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INVESTIGATION OF STUDENTS' ATTITUDES TOWARD MATHEMATICS IN MIDDLE SCHOOLS IN SAUDI ARABIA

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Abstract:
Many students in Saudi Arabia complain that they achieve poor results in mathematics and appear to have a negative attitude toward the subject. The current study, therefore, investigates students' attitudes towards mathematics, using a mixed method approach, in 13-16 years old students from the intermediate level of education. The age was important because this period is thought to be crucial to the formation of lasting attitudes and opinions. The first main research question, the study aims to address is therefore, "What are students' attitudes towards mathematics in Saudi middle schools?" The study also aims to explore gender issues using a second research question, "Is there any significant gender difference in students' attitudes towards mathematics?" The survey was conducted in two government-run middle schools in Saudi Arabia, one boys' school and one girls' school, because Saudi Arabia has an exclusively single-sex education system. 180 participants (90 boys and 90 girls) were asked to complete a questionnaire to show their views about mathematics. Qualitative and quantitative data were collected at the same time, but the analysis of each type of information was conducted separately to enable the full picture to be understood. T-test was used to explore any gender differences. The main findings were that both male and female students in two Saudi middle schools show a positive attitude towards mathematics, with female students being slightly more positive than males. The factors which affect attitudes towards mathematics in both genders include the usefulness of mathematics in everyday and future life and career, the teacher, enjoyment of mathematics and the difficulty of the subjects. Girls' attitudes towards mathematics were also affected by the influence of social media personalities and internet teachers.

Keywords: attitude, mathematics, gender, middle school, t-test

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1. Introduction

1.1 Research Background and Problem

According to Third International Mathematics and Science Study (TIMSS), the mathematics performance of Saudi students was very low in 2015 compared to 2011, with a sharp decline in their mathematics ranking for middle schools. Out of 39 countries they ranked lowest, despite Saudi Arabia having applied a new mathematics curriculum since 2012, which is similar to curricula published by McGraw-Hill (Ministry of Education in Saudi Arabia). These alarming results have encouraged me to focus my attention on investigating the reasons for Saudi Arabia's poor performance in this field. A number of studies have been conducted to ascertain the factors influencing students' performance in mathematics, a major factor being students' attitude toward mathematics (Mclead, 1992).

1.2 Research Aim and Objectives

Several studies have shown that the early years of adolescence are considered a critical period for the development of attitudes toward mathematics (see, for example, Johnstone and Hadden, 1983). Therefore, this research focuses on students in Saudi middle schools (aged 13-16). It identifies the essential factors behind attitudes toward mathematics, and examines what affects them from the student's perspective. The first main research question the study aims to address is, "What are students' attitudes towards mathematics in Saudi middle schools?" Based on first main research question, there are two subsidiary research questions:

a) What factors affect students' attitudes about learning of mathematics?
b) What are students' attitudes about "what mathematics is"?

Furthermore, this research focuses on both boys and girls from Saudi middle schools. Although, the Ministry of Education in Saudi Arabia follows a policy of gender-based separation at all levels (Sait *et al.*,2004), the mathematics curriculum is the same for girls and boys (Ministry of Education, 2006). I explore the issues of gender, as summed up by the second main research question, "Is there any significant gender difference in students' attitudes towards mathematics?" The following steps will contribute to achieving the purpose of the study:

- Conducting a thorough review of the related literature regarding understanding factors that affect students and create a negative attitude towards mathematics. It will also examine the steps which can be taken to minimize this negative attitude and discuss how educators can foster positive attitudes toward mathematics.
- A questionnaire will be used to collect data, based on my reading of the literature.
- An objective method of data collection and analysis will be used to ensure that the study has both validity and reliability.

2. Related Literature

2.1 Definition of Attitude toward Mathematics

Attitude is a major factor in the learning and teaching process in mathematics (McLeod, 1992), helping us to understand ourselves, the world around us and our relationships (Reid, 2006). Several studies have shown that positive or negative attitudes affect the performance of students in mathematics (Hungerman, 1967; Hart, 1989). Attitude can be defined as "*The affect for or against the psychological object*" (Thurstone, 1931, p.261). However, this definition focuses exclusively on affect and ignores other aspects of human experience. In 1935, Allport developed this definition to cover "*mental and neural state of readiness to respond, organized through experience, exerting a directive and or / dynamic influence on behaviour*" (p.810). This definition focuses on behaviour and neglects the cognitive and affective factors. In 1992, Oppenheim combined and summarized the above definitions to explain attitude in an acceptable way for most researchers "*Attitude is a state of readiness, a tendency to respond in certain stimuli ...... attitudes are reinforced by beliefs, often attract strong feelings which may lead to particular behavioral intents*" (Oppenheim, 1992, p.174-175; Ramsden, 1998). This definition includes three components: cognitive (beliefs, thoughts, attributes), affective (feelings, emotions) and behavioural information (past event, experiences) (Maio *et al*., 2010). These components all impact on student attitudes (Eagly and Chaiken, 1993). Oppenheim (1992)'s definition concurs to some extent with Hart's multidimensional definition (1989) which includes three components of attitude: emotional response, beliefs regarding the subject, behaviour related to the subject. In contrast, McLeod (1992) and Haladyna *et al*. (1983) claim that attitude to mathematics is just an emotional disposition, either positive or negative, towards the subject. Despite attempts to define attitude toward mathematics, a number of researchers (e.g. Di Martino and Zan, 2011; Hannula, 2002) show attitude to be an ambiguous construct. Attitude is often ill-defined and requires better theoretical development. Di Martino and Zan (2011) demonstrate that research on attitude falls between a large number of different academic disciplines (e.g. mathematics, psychology, cognitive science, anthropology). The present research position follows McLeod (1992)'s multidimensional definition that includes various types of feelings towards Mathematics, such as love, hate, anxiety, interest, and a perception of the usefulness of Mathematics in life. Thus, statements such as "I like Mathematics" or "I'm interested in Mathematics" are defined as attitudes.

2.2 Factors Affecting Students' Attitude toward Mathematics

2.2.1 Personal Factors

- **Mathematics Anxiety**

Mathematics anxiety measures tend to associate quite closely with attitude measures, where mathematics anxiety is considered one of the factors which influence students' attitude toward mathematics and vice versa (Tahar *et al*., 2010; Dowker *et al*., 2016, Belbase, S., 2010). Furthermore, emotional and motivational factors, including belief and anxiety, can help us understand mathematics achievement (Soleymani and Rekabdar, 2016; Namkung *et al*., 2019). Richardoson and Suinn (1972, p.551) define mathematics anxiety as *"... a feeling of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematics problems in wide variety of ordinary life and academic situation"*.

Many studies reported that females in intermediate stages in schools were significantly more anxious than males (Meece el at., 1990; Wigfield and Meece, 1988; Bonnstetter, 2007). Moreover, in a study of 433 British 11 to 15-year olds, Devine *et al*. (2012) found no significant performance differences between boys and girls who completed a mathematics test and a questionnaire about mathematics and test anxiety. However, girls were significantly more anxious in mathematics and tests than males. In contrast, Olmez and Ozel (2012) reported that sixth and seventh-grade male students were significantly more anxious than females, although the weight of research evidence suggests that girls have greater mathematics anxiety (Dowker *et al.*, 2016). Numerous studies suggest that mathematics anxiety starts around age eight, reaches a peak in middle school and continues to increase with age (Scarpello, 2007). The "*boys are better than girls*" stereotype, might increase mathematics anxiety in females (Dowker *et al.* 2016, Wigfield and Meece, 1988). However, for cultural reasons, Saudi girls might not suffer from this stereotype.

Based on the above literature, it is possible that differences between boys and girls regarding mathematics anxiety could be gender-based or involve other gender-related factors such as cultural, environmental or educational context (developed vs. developing country). For example, Reilly *et al*. (2019), reporting results from the 2011 (TIMSS), found that boys reported more favourable attitudes towards mathematics than females in most countries, while some countries in Middle East showed a reversal of this trend (e.g., Oman). Indeed, the variability of gender differences in STEM across cultures suggests that environmental and cultural factors are significant in the development or suppression of these differences (Reilly *et al*., 2019). In addition, distinctive types of religion, language and mathematics itself are generated by particular cultural groups (Bishop, 1988). Therefore, culture appears to play a role in gender differences in terms of attitude toward mathematics. The present study (in 13-16-year olds) may contribute to understanding the effects of gender differences in this field, in Saudi Arabia.

- **Confidence with Mathematics**

Confidence in mathematics is a belief (Fishbein and Azjen, 1975). If students believe that they can do mathematics, they will have confidence in mathematics. The present study takes adopts the definition that includes the concept of confidence in mathematics in general, not in particular mathematics topics. Thus, statements such as "I am confident in solving mathematics problems" or "I find mathematics easy" are defined as confidence in mathematics in general.

Low confidence in mathematics was among the factors affecting students' attitudes towards mathematics and achievement (Zimmermann, 2000; Çiftçi and Yıldız, 2019). According to Gniewosz *et al*. (2012), the transition into adolescence negatively affects confidence and performance in mathematics, particularly when students change schools.

Confidence has been shown to have a possible gender aspect. Several studies suggest that boys and girls are equally confident in their mathematics ability in elementary school but that boys become more confident than girls in middle and high school (Pajares and Graham, 1999). These results are linked to the previously-mentioned transition into adolescence and changes in confidence levels (Gniewosz *et al.*, 2012; Bandura, 1986,1997).

This study will explore further the importance of confidence in attitudes to mathematics in Saudi middle schools (13-16), including the significance of gender differences.

- **Students' Perceptions on the Learning of Mathematics and the Usefulness of Mathematics**

Adelson and McCoach (2011, p.226) defined the perceived usefulness of mathematics as "*a person's beliefs about the practical use and applicability of mathematics currently and in relationship to his or her future*".

Students' perceptions on the learning of mathematics originate from past experiences, derived from parents, teachers or even the media. These instil bad or good perceptions about mathematics, which in turn affect their attitude toward mathematics (Pepin, 2011). Morrisett and Vinsonhaler (1965) claim that childhood experiences may create attitudes toward mathematics, which endure throughout students' academic careers (Aiken,1969), and affect them during its intermediate stage (Syyeda, 2016). Students have varying perceptions about mathematics in the intermediate stages. For example, Pepin (2011) found that in a comparison between English and Norwegian 11-16 year olds, seven themes emerged related to their perception of what mathematics is, why they liked, or disliked mathematics, and their perception of being/not being able to be successful in mathematics, including later life, interest at the challenge, group work, the teacher's role, family support and examinations.

Some of the above points such as "*Mathematics for jobs and 'later life' and "the role of the teacher*" are related to Dobie (2019)'s findings concerning the perspectives of middle school students about the usefulness of mathematics.

Both old and recent studies indicate that girls tend to hold more negative perspectives toward mathematics in middle schools. For example, Ding *et al*. (2015) studied the attitudes of 4,236 students across grades 6 to 9 and found that 85.8 % of 2,153 boys expressed a liking for mathematics, as opposed to only 77.5 % of 1,703 girls. Moreover, in examining affective or attitudinal variables in middle school students, Fennema-Sherman (1978) found that more boys than girls believed that mathematics would be useful to them. However, Uwineza *et al*. (2018) found that in 15 to 18-year olds, both genders shared perceptions about the importance of the subject, although boys had negative perceptions about girls' abilities to succeed in mathematics.

Negative perceptions among students who do not like mathematics or find it useless might be detrimental to the image of mathematics in Saudi Arabia. It is therefore important for this study to investigate Saudi students' perceptions on the learning and usefulness of mathematics in middle schools, since these are a major factor affecting students' attitude towards mathematics.

- **Enjoyment of Mathematics**

Adelson and McCoach (2011, p.226) defined enjoyment of mathematics as "*the degree to which a person takes pleasure in doing and learning mathematics*". Enjoyment is one of the main constructs that measure mathematics attitude for middle school students (Aiken, 1976). According to PISA (2012) enjoyment and interest foster mathematics learning (OECD, 2013). Therefore, if enjoyment increases, attitude will improve. Moreover, enjoyment of and interest in mathematics give intrinsic motivation, where intrinsic motivation represents a principal source of enjoyment (Ryan and Deci, 2000). Thus, if you enjoy mathematics and have an interest in it, you will study it for its own sake rather than to pass a mathematics exam.

In terms of gender and interest, Leder and Forgasz (2002) found that of 800 middle school students, girls demonstrated more interested in mathematics and enjoyed it more, while boys tended to find it hard and boring. However, in an even larger study, according to PISA (2012) results published by OECD (2013), male students were significantly more interested in mathematics and enjoyed it more than girls. Høgheim and Reber (2019) replicate these results, showing that male students report higher interest in mathematics than do female students in middle school.

Finally, males usually consider mathematics to be more enjoyable and to have more meaning than their female counterparts (Høgheim and Reber, 2019) This study will investigate this aspect of attitude towards mathematics in Saudi middle schools and any significant gender difference in enjoyment of mathematics.

2.2.2 Social Factors

Mathematics class environment relationship with teacher and peers.

Attitudes toward mathematics can result from social factors such as teachers, mathematics class environment and peers (Yang, 2013).

There are many studies which have indicated that student attitudes toward study, teachers, methods, and the overall school climate are influenced by the teacher-student relationship (Torrance *et al*., 1966; Fraser and Fisher, 1982; Hartmut, 1978). In middle schools, certain factors influence this relationship. For example, Roeser *et al*. (1998) observed that perceived unfair and disrespectful treatment by teachers undermined the academic motivation of adolescents and may exacerbate emotional upset and anger, with lasting effects (Aiken, 1969).

In terms of learning environments, support from teachers whether academically or affectively is one of the strongest factors affecting the mathematics classrooms in middle schools (Sakiz *et al*., 2012; Newman and Schwager, 1993). Teachers seek to foster a classroom atmosphere which is conducive to developing a positive attitude, which influences whether or not mathematics learning flourishes (Orton and Wain, 1994, Haladyna *et al*. 1983). Learning environments are social, however, and elementary school children, especially girls, are influenced by the attitudes of their peers (Shapiro, 1961). Goodenow (1993a) noted that students experience a sense of belonging when they connect positively with their classmates. This is one of the most important factors in motivation, dedication and engagement (Goodenow, 1993a; Osterman, 2000), which in turn affects their attitude towards mathematics, especially as peers play an important role in development of mathematics attitudes during adolescence (e.g., Berndt 1979). However, in middle school, it is more difficult for students to establish meaningful relationships with their classmates than in elementary school (Hicks, 1997). This may weaken the sense of belonging among students in middle school and affect their attitude. In terms of gender, Asante (2012) found that for students aged 16 to 21 years, teacher attitudes, the school environment and beliefs about mathematics contribute to the gender differences in attitudes towards mathematics. For example, Lee and Lockheed (1990), found that girls had more positive attitudes to mathematics if taught by women teachers. However, in middle school, the gender of teachers had no impact on students' grading behaviours in some studies (e.g., Wiles, 1992). Nevertheless, it might affect their attitude towards mathematics (Mallam, 1993).

Finally, this study will be applied in one boys' school and one girls' school in Saudi Arabia (aged 13-16), to explore social factors which affect student attitudes and investigate any significant gender differences.

2.3 Attitude towards Mathematics

Mathematics appears to be more appealing to boys than to girls, as several studies have indicated that boys tend to have more positive attitudes than girls in middle school (Frost *et al*., 1994; Foxman *et al*., 1981; Else-Quest *et al*., 2013). For example, Reilly *et al*. (2019), reporting results from the 2011 (TIMSS), found that boys reported more favourable attitudes towards mathematics in most countries. However, Reilly *et al*. (2019) found in Oman that more female students showed positive attitudes toward mathematics than males. One explanation could be due to differences in cultural environments and educational contexts between countries (e.g., Cogan and Schmidt, 1999). Regardless of the type of country, the gender-role socialization pattern in culture affects attitudes towards mathematics. For example, in their study of the effect, on attitude to mathematics of ethnicity and gender on Arab and Jewish eighth-grade students in Israel, Birenbaum and Nasser (2006) found a more positive attitude to mathematics amongst the Arab students. Furthermore, girls had more achievement-enhancing approaches than boys and were more successful. Birenbaum and Nasser (2006) stated that one possible explanation given for this was that, in traditional Arab families, daughters have lower status than sons and are less nurtured, spending more of their free time indoors helping with housework, while boys played outside. Girls might therefore use their studies to avoid some of the chores. They might then be motivated by parental expectations of academic success. In the Jewish group, however, gender differences reflected those found in Western cultures.

Finally, this study seeks to examine the factors that influence attitudes toward mathematics in two Saudi middle schools and recommend strategies to improve attitudes.

3. Research Methodology

3.1 Research Design

The question of whether to use qualitative and quantitative methods in educational research has been a matter of controversy, in the literature. Some researchers favour using only one or other of these methods. However, other commentators combine the approaches because this allows the strengths of each method to work in a complementary manner (Muijs, 2004; Cohen *et al*., 2011 and Yin, 1984). Yin (1984, p.92) stated *"...any finding or conclusion in a case study is likely to be much more convincing and accurate if it is based on several different sources of information..."*. In addition, researchers can have greater confidence in the validity of their results when they used a mixed approach because it allows for the collection of data which is both comprehensive and robust (Cohen *et al*., 2011). Therefore, in this study and, in line with Stromquist's (2000) vision that no one methodological instrument that can guarantee the complete truth, both qualitative and quantitative methods was adopted. Moreover, quantitative methods alone would not be enough to tackle my research questions. I need to find out, not only what students' attitudes to mathematics are, but also the factors influencing those attitudes. Qualitative methods are more appropriate to exploring the factors influencing students' attitude towards mathematics (Yılmaz *et al*., 2010). Finally, qualitative and quantitative data were collected simultaneously, but the analysis of each type of information was conducted separately to enable the full picture to be understood.

3.2 Research Method and Technique

Fishbein and Ajzen (1975) point out that attitude can be measured whether positive or not. However, Henerson (1987) claimed that attitudes are not as easy to measure as heart rate, because we can only infer it by considering what they say and do (Henerson, 1987). Generally, when researchers measure attitude, they should select the method which is suitable for the objective of their research and the research timeline.

In this study, I want to find out about students' attitudes toward mathematics in Saudi middle schools. There are direct approaches (e.g. questionnaires, interviews and projective pictures) and indirect approaches (e.g. observation, or deduction of attitudes from some aspect of behaviour) to attitude measurement (Lemon, 1973; Corcoran and Gibb, 1961). In terms of mathematics, direct approaches are appropriate for academic and applied research (Bohner and Wanke, 2002), but respondents who harbor a negative attitude towards mathematics may not wish to admit it to themselves. Thus, it cannot be guaranteed that direct approaches are completely valid. In fact, in most research, direct methods, especially questionnaires and interviews are used in measuring attitudes toward mathematics.

An interview involves at least two people meeting face to face, with the interviewer posing questions and the respondent answering them (Henerson *et al*., 1987). An interview could help the researcher to gain further insight into the student's attitudes regarding mathematics. However, interviewing students individually is time-consuming and there is a risk that the interviewer may unwittingly influence the respondents' answers (Henerson *et al*., 1987), especially with adolescent students. Thus, the questionnaire approach is more appropriate for young adolescents than interviews (Bill, 1973). In addition, respondents at school levels prefer using questionnaires (Oppnheim, 1992). As a result, I will select the questionnaire as the primary technique to collect data.

There are different kinds of questionnaires to measure attitude towards mathematics. For example, Thurstone, Likert and Osgood's Method are having been used in measurement of attitude towards mathematics by many researchers, and each of these methods has its special style (Thurstone, 1929; Thurstone and Chave, 1929; Heise,1970; Oppenheim, 1966, 1992). In this study, I will follow Likert-style of questionnaire. This type of questionnaire is frequently used in education research because it is simple to construct and to analyse and because it makes standardisation possible (Lowry and Turner, 2007). However, social desirability bias is known to be an issue with self-reported, Likert scale questionnaires. This is because participants tend to respond to the questions in ways, they think others will approve of (Grimm, 2010). Ways of avoiding this problem include using indirect questions and not specifically mentioning the research's subject matter (Ipsos, 2013). This research questionnaire also uses two open-ended questions to give respondents an opportunity to express their own ideas and to communicate their feelings.

3.3 Data Analysis Process

In this study, and based on first main research question, quantitative data was used, in the form of descriptive statistics resulting from the questionnaire. Qualitative data analysis was also used, in the form of thematic analysis resulting from the open-ended questions. While, based on the second main research question, an independent t-test was employed to assess whether there were differing average values for gender.

- **Quantitative Data Analysis**

The quantifiable part of the survey was analysed using quantitative methods. Descriptive statistics, such as mean and standard deviation, were used to understand the overall attitude. Such statistics seek to gather information on the characteristics of the research subjects and their activities without inferences or predictions. They simply inform researchers what has been found, in a variety of ways (Cohen *et al*., 2011).

The process and results of statistical tests were calculated and carried out using SPSS Statistics 25 software program and Excel software program. Excel was used to compile responses and they were imported by version 25 of SPSS. The rating scale was Likert and it was coded in SPSS. There were no missing values, which in turn will provide ease of analysis and increased reliability (Field, 2009). There were questions that contain the negative expression. Therefore, reverse coding was done for them. Normality testing was carried out to ensure that the data was normal. This is because, in parametric testing, there is an underlying assumption that the data is normal (Field, 2009). In other words, I used Kolmogorov–Smirnov test and Shapiro–Wilk test as the numerical means of assessing normality. To test for gender differences, an independent t-test was employed to assess whether there were differing average values for two groups (Field, 2009). For this reason, it was appropriate to use the independent t-test on the measurement related to gender for second main research question.

- **Qualitative Data Analysis**

A qualitative method was employed to analyse non-quantifiable data from the open-ended items (textual), which were analysed using thematic analysis because this is a flexible way of analysing such open-ended responses (Braun and Clarke, 2006). Students' responses to questions: "Do you like mathematics?", and "What is mathematics?" were given codes and arranged according to the themes which emerged. This was conducted manually in a step-by step manner. The first stage of the process involved reading the transcripts repeatedly and noting down the initial issues which emerged. The second stage involved coding the data and identifying the verbal expression which related to each code. Thirdly, the codes were sorted according to the emerging themes. A table was used to organise the themes which had been identified when all the extracts from the data had been assimilated. In the fourth stage, a review of the themes was undertaken to investigate how they related to the whole dataset. The themes were then placed in groups according to subject, in line with the research questions. Classification of the responses was undertaken with great care and patterns within the answers were sought where appropriate. This was particularly helpful where one respondent provided contradictory responses and extra care was taken with thematic classification.

3.4 Ethical Consideration

Ethical considerations are an essential part of research, without which the value of the research can be seriously undermined. Permission for this research was granted by the ethics approval committee at the University of East Anglia in the UK, and approval to collect data in Riyadh Schools for this survey, was provided by the Ministry of Education in Saudi Arabia. Written approval was sought both from the leaders of the targeted schools and parents to approve their children's participation in the study. Participants were informed that I would ensure the anonymity of individuals and organisations participating in the research, and that I would safeguard participants' privacy (Bryman and Bell, 2007).

4. Data Analysis and Discussion

4.1 The Reliability Analysis

Before analyzing the data of the study, it is essential firstly to assess the reliability of the questionnaire using Cronbach alpha (Cronbach, 1951), which is suitable for attitude scales (Dunn *et al*., 2014; Gardner, P.L., 1995). Cronbach's alpha reliability coefficient normally ranges between 0 and 1, George and Mallery (2003, p. 231) provide the following rules of thumb: "_ > .9 – Excellent, _ > .8 – Good, _ > .7 – Acceptable, _ > .6 – Questionable, _ > .5 – Poor, and _ < .5 – Unacceptable". The questionnaire of this study has six standards:

1) Mathematics anxiety.
2) Confidence with mathematics.
3) Students' perceptions on the learning of mathematics.
4) The usefulness of mathematics.
5) Enjoyment of mathematics.
6) Mathematics class environment and relationship with teacher and peers.

The Cronbach's alpha values for the six main attitude scales used in the questionnaire are shown in Table 4.1. The values of all scales, except the scale of students' perceptions on the learning of mathematics, range from 0.621 to 0.804, which satisfy the "Acceptable" criterion of reliability and provide evidence for the reliability of the questionnaire. The scale for students' perceptions on the learning of mathematics, rated "unacceptable" according to the criterion. Therefore, I combined it with analysis of the open-ended questions, with which this scale fitted in perfectly.

Table 4.1: Reliability of the Questionnaire

Standards	No. of items	Cronbach alpha	Reliability Level
Mathematics anxiety	5	.744	Acceptable
Confidence with mathematics	6	.663	Questionable
Students' perceptions on the learning of mathematics	2	.143	Unacceptable
The usefulness of mathematics	7	.804	Good
Enjoyment of mathematics.	3	.771	Acceptable
Social factors	7	.621	Questionable
Overall Cronbach's value	29	.881	Good

The overall Cronbach's value is estimated at 0.88, even when including students' perceptions on the learning of mathematics. This demonstrates a high level of reliability for the entire questionnaire, independent of the standards.

4.2 Result of Mathematics Anxiety

Table 4.2: Summary of Participants Response on Mathematic Anxiety

Mathematics Anxiety										
Statement	**Gender**		**Strongly disagree**	**Disagree**	**Unsure**	**Agree**	**Strongly agree**	**Mean**	**SD**	**Level**
I worry about how well I am doing in mathematics.	*Female*	N	25	34	15	9	7	3.68	1.2	Disagree
		%	27.8%	37.8%	16.7%	10%	7.8%			
	male	N	20	20	23	9	18	3.17	1.41	Unsure
		%	22.2%	22.2%	25.6%	10%	20%			
Taking mathematics tests scares me.	*Female*	N	32	32	12	7	7	3.83	1.22	Disagree
		%	35.6%	35.6%	13.3%	7.8%	7.8%			
	male	N	21	16	25	16	12	3.20	1.34	Unsure
		%	23.3%	17.8%	27.8%	17.8%	13.3%			
I worry that other students might understand the problem better than me, when the teacher is showing the class how to do a problem.	*Female*	N	36	25	13	9	7	3.82	1.27	Disagree
		%	40%	27.8%	14.4%	10%	7.8%			
	male	N	22	28	15	11	14	3.37	1.38	Disagree
		%	24.4%	31.1%	16.7%	12.2%	15.6%			
I worry about how well I am doing in mathematics more than other subjects.	*Female*	N	25	40	15	8	2	3.87	.997	Disagree
		%	27.8%	44.4%	16.7%	8.9%	2.2%			
	male	N	24	16	25	15	10	3.32	1.33	Unsure
		%	26.7%	17.8%	27.8%	16.7%	11.1%			
When the teacher says he/she is going to ask me some questions to find out how much I know about mathematics, I worry that I will do poorly.	*Female*	N	18	21	14	21	16	3.04	1.41	Unsure
		%	20%	23%	15.6%	23.3%	17.8%			
	male	N	13	14	19	25	19	2.74	1.34	Unsure
		%	14.4%	15.6%	21.1%	27.8%	21.1%			
	Female	**Weighted mean = 2.3511**				**Std.Deviation= .79000**				
	male	**Weighted mean = 2.8400**				**Std.Deviation= .99310**				

Table 4.2 shows the mathematics anxiety of students. Reverse coding of negative expressions was not used for separate analysis of the statements separately, so high scores represent low anxiety, while a low score means high anxiety. Females and males did not show any high anxiety level for all statements in Table 4.2.

Total anxiety level score, after reverse coding for all negative expressions, it can be seen from demonstrate lower anxiety levels for females, (Weighted mean = 2.35, SD = .79), while males students showed moderate anxiety, (Weighted mean = 2.84, SD =.993). T-test was applied to compare the means between males and females, revealing significant differences between male and female (t=-3.655, df= 169.4, $p < 0.001$).

Two main points emerge from the above results. Firstly, in all statements, females showed low anxiety levels, except when asked questions to ascertain how much they knew about mathematics. Here both females and males just showed moderate anxiety, because of concerns about performing poorly. This worry, which is cognitive and concerns performance and the effects of failing (Wigfield and Meece, 1988), may affect their attitude towards mathematics (Tahar *et al*., 2010; Dowker *et al*., 2016, Belbase, 2010). Secondly, although the weight of research evidence suggests that girls have greater mathematics anxiety (Dowker *et al*., 2016), Table 4.2 shows that female students showed lower anxiety levels compared with males. This is not easy to interpret but perhaps reflects different emphases in cultural environment and educational context, due to gender-based separation at all levels (Sait *et al*., 2004). This concurs with Norton and Rennie (1998)'s findings in 13-16-year olds in Australia, that girls from coeducational schools report more anxiety than girls in the single-sex schools. However, it is the view of the current researcher that girls have greater mathematics anxiety in a co-educational situation, where reluctance to answer questions may be due to fear of mockery by the boys. In an all-female class with a female teacher, they may feel more relaxed about responding: a potential argument in favour of single sex schools.

4.3 Result of Confidence with Mathematics

Table 4.3 shows confidence with mathematics for students. All statements are positive expressions except "Mathematics is more difficult for me than for many of my classmates", I did not conduct reverse coding for this statement. Therefore, high scores on negative statement represent high confidence, while a low score means low confidence.

For total confidence with mathematics level score, after reverse coding for negative expression, it can be seen from Table 4.3 that both females and males show high confidence toward mathematics. However, females show slightly higher confidence (Weighted mean = 1.83, SD = .543) toward mathematics than males (Weighted mean = 2.08, SD = .639). T-test was applied to compare the means between males and female students. The tests revealed that there is significant difference between male and female (t = -2.743, df = 174.44, p = 0.007).

Table 4.3: Summary of Participants Response on Confidence with Mathematics

Confidence with mathematics

Statement	Gender		Strongly disagree	Disagree	Unsure	Agree	Strongly agree	Mean	SD	Level
Mathematics is more difficult for me than for many of my classmates.	*Female*	N	56	26	6	2	0	4.51	.723	Strongly disagree
		%	62.2%	28.9%	6.7%	2.2%	0%			
	male	N	35	25	14	10	6	3.81	1.25	Disagree
		%	38.9%	27.8%	15.6%	11.1%	6.7%			
I'm confident I can understand the basic concepts taught in my mathematics class	*Female*	N	1	0	7	26	56	1.49	.738	Strongly agree
		%	1.1%	0%	7.8%	28.9%	62.2%			
	male	N	4	1	10	29	46	1.76	1.009	Strongly agree
		%	4.4%	1.1%	11.1%	32.2%	51.1%			
I am good at using mathematics to solve real-life problems	*Female*	N	7	11	23	36	13	2.59	1.12	Agree
		%	7.8%	12.2%	25.6%	40%	14.4%			
	male	N	9	11	29	30	11	2.74	1.13	Unsure
		%	10%	12.2%	32.2%	33.3%	12.2%			
I find mathematics easy.	*Female*	N	2	4	17	22	45	1.84	1.02	Agree
		%	2.2%	4.4%	18.9%	24.4%	50%			
	male	N	7	10	23	26	24	2.44	1.21	Agree
		%	7.8%	11.1%	25.6%	28.9%	26.7%			
My teacher thinks I can do well in mathematics.	*Female*	N	1	3	8	32	46	1.68	.859	Strongly agree
		%	1.1%	3.3%	8.9%	35.6%	51.1%			
	male	N	0	0	6	27	63.3	1.43	.619	Strongly agree
		%	0%	0%	6.7%	30%	63.3%			
I am confident in solving mathematics problems.	*Female*	N	0	3	20	36	31	1.94	.839	Agree
		%	0%	3.3%	22.2%	40%	34.4%			
	male	N	0	3	21	32	34	1.92	.864	Agree
		%	0%	3.3%	23.3%	35.6%	37.8%			
	Female	**Weighted mean = 1.8389**				**Std.Deviation= .54306**				
	male	**Weighted mean = 2.0815**				**Std.Deviation= .63954**				

Finally, based on the results above, two main points emerge. Firstly, although both females and males showed high levels of confidence about mathematics, out of 39 countries, Saudi middle schools ranked lowest in their TIMSS mathematics performance in 2015 an ongoing downward trend since 2011. According to result of TIMMS in 2015, the majority of Saudi students (62%) were very confident or confident in mathematics, but 38% were not confident. Therefore, there is gap between performance and confidence about mathematics, with high confidence but low performance. Secondly, Table 4.3 shows that females tend to be more confident in mathematics than males. This raises two points:

Firstly, as mentioned previously, this might be attributable to the cultural educational context. For example, US study of middle school students' attitudes and behaviour found a positive impact for the single-sex setting for girls' mathematics learning, their asking of mathematics questions and how they see themselves as mathematicians (Streitmatter, 1997).

Secondly, in my study, high confidence in mathematics in girls could be associated with their low anxiety levels, which is consistent with prior research findings across recent decades (Parsons *et al*., 2009).

4.4. Result of Perceived Usefulness of Mathematics

Table 4.4 shows the perceived usefulness of mathematics. To analyse the statements separately, all statements are positive expressions except, "I think mathematics is useful only for tests.". I did not conduct reverse coding for this question. Therefore, high scores on this question represent positive perceptions about usefulness of Mathematics, while a low score means negative perceptions about usefulness of Mathematics. There were no negative perceptions among female and male students about usefulness of mathematics in the real world for all statements (see Table 4.4).

For total usefulness of mathematics level score, after reverse coding for all negative expressions, it can be seen that boys and girls hold positive views regarding usefulness of mathematics. Although, females show slightly high positive perceptions about usefulness of Mathematics (Weighted mean = 1.8254, SD = .66621) compared with males, (Weighted mean = 2.0190, SD = .75538), the results indicate no significant differences between females and males ($t = -1.824$, $df = 175.26$, $p = 0.07$).

Finally, based on results above, despite the suggestions by other studies that girls hold negative perceptions (Sherman, 1978), in this study both genders recognise the relevance of mathematics to their daily lives and futures, and there are no statistically significant gender differences. This belief is in line with the Adelson and McCoach (2011, p.226)'s definition of the perceived usefulness of mathematics (see chapter 2). Therefore, for the students in the current study, positive perceptions may increase motivation to study and practice mathematics (Pajares & Miller, 1994).

Table 4.4: Summary of Participants' Responses on Perceived Usefulness of Mathematics

Perceived Usefulness of Mathematics										
Statement	**Gender**		**Strongly disagree**	**Disagree**	**Unsure**	**Agree**	**Strongly agree**	**Mean**	**SD**	**Level**
Mathematics teaches me to think clearly.	*Female*	N	0	3	5	44	38	1.70	.726	Strongly agree
		%	0%	3.3%	5.6%	48.9%	42.2%			
	male	N	2	1	14	47	26	1.96	.833	Agree
		%	2.2%	1.1%	11.1%	52.2%	28.9%			
Mathematics is related in my life.	*Female*	N	8	8	15	23	36	2.21	1.30	Agree
		%	8.9%	8.9%	16.7%	25.6%	40%			
	male	N	10	15	17	25	23	2.60	1.33	Unsure
		%	11.1%	16.7%	18.9%	27.8%	25.6%			
Mathematics is useful for my career.	*Female*	N	3	3	4	25	55	1.60	.969	Strongly agree
		%	3.3%	3.3%	4.4%	27.8%	61.1%			
	male	N	6	3	9	18	54	1.77	1.18	Strongly agree
		%	6.7%	3.3%	10%	20%	60%			
I think mathematics is useful only for tests.	*Female*	N	55	21	7	5	2	4.36	.998	Strongly disagree
		%	61.1%	23.3%	7.8%	5.6%	2.2%			
	male	N	51	22	10	4	3	4.27	1.04	Strongly disagree
		%	56.7%	24.4%	11.1%	4.4%	3.3%			
Mathematics helps me to understand reports and advertisements about prices, sale, percentages etc.	*Female*	N	3	0	4	20	63	1.44	.863	Strongly agree
		%	3.3%	0%	4.4%	22.2%	70%			
	male	N	5	2	3	17	63	1.54	1.06	Strongly agree
		%	5.6%	2.2%	3.3%	18.9%	70%			
Mathematics is an important subject for me.	*Female*	N	1	2	9	25	53	1.59	.847	Strongly agree
		%	1.1%	2.2%	10%	27.8%	58.9%			
	male	N	5	4	14	23	44	1.92	1.15	Agree
		%	5.6%	4.4%	15.6%	25.6%	48.9%			
I think mathematics is useful in solving real world problems.	*Female*	N	4	12	33	25	16	2.59	1.06	Agree
		%	4.4%	13.3%	36.7%	27.8%	17.8%			
	male	N	5	16	28	21	20	2.61	1.17	Unsure
		%	5.6%	17.8%	31.1%	23.3%	22.2%			
	Female	**Weighted mean = 1.8254**				**Std.Deviation= .66621**				
	male	**Weighted mean = 2.0190**				**Std.Deviation= .75538**				

4.5. Result of Enjoyment of Mathematics

Table 4.5: Summary of Participants' Responses on Enjoyment of Mathematics

Enjoyment of Mathematics										
Statement	**Gender**		**Strongly disagree**	**Disagree**	**Unsure**	**Agree**	**Strongly agree**	**Mean**	**SD**	**Level**
I am enjoying doing mathematics.	*Female*	N	1	5	13	22	49	1.74	.978	Strongly agree
		%	1.1%	5.6%	14.4%	24.4%	54.4%			
	male	N	7	4	27	28	24	2.36	1.15	Agree
		%	7.8%	4.4%	30%	31.1%	26.7%			
I find mathematics interesting and motivating.	*Female*	N	3	6	10	29	42	1.88	1.06	Agree
		%	3.3%	6.7%	11.1%	32.2%	46.7%			
	male	N	6	5	24	33	22	2.33	1.11	Agree
		%	6.7%	5.6%	26.7%	36.7%	24.4%			
I find mathematics boring.	*Female*	N	42	26	14	3	5	4.08	1.12	Disagree
		%	46.7%	28.9%	15.6%	3.3%	5.6%			
	male	N	27	25	18	10	10	3.54	1.32	Disagree
		%	30%	27.8%	20%	11.1%	11.1%			
	Female	**Weighted mean = 1.8481**				**Std.Deviation= .87718**				
	male	**Weighted mean = 2.3815**				**Std.Deviation= .97222**				

Table 4.5 shows result of enjoyment of mathematics. All statements are positive expressions except "I find mathematics boring" I did not conduct reverse coding for this question. Therefore, high scores on this question represent high enjoyment in mathematics, while a low score means low enjoyment of mathematics.

For total enjoyment of mathematics level score, after reverse coding "I find mathematics boring", it can be seen from the table that females have slightly more enjoyment of mathematics than males (Females, Weighted mean = 1.8481, SD = .87718), (Males, Weighted mean = 2.3815, SD = .97222). The results show significant differences between female and male students in terms of enjoyment of mathematics ($t = -3.86$, $df = 176.14$, $p = 0.007$).

Two main points emerge from these results. Firstly, as depicted in Table 4.5, the weighted mean was below 2.60, suggesting that female and male students really enjoyed mathematics, an important indicator of intrinsic motivation (Ryan and Deci, 2000), encouraging study for its own sake. Secondly, females experience slightly more enjoyment of mathematics than males, in line with Leder and Forgasz (2002)'s findings that, in Australia, female middle school students had higher levels of interest in and enjoyment of mathematics. It contrasts with PISA (2012)'s findings, published by OECD (2013), that male students were significantly more interested in mathematics and enjoyed it more than girls. This could relate to the cultural environmental and educational context.

For example, an Irish study by Prendergast and O'Donoghue (2014) found that the two top ranking schools in terms of students' enjoyment of mathematics were both single-sex schools. The latter findings support Saudi single-sex educational policy.

4.6. Results of Mathematics Class Environment Relationship with Teacher and Peers

Table 4.6: Summary of Participants' Responses on Mathematics Class Environment Relationship with Teacher and Peers

Mathematics class environment relationship with teacher and peers										
Statement	**Gender**		**Strongly disagree**	**Disagree**	**Unsure**	**Agree**	**Strongly agree**	**Mean**	**SD**	**Level**
My mathematics teacher encourages me at times when I don't do well in class.	*Female*	N	6	3	13	34	34	2.03	1.12	Agree
		%	6.7%	3.3%	14.4%	37.8%	37.8%			
	male	N	5	5	13	25	42	1.96	1.16	Agree
		%	5.6%	5.6%	14.4%	27.8%	46.7%			
Other students in my mathematics class take my ideas seriously.	*Female*	N	7	6	30	30	17	2.51	1.11	Agree
		%	7.8%	6.7%	33.3%	33.3%	18.9%			
	male	N	13	18	29	19	11	3.03	1.22	Unsure
		%	14.4%	20%	32.2%	21.1%	12.2%			
Even thinking about my mathematics class makes me feel hopeless.	*Female*	N	53	24	8	3	2	4.37	.942	Strongly disagree
		%	58.9%	26.7%	8.9%	3.3%	2.2%			
	male	N	33	28	17	7	5	3.86	1.16	Disagree
		%	36.7%	31.1%	18.9%	7.8%	5.6%			
I enjoy participating in this mathematics class.	*Female*	N	1	2	3	26	58	1.47	.767	Strongly agree
		%	1.1%	2.2%	3.3%	28.9%	64.4%			
	male	N	2	5	16	25	42	1.89	1.03	Agree
		%	2.2%	5.6%	17.8%	27.8%	46.7%			
My mathematics teacher respects me.	*Female*	N	2	3	6	20	59	1.54	.926	Strongly agree
		%	2.2%	3.3%	6.7%	22.2%	65.6%			
	male	N	0	0	3	14	73	1.22	.492	Strongly agree
		%	0%	0%	3.3%	15.6%	81.1%			
I feel like my presence matters in my mathematics class.	*Female*	N	0	3	18	32	37	1.86	.855	Agree
		%	0%	3.3%	20%	35.6%	41.1%			
	male	N	5	10	30	23	22	2.48	1.14	Agree
		%	5.6%	11.1%	33.3%	25.6%	24.4%			
	Female	**Weighted mean = 1.8407**				**Std.Deviation= .57459**				
	male	**Weighted mean = 2.1204**				**Std.Deviation= .58006**				

Table 4.6 shows the satisfaction of students in the Mathematics class environment, which is related to teachers and peers. All statements are positive expressions except

"Even thinking about my mathematics class makes me feel hopeless". I did not conduct reverse coding for this question.

When examining the total for all statements, I reversed coding for the negative expression. The table shows that females were more satisfied than boys with the mathematics class environment, teachers and peers (Females, Weighted mean = 1.8407, SD = .57459), (Males, Weighted mean = 2.1204, SD = .58006). T-test was applied to compare the means between males and female students. The test revealed a significant difference between males and females (t = -3.24, df = 177.984, p = 0.001).

Finally, based on results above, two main points can be made. Firstly, both females and males showed satisfaction with their teacher, particularly for the statement, "My mathematics teacher respects me". Their positive relationship with their teacher will affect the mathematics classrooms and hence their attitude toward mathematics (Sakiz *et al*., 2012; Newman and Schwager, 1993; Orton and Wain, 1994). Moreover, all students experience a sense of belonging to the mathematics classrooms, because they relate positively with their peers (Goodenow, 1993a), which will also affect their attitude toward mathematics, especially, as peers play an important role in development of mathematics attitudes during adolescence (e.g., Berndt 1979). Secondly, females were more satisfied than boys with the mathematics class environment, related to teacher. This might be attributable to the cultural environment and educational context. For example, in Nigeria, Lee and Lockheed (1990), found that girls had more positive attitudes to mathematics if taught by women teachers. However, in middle school, the gender of teachers had no impact on students' grading behaviors in some studies (e.g. Wiles, 1992).

4.7 Overall Result of Students' Attitudes towards Mathematics

Table 4.7: Summary of Participants' Responses on Attitude toward Mathematics

Attitude towards mathematics	*Female*	**Weighted mean = 2.0479**	**Std.Deviation= .48551**
Attitude towards mathematics	*male*	**Weighted mean = 2.3368**	**Std.Deviation= .54737**

Table 4.7 shows overall result of students' attitudes towards mathematics in the following areas:

1) Mathematics anxiety.
2) Confidence with mathematics.
3) Students' perceptions on the learning of mathematics.
4) The usefulness of mathematics.
5) Enjoyment of mathematics.
6) Mathematics class environment and relationship with teacher and peers.

After reverse coding for all negative expressions, it can be seen from Table 4.7 that more females than males show positive attitudes toward mathematics. (Females, Weighted mean = 2.0479, SD = .48551), (Males, Weighted mean = 2.3368, SD = .54737). However, both male and female students have almost the same attitude toward mathematics. T-test was applied to compare the means between males and female students. The test revealed that there is significant difference between male and female ($t = -3.746$, $df = 175.501$, $p < 0.001$).

Based on results above, although, studies suggest that boys' attitudes are generally more positive than girls' (Frost *et al*., 1994; Foxman *et al*., 1981, Else-Quest *et al*., 2013), Table 4.7 shows that female students had more positive attitudes toward mathematics than their male counterparts. This is not easy to interpret. The explanation for the findings of the current study can be attributed three reasons. Firstly, they can reflect different emphases in the cultural environment and educational context, from country to country (e.g. Cogan and Schmidt, 1999). For example, Reilly *et al.* (2019), reporting results from the 2011 (TIMSS), indicate that boys showed more positive attitudes than girls in most countries, with the exception of some Middle Eastern countries (e.g., Oman) where this trend was reversed. Secondly, the explanation for the findings of the current study can be attributed the gender-role socialization pattern in Saudi culture in line with the findings of Birenbaum and Nasser (2006) about the influences of gender and ethnicity on attitudes towards mathematics for Jewish and Arab eighth graders in Israel. Thirdly, one other explanation could be the strict gender segregation in Saudi educational policy. For example, in his study of attitude relating to gender separated schools in Australia in secondary schools (including age 13 to 16), Norton and Rennie (1998), generally, found that girls from single- sex schools report more positive attitudes toward mathematics than girls in the coeducational schools. However, Reilly *et al.* (2019) found mixed support for the gender segregation hypothesis.

Finally, both male and female students have positive attitudes toward mathematics. Beaton *et al*. (1996) found that it is often possible to observe a positive connection between achievement in mathematics and students' attitudes towards the subject. Therefore, it might be that the students in the current study had high achievement in mathematics in class. However, I am expecting that they probably will have lower achievement in TIMMS, if participants in my study take part in next TIMMS in 2019. If this is the case, they will have positive attitudes towards mathematics, but have lower achievement. Papanastasiou (2000) attributed this anomaly to teachers' low expectations, which are easy for students to satisfy and leads to the development of a positive attitude towards mathematics. In other words, Saudi teachers may want from their students get high achievement in mathematics in the exam class, through giving them easy exams in mathematics, which in turn causes them to develop positive attitudes towards mathematics. However, Saudi teachers may not be fostering a good future in mathematics for their students, as evidenced by the fact that Saudi Arabia has continued to take part in TIMMS, getting low rankings in mathematics for middle schools.

4.8 Analysis the Open-ended Questions

A qualitative method, with thematic analysis, was employed to analyse open-ended questions.

Question one: an open-ended question asked girl and boy students to report on their perceptions of why they liked, or disliked mathematics. 87 out of 90 of the girls' responses to this question were analysed and 85 out of 90 of the boys' responses. 3 responses from females and 5 responses from males were excluded because they were unclear. 79 out of 87 of females like mathematics, while 72 out of 85 of males like mathematics. In contrast, 8 out of 87 of females dislike mathematics, while 13 out of 85 of males dislike mathematics. Coding of this question resulted in five interpretable themes for both females and males, as shown, in order of importance in the Table 4.8. There were themes which appeared only for girls, which are teachers on the internet and social media personalities, links between mathematics and the Islamic religion, and Mathematicians. One theme appeared only for boys, which is the encouragement and support received from parents. (I differentiated thematically between some answers, where multiple responses were given. For example, some students said I like mathematics because it is useful for my daily life and my career, but also said I like it because of my teacher and it is important in my life).

Table 4.8: Summary of Students' Perception of Why They Liked, or Disliked Mathematics

Factors affecting the females' attitudes about learning of mathematics	Factors affecting the males' attitudes about learning of mathematics
1- Usefulness of mathematics in everyday life.	1- Usefulness of mathematics in everyday life.
2- The importance of the teacher (positive and negative)	2- The importance of the teacher (positive).
3- Teachers on the internet and social media personalities (positive).	3- The notable difficulty of mathematics.
4- Mathematics for career and 'future life'	4- Enjoyment of mathematics.
5- Enjoyment of mathematics.	5- Mathematics for career and 'future life'.
6- The links between mathematics and the Islamic religion, and mathematicians (positive).	6- The encouragement and support received from parents.
7- The notable difficulty of mathematics.	

a. Usefulness of Mathematics in Everyday Life

The most common reasons for perceptions of why students liked or disliked mathematics was the usefulness of mathematics in everyday life. 56 out of 87 girls and 33 out of 85 boys, liked mathematics because of its usefulness. They said that mathematics helps us for most of the things in everyday life. One male respondent illustrated this finding by saying, "Mathematics helps me to understand prices, sales, percentages", while one of the girls said, "Mathematics is useful for my daily life, for example, when I want to calculate the area of a room."

According to Freudenthal's (1977) theory of RME, mathematics must be connected to reality. Therefore, when a student recognises that mathematics is related to their life, this idea could improve their attitude towards mathematics. This argument is supported by a number of studies which refer to the theory that Realistic Mathematics Education positively impacts students' attitude levels towards mathematics (Devrim and Uyangor, 2006).

b. The Importance of the Teacher

The second most common reasons for perceptions of why girls and boys liked, or disliked mathematics was the importance of the teacher. 35 out of 87 of the female students liked mathematics, and 3 out of 87 of the female students disliked mathematics because of its teacher. In contrast, 29 of 85 of the male students liked mathematics because of their teacher.

The importance of the teacher in helping students to like mathematics was stressed by the female and male respondents. It is essential for students to have a teacher who makes lessons enjoyable, ensures that students understand the work and is a kind and respectful person. These factors help foster a positive attitude towards mathematics. This is evidenced by quotes from three respondents. The first, by a boy was, "I like it because of my teacher, and I believe that the main reason to like mathematics is the teacher". The second, from one of the girls, "I like mathematics because my teacher a kind person, she loves us and we love her; she respects us and we respect her." The third, from a boy, "I like it because my teacher respects me". There are many studies which have indicated that student attitudes toward study, teachers, methods, and the overall school climate are influenced by the teacher-student relationship (e.g. Torrance *et al.*, 1966; Fraser and Fisher, 1982; Hartmut, 1978).

c. Mathematics for Career and 'Future Life'

The fourth most common reasons for girls and the fifth most common reasons for boys liking of mathematics was career prospects and future life. 15 out of 87 of the female students liked mathematics because of its importance in their future. In contrast, 9 out of 85 of the male students liked mathematics because of its importance in their future. They expected that they would study mathematics at university, or they dreamed of a career requiring mathematics. One female respondent illustrated this finding by saying, "I like mathematics because it will help me realize my dream of becoming an astronomer", while a boy said, "I like mathematics because I want to study Computer Science in the future life, so I need mathematics".

Dr. Judy Willis (2010), who has combined the knowledge and experience gained through her dual careers as a maths teacher and a neurologist, suggests that a love of maths can be fostered through its connection to students' personal interests and targets. This is illustrated in the current study, since respondents who like mathematics, related it to their future goals.

d. Enjoyment of Mathematics

Enjoyment of mathematics: the fifth most common reasons for girls and the fourth most common reasons for boys was career prospects and future life. 9 out of 87 of the female students, and 10 out of 85 of the male students, liked mathematics because they enjoyed it. One female respondent illustrated this finding by saying, " I liked mathematics because it is interesting and enjoyable". A male student said, " I like mathematics because it is enjoyable and has ambiguity that makes you enthusiastic about solving its problems ". (see also "4.6. Result of Enjoyment of Mathematics").

e. The Notable Difficulty of Mathematics

The most common reasons for perceptions of why girl and boys disliked mathematics was the mathematics is notably difficult. 5 out of 87 of the female students, and 13 out of 85 disliked mathematics because its difficulty. This is evidenced by quotes from one respondent. The first, by a girl was, "I dislike mathematics. Mathematics is difficult because it depends on understanding, and I prefer memorising". The second, from one of the boys, " I dislike mathematics because it is complicated and difficult". Unfortunately, mathematics is regarded by many students as a difficult, complicated and abstract subject (Sharples, 1969; Dossey et.al, 1988). Such negative attitudes towards mathematics may be detrimental to the learning process. Although, girls have a greater tendency than boys to believe that mathematic is difficult (Foxman *et al.*, 1982), in my study, boys tend to believe, more than do girls, that mathematics is difficult. This finding is in line with Leder and Forgasz (2002). The difficulties of mathematics generally, they could be due to many reasons such as teacher style, curriculum, ...etc.

f. Teachers on the Internet and Social Media Personalities

One of the most striking results to emerge from this study was the impact of social media personalities and internet teachers on girls' attitudes to mathematics. It was the third most common reasons for perceptions of why girls liked mathematics. However, I had not expected this to be a factor at all in student perceptions. 18 out of 87 of the female students liked mathematics because of social media. This is evidenced by quotes from two respondents. One stated, "I like mathematics because one of the social media personalities on " Snapchat" was talking about the benefits of mathematics". The second said, "I am following one of the social media personalities, and from his style and his speaking about mathematics, I liked mathematics."

g. The Links between Mathematics and the Islamic Religion, and Mathematicians
The sixth most common reasons for perceptions of why girls liked, or disliked mathematics was the links between mathematics and the Islamic religion, and Mathematicians. 5 out of 87 of the female students disliked mathematics because it is difficult. This is evidenced by quotes from one respondent. One stated, "*I dislike mathematics. Mathematics is difficult because it depends on understanding, and I prefer memorising*". 2 out of 87 liked mathematics because of Islamic religion. One stated, "It is useful in terms of religion. Allah said in Holy Quran "*that you might know the number of years and how to calculate time*" (Quran surah Jonah 10, P: 127; Translated by Haleem). 2 out of 87 liked mathematics because of Mathematicians, one stated "*I like mathematics because of Al-Khwarizmi*".

Question two: an open-ended question asked girl and boy students to report on their perceptions of mathematics expressed with ''mathematics is...''. 90 out of 90 of the girls' responses to this question were analysed and 86 out of 90 of the boys' responses. 4 responses from males were excluded because they were unclear. Coding of this question resulted in two interpretable themes for both females and males. Firstly, mathematics is an arithmetic subject which helps us in daily live, science, and career. Secondly, Mathematics is addition, subtraction multiplication, division, shapes, geometry, ...etc.

5. Conclusion

5.1 Conclusion
Mathematics is an essential subject and is compulsory for middle school educational provision in most countries. It is fundamental for the study of science and for coping in everyday life. However, some students do not enjoy their studies in mathematics and cannot see any usefulness in it, leading to negative attitudes to the subject and poor exam results. This may create a vicious circle since there is a reciprocal relationship between attitude and achievement.

This study has investigated attitudes relating to mathematics, considering in particular any gender differences in the following areas:
1) Mathematics anxiety.
2) Confidence with mathematics.
3) Students' perceptions on the learning of mathematics.
4) The usefulness of mathematics.
5) Enjoyment of mathematics.
6) Mathematics class environment and the relationship with teacher and peers.

The research also considered students' perception of what mathematics is, and why they liked, or disliked mathematics.

The study employed a mixed methodology to answer the research questions. Quantitative data were collected, using a questionnaire, to answer the first research question and were analysed statistically. This was supported by the addition of qualitative, open-ended questions, which were analysed thematically. For the second main research question, an independent t-test was employed to assess whether there were differing average values for gender. The questionnaire was applied in two Saudi government-run middle schools (one for girls and one for boys) from different areas in Riyadh city in Saudi Arabia, giving an overall sample of 180. Students indicated their attitude towards mathematics by rating 29 statements on a 5-point scale, in the Likert scale style, coded in SPSS. The responses for each part of each statement were summarised according to gender. Open-ended questions allowed participants to provide their own responses, unguided by the researcher.

Both male and female students demonstrated positive attitudes toward mathematics. Interestingly, in all areas of this study (mathematics anxiety, confidence with mathematics, students' perceptions on the learning of mathematics, the usefulness of mathematics, enjoyment of mathematics, mathematics class environment and relationship with teacher and peers), it appears that female students tend to have more positive attitudes towards mathematics than the male students, although the weight of research evidence suggests a reversal of this trend (Dowker *et al*., 2016; Pajares and Graham, 1999; Sherman, 1978; Organisation for Economic Co-operation and Development (OECD), 2013; Frost *et al*., 1994; Foxman *et al*., 1981; Else-Quest *et al*., 2013; Reilly *et al*., 2019). This is not easy to interpret, but has been attributed to the following three main reasons:

1) Cultural environment and educational context, from country to country (Cogan and Schmidt, 1999). (The same result was found by Reilly *et al*. (2019) in relation to Oman students)
2) The gender-role socialization pattern in Saudi culture (See Birenbaum and Nasser (2006), in relation to Jewish and Arab students in Israel).
3) Saudi educational policy, which keeps strict gender segregation. (The same result was found by Norton and Rennie (1998) in relation to Australia students, in terms of anxiety and attitudes, Streitmatter (1997) in relation to US students, in terms of confidence, Prendergast and O'Donoghue (2014) in relation to US students, in terms of enjoyment, Lee and Lockheed (1990), in relation to Nigerian students, in terms of teacher). All areas of the current study show that there are statistically significant gender differences, except area of usefulness of mathematics.

In terms of open-ended questions, the results show that both female and male students liked mathematics, and their attitude appeared to be influenced by the following:

1) Usefulness of mathematics in everyday life (both females and males).
2) The importance of the teacher (both females and males).
3) Mathematics for career and 'future life' (both females and males).
4) The encouragement and support received from social media personalities (females), and parents (males).
5) Enjoyment of mathematics (both females and males).
6) The Notable Difficulty of mathematics (both females and males).

5.2 Recommendations and Limitations

The findings of this study have useful and practical applications for the education system in Saudi Arabia. In view of the results and conclusions which have been produced, the following recommendations could be made to the Ministry of Education in Saudi Arabia:

- Given that students have a generally positive attitudes towards mathematics in this study, there are clearly important issues to address about why TIMMS results for Saudi Arabia are currently so low.
- More research needs to be conducted into why girls in Saudi Arabia have more positive attitudes towards mathematics than boys, which is contrary to most findings elsewhere in world.
- Teachers have been shown to be an important factor in student attitudes towards mathematics. It would be beneficial to introduce some in-service training to ensure that they do not teach with a view to helping students pass easy exams, but are aware of the need to teach the more challenging aspects of mathematics, in an engaging manner, so that their students will be better prepared to succeed in exams such as TIMMS. It is important for students to achieve well in such exams so that their positive attitudes are maintained for the future.
- It might be useful to conduct future studies which measure student attitudes towards mathematics on more than occasion, to see whether they develop or change in any way.
- The study has highlighted the importance of social media personalities and internet teachers in shaping girls' attitudes towards mathematics. It is therefore recommended firstly that classroom teachers are made aware of this finding and are given ways in which they can maximise the benefits of this phenomenon for their students. Secondly, it might also be useful to organize a conference on this topic and invite some of these personalities to take part, along with classroom teachers and researchers.

Any study inevitably has its limitations, but these provide opportunities to develop further and conduct more research. Firstly, this study only focused on two schools, in Riyadh and was not able to cover schools in other regions, away from the capital city. With more time and greater resources, the study could be extended to other cities and to rural areas to give a fuller picture of the country as a whole, which would make the study more generalisable.

This study used a questionnaire and two open ended questions. There is always a risk with these types of tools that the response does not fully express the views of the participants. It might therefore be useful in future to conduct interviews or focus groups to follow up the information received through the questionnaire. However, for the present researcher, it would not have been possible for me to have access to female students for interviews. It might therefore be useful in future for both a male and a female researcher to conduct the research.

Finally, the size of the study sample was comparatively small, making it more difficult to generalise the findings. It would be useful to recruit a larger sample with students from more schools across Saudi Arabia.

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Conflict of Interest Statement

The authors declare no conflicts of interest.

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