathematics and mathematics achievement. The following research questions guide this study:

- What is the attitude of female college students toward mathematics in the domains of self-confidence, perceived value, enjoyment, motivation, and anxiety?
- Is there a statistically significant relationship between female students' attitudes and their achievement in mathematics?

Methodology

This quantitative research study assesses and examines the current attitudes Saudi first-year female students have toward mathematics, owing to the challenges to learning mathematics that they face. To achieve this objective, two descriptive questionnaires—the Attitudes Toward Mathematics Inventory (Tapia & Marsh, 2004) and the Single-Item Math Anxiety Scale (Ashcraft, 2002)—were used to assess female students' attitudes toward mathematics across five domains and to examine their relationships with mathematics achievement. Descriptive statistics and Pearson correlation analysis were used to analyze the data generated.

Instruments

Attitudes Toward Mathematics Inventory

For its use in this study, the Attitudes Toward Mathematics Inventory (ATMI) was adapted to assess four domains of students' attitudes toward mathematics (Tapia, 1996; Tapia & Marsh, 2002, 2004). The ATMI scale was translated into Arabic, and the translated version was reviewed by an expert to ensure the clarity of the statements. This scale comprises 40 items that assess self-confidence, perceived value, enjoyment, and motivation. The first domain, self-confidence (15 items), is the degree to which students trust their ability to handle mathematics. The second domain, perceived value (10 items), refers to the usefulness and importance that students place on mathematics in professional and everyday life. The third domain, enjoyment (10 items), is defined as a student's happiness and interest in working with mathematics. The fourth domain, motivation (5 items), refers to a student's desire and motivation to learn mathematics. The scale employs a five-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree), with 1 indicating especially negative attitudes and 5 indicating especially positive attitudes. The ATMI scale was developed to measure high school students' attitudes. Hence, to determine whether the scale would hold for a population comprising higher education students, an exploratory factor analysis was conducted (Tapia & Marsh, 2002) to determine the reliability of the scale (ATMI), followed by a confirmatory factor analysis for implementation of the scale in a college setting (Karjanto, 2017; Tapia & Marsh, 2004). The ATMI was chosen for measuring students' attitudes toward mathematics because of its comprehensive nature and psychometric properties.

In addition, to determine whether the ATMI scale would hold for Arabic populations, the reliability of the Arabic ATMI scale was verified by calculating its Cronbach's alpha coefficient after it was administered to a pilot sample comprising 30 Saudi female students (Table 1). The value of the Cronbach's alpha coefficient for the total scores related to students' attitudes toward mathematics was 0.951, which is a very high value in terms of internal consistency. Furthermore, the reliability values were greater than the cutoff point (0.70) for the four domains on the ATMI, indicating that the translated scale is statistically acceptable (Cronbach, 1951).

Table 1: *Cronbach's Alpha Results*

Domain	No. of Items	Cronbach's Alpha
Self-Confidence	15	.8900
Perceived Value	10	.9460
Enjoyment	10	.9320
Motivations	5	.8580
All Domains	40	.9510

Single-Item Math Anxiety Scale

The Single-Item Math Anxiety Scale (SIMA) is used to measure students' attitudes toward mathematics in the domain of anxiety (Ashcraft, 2002); such anxiety comprises feelings of fear, tension, and worry related to handling mathematical situations at school and in daily life (Richardson & Suinn, 1972). The scale asks students only one question: "On a scale from 1 to 10, how math anxious are you?" The response scale ranges from 1 (not anxious) to 10 (very anxious). The SIMA exhibits a high correlation with mathematical anxiety instruments such as the shortened scales of the Mathematics Anxiety Rating Scale (Ashcraft, 2002; Núñez-Peña et al., 2014). A systematic study conducted by Núñez-Peña et al. (2014) demonstrates the validity and reliability of the SIMA, after which the researchers demonstrated its strong reliability and validity for implementation within university settings. The SIMA was chosen because it is a valuable instrument for quickly measuring the level of general mathematical anxiety in students.

Study Participants

The population from which this study derived its main data is first-year students enrolled in an introductory mathematics course at a local university in Eastern Saudi Arabia. The major sources of the data collected in this study are all female students enrolled in *General Mathematics* course that is mandatory for all college students. The course covers the concepts and their applications: *Basic Concepts of Algebra, Equations and Inequalities, Limits, Continuity, Functions, Vectors and Matrices, Determinants, Linear System, Differential and Integral Calculus*. The objective of this course is to enable students to acquire mathematical skills and improve their mathematical analysis skills.

Data Collection

After receiving ethical approval from the research ethics committee of the university at which the researcher works and the study participants (female students at the university) take the introductory mathematics course, data were collected during the second semester of the 2022 academic year with a comprehensive sample of all 300 first-year female students to provide a complete picture of the population under study. According to Shannon and Bradshaw (2002), using the entire population as a sample gives everyone the chance to participate, reduces concerns about accuracy, and makes

the survey administration process easier because everyone receives a questionnaire.

The measuring instruments used in this study, the ATMI and the SIMA, were designed on Google Forms and electronically distributed to 300 female students via email, WhatsApp, and their instructors. The researcher visited the study participants during their lectures to emphasize participants' privacy and confidentiality and describe the purpose of the study and the benefits to the participants—as the study findings will contribute to deepening our understanding of their attitudes toward mathematics, which will help educators support them in developing effective attitudes toward mathematics.

Data Analysis

The data collected in this study were analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistical analysis, including the means and standard deviations of the scale results, was used to describe the participants' responses on the ATMI and the SIMA. The descriptive analysis was aimed at identifying female students' attitudes toward mathematics in the self-confidence, perceived value, enjoyment, motivation, and anxiety domains. In addition, the Pearson correlation coefficient was used to identify the relationships between each domain of students' attitudes toward mathematics and their mathematics achievement. The results of the descriptive statistics and the Pearson correlation analysis are discussed in the Results section of this study.

This study design employed a quantitative research approach and descriptive statistics because these provide an efficient and quick way to collect the study data (Chapman et al., 2005). Providing educators with numerical descriptions of their students' attitudes helps them provide the support required to improve their students' achievements.

Results

The results of the descriptive statistics analysis and the Pearson correlation analysis are summarized in Tables 2–7. The overall arithmetic means for each domain of attitudes toward mathematics show that the study participants generally have positive attitudes toward mathematics in the domains of self-confidence, perceived value, enjoyment, and motivation. In essence, they recognize the value and importance of mathematics, are confident about their ability to do mathematics, enjoy learning mathematics, and are motivated to learn mathematics (Table 2). Furthermore, the study participants have positive attitudes toward mathematics in the MA domain. The correlation analysis shows that correlations between mathematics achievement and the five domains of attitudes toward mathematics were statistically significant. The results of the descriptive statistics and the Pearson correlation analysis of each domain of attitudes toward mathematics are subsequently explained in detail.

Table 2 *: Students' Attitudes Toward Mathematics*

Attitude Domain	Arithmetic Mean	Standard Deviation	Attitude Level
Perceived Value	3.76	0.772	High
Self-Confidence	3.73	0.782	High
Enjoyment	3.52	0.805	High
Motivations	3.45	0.868	High
Anxiety	3.84	2.675	Low

Self-Confidence Regarding Mathematics (CM)

The participants' overall arithmetic mean for CM was 3.73 (SD = 0.782) for the CM domain, which is verbally interpreted as high (Table 3). This means that most female students have high self-confidence regarding mathematics and have positive beliefs about their ability to learn the subject. A statistical analysis of the responses to the self-confidence statements on the ATMI reveals that the participants seemed more confident of their feelings of security and comfort in learning mathematics (CM 13 & CM 15) than in performing calculations and solving mathematical problems (CM 7 & CM 8).

Table 3:*Students' Self-Confidence Regarding Mathematics*

Self-Confidence Item	Arithmetic Mean	Standard Deviation	Ranking	Attitude Level
CM 13	4.04	0.989	1	High
CM 15	4.01	1.060	2	High
CM 10	3.99	1.022	3	High
CM 5	3.90	1.167	4	High
CM 4	3.86	1.104	5	High
CM 2	3.85	1.058	6	High
CM 11	3.77	0.964	7	High
CM 14	3.72	1.198	8	High
CM 12	3.67	0.972	9	High
CM 3	3.65	1.173	10	High
CM 1	3.64	1.235	11	High
CM 6	3.52	1.151	12	High
CM 9	3.50	0.988	13	High
CM 7	3.46	1.092	14	High
CM 8	3.37	0.985	15	Medium
CM	3.73	0.782		High

Value Placed on Mathematics (VM)

The participants' overall arithmetic mean for VM was 3.76 (SD = 0.772) for the VM domain, which is verbally interpreted as high (Table 4). This indicates that the female students place a high value on the importance and usefulness of mathematics in professional and everyday life. However, the results of the data analysis show that the participants value the usefulness of mathematics in

developing their thinking and their mathematical skills (VM 2 & VM 3) more than the importance of mathematics in applications outside of school and in other areas (VM 7 & VM 10). Some participants indicated a high level of agreement with the statement "Mathematics helps develop the mind and teaches a person to think" (arithmetic mean = 4.14), while a low level of agreement was indicated for the statements "I can think of many ways that I use mathematics outside of school" (arithmetic mean = 3.47).

Table 4: *Students' Perceived Value of Mathematics*

Value Item	Arithmetic Mean	Standard Deviation	Ranking	Attitude Level
VM 3	4.14	0.846	1	High
VM 2	4.05	0.895	2	High
VM 1	3.84	0.983	3	High
VM 5	3.80	0.985	4	High
VM 9	3.77	0.950	5	High
VM 6	3.75	0.987	6	High
VM 8	3.66	0.962	7	High
VM 4	3.64	0.989	8	High
VM 10	3.48	1.064	9	High
VM 7	3.47	1.000	10	High
VM	3.76	0.772		High

Enjoyment of Mathematics (EM)

The participants' overall arithmetic mean for EM was 3.52 (SD = 0.805), which is verbally interpreted as high (Table 5). This means that the female students find significant enjoyment in learning mathematics, and they feel satisfied and happy when solving mathematics problems. Some female students indicated moderately high enjoyment of mathematics classes and new mathematics problems. They responded positively to the following statements: "I am happier in a mathematics class than in any other class" (arithmetic mean = 3.33), "I would prefer to do an assignment in mathematics than to write an essay" (arithmetic mean = 3.25), and "I like to solve new problems in mathematics" (arithmetic mean = 3.10).

Table 5 *: Students' Enjoyment of Mathematics*

Enjoyment Item	Arithmetic Mean	Standard Deviation	Ranking	Attitude Level
EM 10	3.90	0.904	1	High
EM 9	3.69	0.925	2	High
EM 2	3.68	1.072	3	High
EM 7	3.58	1.061	4	High
EM 1	3.57	1.033	5	High
EM 5	3.55	1.052	6	High
EM 8	3.51	0.950	7	High
EM 6	3.33	1.159	8	Medium
EM 4	3.25	1.203	9	Medium
EM 3	3.10	1.056	10	Medium
EM	3.52	0.805		High

Motivation of Mathematics (MM)

The participants' overall arithmetic mean for MM was 3.45 (SD = 0.868), which is verbally interpreted as high (Table 6). This means that the female students are highly motivated to learn mathematics. Although the female students surveyed have great faith in their ability to learn advanced mathematics and to solve challenging mathematics problems (MM 1 & MM 5), they had an only moderately high desire to take mathematics courses (MM 2, MM 3, & MM 4). They responded moderately positively to the statement "I plan to take as much mathematics as I can during my education" (arithmetic mean = 3.16).

Table 6:*Students' Motivation of Mathematics*

Motivation Item	Arithmetic Mean	Standard Deviation	Ranking	Attitude Level
MM 1	3.99	0.974	1	High
MM 5	3.54	1.103	2	High
MM 2	3.35	1.110	3	Medium
MM 3	3.22	1.138	4	Medium
MM 4	3.16	1.128	5	Medium
MM	3.45	0.868		High

Mathematics Anxiety (MA)

The arithmetic means and standard deviations were also used to assess the level of MA of the students (Table 2). The results show that the overall arithmetic mean for MA was 3.84, and the standard deviation was 2.675, which is verbally interpreted as low. This means that most of the female students assessed had low levels of MA, and only a few of the study participants had a sense of tension or fear regarding mathematics.

Relation Between Attitudes and Achievement

The Pearson correlation analysis revealed that the relationship between the variables—mathematics attitude domains and mathematics achievement—is significant. There is a statistically significant positive relationship between female students' mathematics achievements and their attitudes toward mathematics in terms of self-confidence, perceived value, enjoyment, and motivation (Table 7). However, the results appear to indicate a variance in the degree of correlation between academic achievement and the domains of attitude toward mathematics. The highest correlation was found between mathematics achievement and motivation, while the lowest correlation was found between mathematics achievement and self-confidence. Furthermore, the results show that female students' attitudes toward MA are significantly and negatively related to their mathematics achievement. The value of the Pearson correlation coefficient (−0.909) indicates that female students with low levels of MA perform better academically. In general, this implies that female students' attitudes toward mathematics are predictive of their performance in mathematics.

Table 7: *Pearson Correlation Coefficients for Attitude Domains and Achievement in Mathematics*

Attitude Domain	Mathematics Achievement
Self-Confidence	.461**0
Perceived Value	0.746**
Enjoyment	.698**
Motivations	0.764**
Anxiety	−0.909**

**Correlation is significant at the 0.01 level.

Discussion

This study was conducted to assess the current attitudes of Saudi first-year female students toward mathematics in the domains of self-confidence, perceived value, enjoyment, motivation, and anxiety. Furthermore, it examines the relationships between these domains and the female students' mathematics achievement. The study findings show that the study participants had positive attitudes toward mathematics in the four domains assessed by the ATMI and low levels of MA. The study findings also reveal that female students with positive attitudes toward mathematics and low levels of MA tend to perform particularly well academically in mathematics. As revealed in the literature review, previous studies on the relationships between students' mathematics achievement and their attitudes toward mathematics report mixed findings. The findings of this study are consistent with the findings of many previous studies conducted in various countries such as Malaysia, Singapore, Spain, the US, and Ethiopia (Anuar et al., 2020; Hwang & Son, 2021; Jameson et al., 2022; Kebede, 2023; Segarra & Julià, 2022;) and are inconsistent with the findings of other previous studies, which were conducted in various countries such as Pakistan, the US, Japan, Cyprus, and the Philippines (Cerbito, 2020; Laranang & Bondoc; 2020; Mubeen et al., 2013; Papanastasiou, 2000).

The study findings show that the study participants have positive attitudes toward mathematics in the domains of self-confidence, perceived value, motivation, and enjoyment, as well as low levels of MA. Researchers have discussed a variety of factors that may influence students' attitudes toward mathematics, such as the academic skills of teachers and students, including the following: conceptual understanding in mathematics, study techniques, and instructional strategies (Castillo et.al, 2022; Jeong & González-Gómez, 2021; Tymms, 2001); instructor characteristics (Luke & Sinclair, 1991); classroom learning environment (Zakaria et al., 2010); mathematics course level (Moussa & Saali, 2022); and parents' level of education (Laranang & Bondoc, 2020). In addition, the results of this study show that study participants who are confident in their ability to learn mathematics, who believe that learning mathematics will result in success in school and in job opportunities, who have an interest in learning mathematics, and who trust in their own mathematical abilities are likely to be high achievers in mathematics. There are many possible reasons for this relationship between students' mathematical achievement and their attitudes toward mathematics. Students with these attitudes may tend to invest a considerable amount of time and effort into studying mathematics (Chouinard et al., 2007), and they may solve many mathematical problems and pursue mathematics-related activities. Furthermore, they may actively participate in mathematics classes. All these learning styles may increase brain activity linked to memory retrieval and hippocampus function related to mathematics, which could increase the student's ability to become proficient in mathematics, thereby improving their achievement in mathematics (Santos et al., 2022). The student's age may also influence this relationship. Köller et al. (2001) noted that the relationship between students' academic achievement and their attitudes to mathematics differed depending on the student's grade level. They investigated the same students at the end of grades 7, 10, and 12 and found no significant relationship between students' academic achievement and their attitudes to mathematics from grade 7 to grade 10; however, they did find a significant relationship from grade 10 to grade 12.

Conclusion

This study evaluates the attitudes toward mathematics of first-year Saudi female students and examines the relationship between attitudes toward mathematics and mathematics achievement. The results reveal that Saudi female students have positive attitudes toward mathematics and low MA, and the assessed attitude domains are significantly linked to mathematical achievement. Students who are confident in their mathematical ability, who value mathematics, enjoy working with mathematics, feel motivated to learn mathematics, and are not anxious about mathematics are more likely to have high levels of mathematics achievement.

This finding can be very useful to educators and teachers for promoting their students' attitudes toward mathematics, as these domains contribute significantly to mathematics achievement. Educators need to assess their students' attitudes toward mathematics in various domains and support them differently, based on their current attitudes in these domains. Educators and teachers can improve their students' attitudes toward mathematics by enhancing the methods of instruction and evaluation to ensure that students are motivated to learn mathematics and enjoy learning mathematics. Furthermore, educators and teachers can support students in being aware of the value of mathematics in their academic pursuits and everyday life, as well as promote their confidence in their ability to learn mathematics and lower their mathematics anxiety.

Despite its many limitations, the findings of this study offer several recommendations for future research. First, this study focuses on five domains of attitudes toward mathematics that are based on affective and cognitive

components; future research may consider the behavioral component. Second, the sample in this study comprised Saudi female students at a single university taking the same course. Future research may be designed to compare students' attitudes toward mathematics in terms of gender, course level, and vis-à-vis various universities. In addition, this study is quantitative research that assesses the relationship between Saudi female students' attitudes toward mathematics and their mathematics achievement. Further qualitative research is needed to unravel the factors that shape Saudi female students' attitudes toward mathematics.

Declarations

Conflict of interest: The authors have no relevant financial or non-financial interests to disclose. The authors declare no conflict of interest.

References

Aiken, L. (1970). Attitudes towards mathematics. *Review of Educational Research, 40*(4), 551–596. https://doi.org/10.3102/00346543040004551

Aiken, L. (1976). Update on attitudes and other affective variables in learning mathematics. *Review of educational research, 46*(2), 293-311. https://doi.org/10.3102/00346543046002293

Anuar, N., Abdullah, N., & Hod, S. N. S. (2020). Pre-university students' learning styles and attitude towards mathematics achievements. *Advances in Science, Technology and Engineering Systems, 5*(6), 269–273. https://dx.doi.org/10.25046/aj050632

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin & Review, 14*(2), 243–248. https://doi.org/10.3758/BF03194059

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science, 11*(5), 181–185. https://doi.org/10.1111/1467-8721.00196

Askew, M., Hodgen, J., Hossain, S., & Bretscher, N. (2010). *Values and variables: Mathematics education in high-performing countries.* Nuffield Foundation.

Aşkar, P. (1986). Matematik dersine yönelik tutumu ölçen likert-tipi bir ölçeğin geliştirilmesi. [Developing a likert-type scale measuring attitude toward mathematics lesson]. *Education and Science, 11*(62), 31–36

Brezavšček, A., Jerebic, J., Rus, G., & Žnidaršič, A. (2020). Factors influencing mathematics achievement of university students of social sciences. *Mathematics, 8*(12), 2134. https://doi.org/10.3390/math8122134

Castillo, A. J., Durán, P., Fuller, E., Watson, C., Potvin, G., & Kramer, L. H. (2022). Student attitudes in an innovative active learning approach in calculus. *International Journal of Mathematical Education in Science and Technology, 53*, 1–29. https://doi.org/10.1080/0020739X.2021.2023771

Caviola, S., Toffalini, E., Giofrè, D., Ruiz, J. M., Szűcs, D., & Mammarella, I. C. (2022). Math performance and academic anxiety forms, from sociodemographic to cognitive aspects: A meta-analysis on 906,311 participants. *Educational Psychology Review*, 1-37. https://doi.org/10.1007/s10648-021-09618-5

Cerbito, A. F. (2020). Comparative analysis of mathematics proficiency and attitudes toward mathematics of senior high school student. *Online Submission, 10*(5), 211–222. http://dx.doi.org/10.29322/IJSRP.10.05.2020.p10125

Chouinard, R., Karsenti, T., & Roy, N. (2007). Relations among competence beliefs, utility value, achievement goals, and effort in mathematics. *British Journal of Educational Psychology, 77*(3), 501–517. https://doi.org/10.1348/000709906X133589

Chamberlin, S. A. (2023). A review of instruments created to assess affect in mathematics. *Journal of Mathematics Education, 3*(1), 167–182. https://journalofmathed.scholasticahq.com/article/90462

Chapman, S., McNeill, P., & Mcneill, P. (2005). *Research methods.* Routledge. https://doi.org/10.4324/9780203463000

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297–334. https://doi.org/10.1007/BF02310555

Di Martino, P., & Zan, R. (2010). 'Me and maths': Towards a definition of attitude grounded on students' narratives. *Journal of Mathematics Teacher Education, 13*(1), 27–48. https://doi.org/10.1007/s10857-009-9134-z

Dua, C. C. R., Mancera, A. C., Solis, Y. J. R., Pentang, J. T., & Bautista, R. M. (2022). Preservice teachers' self-concept, self-efficacy, and attitude: Its implications to mathematics achievement. *Studies in Technology and Education, 1*(1), 1–13. https://www.azalpub.com/index.php/ste

Eagly, A. H., & Chaiken, S. (1993). *The psychology of attitudes.* Harcourt Brace Jovanovich College Publishers. https://psycnet.apa.org/record/1992-98849-000

Fennema, E., & Sherman, J. A. (1976). Fennema-Sherman mathematics attitudes scales: Instruments designed to measure attitudes toward the learning of mathematics by females and males. *Journal for Research in Mathematics Education, 7*(5), 324–326. https://doi.org/10.5951/jresematheduc.7.5.0324

Giofrè, D., Borella, E., & Mammarella, I. C. (2017). The relationship between intelligence, working memory, academic self-esteem, and academic achievement. *Journal of Cognitive psychology, 29*(6), 731–747. https://doi.org/10.1080/20445911.2017.1310110

Hagan, J. E., Amoaddai, S., Lawer, V. T., & Atteh, E. (2020). Students' perception towards mathematics and its effects on academic performance. *Asian Journal of Education and Social Studies, 8*(1), 8–14. DOI: 10.9734/AJESS/2020/v8i130210

Haladyna, T., Shaughnessy, J., & Shaughnessy, J. M. (1983). A causal analysis of attitude toward mathematics. *Journal for Research in Mathematics Education, 14*(1), 19–29. https://doi.org/10.5951/jresematheduc.14.1.0019

Hwang, S., & Son, T. (2021). Students' attitude toward mathematics and its relationship with mathematics achievement. *Journal of Education and e-Learning*

Research, *8*(3), 272–280. DOI: 10.20448/journal.509.2021.83.272.280

Jameson, M. M., Dierenfeld, C., & Ybarra, J. (2022). The mediating effects of specific types of self-efficacy on the relationship between math anxiety and performance. *Education Sciences*, *12*(11), 789. https://doi.org/10.3390/educsci12110789

Jeong, J. S., & González-Gómez, D. (2021). Flipped-OCN method in mathematics learning to analyze the attitudes of pre-service teachers. *Mathematics*, *9*(6), 607. https://doi.org/10.3390/math9060607

Karjanto, N. (2017). Attitude toward mathematics among the students at Nazarbayev University Foundation Year Programme. *International Journal of Mathematical Education in Science and Technology*, *48*(6), 849–863. https://doi.org/10.1080/0020739X.2017.1285060

Kebede, W. (2023). Investigating female learners' attitude and challenges towards mathematics at the Department of Mathematics, Injibara College of Teachers' Education, Injibara, Ethiopia. *Cogent Education*, *10*(2), 2256202. https://doi.org/10.1080/2331186X.2023.2256202

Köller, O., Baumert, J., & Schnabel, K. (2001). Does interest matter? The relationship between academic interest and achievement in mathematics. *Journal for Research in Mathematics Education*, *32*(5), 448–470. https://doi.org/10.2307/749801

Laranang, J. A. I., & Bondoc, J. M. F. (2020). Attitudes and self-efficacy of students toward mathematics. *International Journal of English Literature and Social Sciences (IJELS)*, *5*(5). https://dx.doi.org/10.22161/ijels.55.11

Luke, M. D., & Sinclair, G. D. (1991). Gender differences in adolescents' attitudes toward school physical education. *Journal of Teaching in Physical Education*, *11*(1), 31–46. https://doi.org/10.1123/jtpe.11.1.31

Ma, X. (1997). Reciprocal relationships between attitude toward mathematics and achievement in mathematics. *The Journal of Educational Research*, *90*, 221–229. https://doi.org/10.1080/00220671.1997.10544576

Ma, X., & Kosher, N. (1997). Assessing the relationship between attitude toward mathematics and achievement in mathematics: A meta-analysis. *Journal for Research in Mathematics Education*, *28*, 26–47. https://doi.org/10.2307/749662

Maass, K., Geiger, V., Ariza, M. R., & Goos, M. (2019). The role of mathematics in interdisciplinary STEM education. *ZDM Mathematics Education*, *51*, 869–884. https://doi.org/10.1007/s11858-019-01100-5

Manalaysay, E. G. (2019). Gender differences, mathematics anxiety, and first-year college students' mathematical achievement. *International Journal of Scientific and Technology Research*, *8*(6), 25. http://www.ijstr.org/

McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization. In D. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575–596). Macmillan.

Moussa, N. M., & Saali, T. (2022). Factors affecting attitude toward learning mathematics: A case of higher education institutions in the Gulf region. *SAGE Open*, *12*(3). https://doi.org/10.1177/21582440221123023

Mubeen, S., Saeed, S., & Arif, M. H. (2013). Attitude towards mathematics and academic achievement in mathematics among secondary level boys and girls. *Journal of Humanities and Social Science*, *6*(4), 38–41. http://www.iosrjournals.org/

Muis, K. R. (2004). Personal epistemology and mathematics: A critical review and synthesis of research. *Review of educational research*, *74*(3), 317-377. https://doi.org/10.3102/00346543074003317

Neale, D. C. (1969). The role of attitudes in learning mathematics. *Arithmetic Teacher*, *16*, 631–640. https://www.jstor.org/stable/41187564

Ndiaye, S. (2019). Attitudes regarding Perceived Values and Usefulness of Mathematics in a Community College Mathematical Literacy Course. *International Journal of Educational Studies in Mathematics*, *6*(4), 182-192. https://dergipark.org

Núñez-Peña, M. I., Guilera, G., & Suárez-Pellicioni, M. (2014). The Single-Item Math Anxiety Scale: An alternative way of measuring mathematical anxiety. *The Journal of Psychoeducational Assessment*, *32*(4), 306–317. https://doi.org/10.1177/0734282913508528

Papanastasiou, C. (2000). Effects of attitudes and beliefs on mathematics achievement. *Studies in Educational Evaluation*, *26*(1), 27–42. https://doi.org/10.1016/S0191-491X(00)00004-3

Peteros, E., Columna, D., Etcuban, J. O., Almerino Jr, P., & Almerino, J. G. (2019). Attitude and academic achievement of high school students in mathematics under the conditional cash transfer program. *International Electronic Journal of Mathematics Education*, *14*(3), 583–597. https://doi.org/10.29333/iejme/5770

Pyzdrowski, L. J., Sun, Y., Curtis, R., Miller, D., Winn, G., & Hensel, R. A. (2013). Readiness and attitudes as indicators for success in college calculus. *International Journal of Science and Mathematics Education*, *11*, 529–554. https://doi.org/10.1007/s10763-012-9352-1

Quinn, B., & Jadav, A. D. (1987). Causal relationship between attitude and achievement for elementary grade mathematics and reading. *The Journal of Educational Research*, *80*(6), 366-372. ttps://doi.org/10.1080/00220671.1987.10885785

Richardson, F. C., & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. *Journal of Counseling Psychology*, *19*(6), 551–554. https://psycnet.apa.org/doi/10.1037/h0033456

Sandman, R. S. (1980). The mathematics attitude inventory: Instrument and user's manual. *Journal for Research in Mathematics Education*, *11*, 148–159. https://doi.org/10.5951/jresematheduc.11.2.0148

Santos, L. A., Voelkel, J. G., Willer, R., & Zaki, J. (2022). Belief in the utility of cross-partisan empathy reduces partisan animosity and facilitates political persuasion. *Psychological Science*, *33*(9), 1557–1573. https://doi.org/10.1177/09567976221098594

Semeraro, C., Giofrè, D., Coppola, G., Lucangeli, D., & Cassibba, R. (2020). The role of cognitive and non-cognitive factors in mathematics achievement: The importance of the quality of the student-teacher relationship in middle school. *PLoS one*, *15*(4), e0231381. https://doi.org/10.1371/journal.pone.0231381

Segarra, J., & Julià, C. (2022). Mathematics teaching efficacy belief and attitude of pre-service teachers and academic achievement. *European Journal of Science and Mathematics Education*, *10*(1), 1–14. https://doi.org/10.30935/scimath/11381

Shannon, D. M., & Bradshaw, C. C. (2002). A comparison of response rate, response time, and costs of mail and electronic surveys. *The Journal of Experimental Education*, *70*(2), 179–192. https://doi.org/10.1080/00220970209599505

Sölpük, N. (2017). The effect of attitude on student achievement. In E. Karadag (Ed.), *The factors effecting student achievement* (pp. 57–74). Springer. https://doi.org/10.1007/978-3-319-56083-0_4

Stevenson, H. W., Lee, S. Y., Chen, C., Stigler, J. W., Hsu, C. C., Kitamura, S., & Hatano, G. (1990). Contexts of achievement: A study of American, Chinese, and Japanese children. *Monographs of the Society for Research in Child Development*, *55*(1/2), i–119. https://doi.org/10.2307/1166090

Tapia, M. (1996). *The attitudes toward mathematics instrument* [Conference presentation]. The Annual Meeting of the Mid-South Educational Research Association, Tuscaloosa, AL, United States.

Tapia, M., & Marsh, G. E., II. (2002). *Confirmatory factor analysis of the Attitudes Toward Mathematics Inventory* [Conference presentation]. The Annual Meeting of the Mid-South Educational Research Association, Chattanooga, TN, United States.

Tapia, M., & Marsh, G. E. (2004). An instrument to measure mathematics attitudes. *Academic Exchange Quarterly*, *8*(2), 16–22.

Tymms, P. (2001). A test of the big fish in a little pond hypothesis: An investigation into the feelings of seven-year-old pupils in school. *School Effectiveness and School Improvement, 12*(2), 161–181. https://doi.org/10.1076/sesi.12.2.161.3452

Wen, R., & Dubé, A. K. (2022). A systematic review of secondary students' attitudes towards mathematics and its relations with mathematics achievement. *Journal of Numerical Cognition*, *8*(2), 295–325. https://doi.org/10.5964/jnc.7937

Zakaria, E., Chin, L. C., & Daud, M. Y. (2010). The effects of cooperative learning on students' mathematics achievement and attitude towards mathematics. *Journal of Social Sciences*, *6*(2), 272–275. https://doi.org/10.3844/jssp.2010.272.275

Zan, R., & Di Martino, P. (2007). Attitude toward mathematics: Overcoming the positive/negative dichotomy. *The Montana Mathematics Enthusiast, 3*, 157–168.