

The Relationship Between Female Students' Attitude and Their Mathematics Achievement

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To cite this article:

Christopher Owu-Annan, Charles Kojo Assuah. The Relationship Between Female Students' Attitude and Their Mathematics Achievement. *International Journal of Secondary Education*. Vol. 11, No. 1, 2023, pp. 18-25. doi: 10.11648/j.ijsedu.20231101.14

Received: January 11, 2023; **Accepted:** February 9, 2023; **Published:** February 24, 2023

Abstract: There is a great effort in curriculum reforms in Ghana to create opportunities to close the gender gap in mathematics achievement for Senior High School (SHS) students. However, it remains unclear how female students are ready to bridge this gap in order to take-up mathematics related programs at the tertiary level. The purpose of this study was to investigate the relationship between senior high school female students' attitude and their mathematics achievement. The study was grounded in a pragmatic paradigm, using a sequential explanatory mixed-method design with questionnaires and interview guide as the research instruments to collect data from the respondents. A simple random sampling technique was used to select 331 female students. The findings showed that, self-confidence, $r = .13$, $n = 331$ and $P < 0.05$ ($.016 < .05$), enjoyment of mathematics, $r = .22$, $n = 331$ and $P < 0.01$ ($.000 < .01$), and value of mathematics $r = .11$, $n = 331$ and $P < 0.05$ ($.04 < .05$) had a positive and significant relationship with mathematics achievement while motivation $r = .07$, $n = 331$ and $P > 0.05$ ($.20 > .05$) have no relationship with mathematics achievement. The implication of the study to teaching and learning is that teachers should use instructional strategies that would meet the needs of all female students. Teachers must also take into account students' learning differences and assist them with the counselling they need to increase the students' motivation towards mathematics.

Keywords: Attitude, Mathematics, Female Students' Learning, Achievement

1. Introduction

Attitude towards mathematics is defined as liking or disliking the subject; a tendency to engage in or avoid mathematical activities; a belief that one is good or bad at mathematics; and a belief that mathematics is useful or useless [1]. A person's learned propensity to react favourably or unfavourably to an object, circumstance, idea, or person is referred to as their attitude [2]. It is also viewed as a personal idea that people have, one that reflects their thoughts and emotions and occasionally shows up in behaviour. People's attitudes influence their behaviour toward things, circumstances, and other people since attitudes, behaviour, and feelings are all interconnected. Additionally, they have an impact on how these variables are related to one another [2]. Although it cannot be directly observed, attitude is a hypothetical concept that can be deduced from quantifiable responses to the attitude object. Attitudes can change and

develop with time, and once a positive attitude is formed, it can improve students' learning. On the other side, a negative outlook prevents effective learning and subsequently has an impact on performance [2]. As a result, attitude is a crucial element that must be taken into consideration. Depending on the student, attitude may have a favourable or negative impact on how well students succeed in mathematics. Majority of the students do not have the opportunity to learn a substantial proportion of the content of the mathematics curriculum and that, most students lack the conceptual understanding of the mathematics they have learnt which is needed to make informed judgments and applications to other related context or problems [3]. Improving students' attitudes toward learning is a major curricular goal for many countries [4]. Sex differences in mathematics performance and ability remain a concern as scientists seek to address the underrepresentation of women at the highest levels of mathematics, the physical sciences, and engineering [5].

2. Literature Review

Attitudes are made up of cognitive, affective, and behavioural responses that people exhibit toward an object or their environment based on their emotions or interests [6]. The cognitive component of attitude is what a person believes or thinks about mathematics [7]. The person's feelings or emotions related to learning mathematics make up the affective part of attitude. Therefore, the emotive element is what motivates students to become interested in mathematics. Additionally, the cognitive component of attitude forms beliefs that have an impact on the affective part as well. These beliefs lead to a long-lasting mindset that affects how students feel about learning mathematics [8]. As a result, the cognitive and affective aspects of attitude are connected and actively interact [9]. The behavioral component of attitude is the propensity to react in a particular way to studying mathematics. Affective attitude also has an impact on behavioural attitude. Success in mathematics correlates with a student's level of mathematical confidence, which is viewed as a desirable behaviour. Students who lack mathematical confidence may not succeed, and poor behaviour is viewed as negative feelings [10]. Therefore, the behavioural aspect of attitude also influences the cognitive aspect of attitude. Generally, confidence in mathematics has been associated with mathematics achievement [11]. Gender differences in self-confidence were more marked for application problems than computation problems, with female students showing significantly lower confidence for application problems [12]. Despite such consistent findings of female students' low confidence in mathematics, studies of the classroom environment have shown that female students' confidence in mathematics improved greatly in classes that actively involved female students in the learning of mathematics [13].

Research conducted in South Africa claim that one of the factors contributing to the low representation of female students in mathematics and science-related courses is the attitude of mathematics teachers toward female students [14]. They claim that teachers provide males more opportunities than females to participate in practical demonstrations during mathematics lessons. They said that while female students were neglected during mathematics courses, male students had the chance to connect with mathematics lecturers, which put female students at a disadvantage. Female students exhibit decreased interest in and unfavourable attitudes toward the study of mathematics and other science-related courses, they say, while having the same or even better aptitude for the subject than their male counterparts. Parents and teachers continue to hold the stereotype that females are not good at mathematics. They assume that females are unable to compete on an equal footing with their male colleagues.

Currently, there is a great effort in literature and curriculum reforms in Ghana to create opportunities to close the gender gap in mathematics achievement. Attitude is key in the learning of mathematics and could potentially change

female students' approach to mathematics achievement if we should close the gender gap in mathematics achievement then, there is the need to examine the attitudes of students towards the learning of mathematics.

The study was guided by the research question below:

What is the relationship between female students' attitude and mathematics achievement?

3. Methodology

3.1. Research Design

A sequential explanatory mixed-method design was employed in this study to gain a broader and more in-depth understanding of female students' attitudes towards the learning of Mathematics in the central region. The explanatory design is a two-phase mixed method with a quantitative phase and a qualitative phase later. This strategy aimed to collect qualitative data augmented by qualitative to produce more trustworthy and valid results [15]. The study's first phase included a quantitative description of Senior High School female students' attitudes toward Mathematics in the central region of Ghana. A questionnaire was used to collect quantitative data and semi-structured interview guide was used to collect qualitative data. This is consistent with the purpose of the study, which sought to investigate relationship between female students' attitudes and their mathematics achievement.

3.2. Participants and Sampling Technique

The participants were three hundred and thirty-one (331) senior high and senior high technical school female students from four public Senior High and Technical Schools who were randomly and conveniently sampled within the Mfantseman municipality in the central region of Ghana. The sampling technique employed for the study was simple random sampling. The sample included fifty-five (55) students from the general science program, sixty (60) students from the general Art program, fifty-three (53) students from the visual art program, sixty-five (65) students from the business program, sixty (60) students from the home economics program and thirty-eight (38) students from the technical program. All of them are form three female students and had taken mathematics subject from form one to form three and were about to write their final standardized test to enable them enrol in tertiary institutions. The average age of the students was eighteen (18) years.

3.3. Instrumentation, Validity, and Reliability

The instruments employed for this study were a semi-structured interview guide and a Likert-type questionnaire which is one of the most extensively used strategies for measuring attitudes [16]. Attitudes Toward Mathematics Questionnaire (ATMQ) is a 40-item survey that assesses students' attitudes toward mathematics and was adapted for the study. The tool comprises four factors: (a) self-confidence, (b) value, (c) enjoyment, and (d) motivation, and

it uses a five-point Likert-type scale that ranges from strongly disagree to strongly agree. The instruments were subjected to validity and reliability tests. The instruments were given to experts and research fellows at the University of Education, Winneba to check their validity. The suggestions given by them were used to effect the necessary changes to improve upon the instruments. A pilot test of the questionnaire was conducted using 100 respondents from four senior high schools in the Central Region of Ghana. The reliability of the instruments was estimated on a scale with the help of the Statistical Package for Social Sciences (SPSS) version 26.0 programme, on the computer. Cronbach alpha values or reliability co-efficient values were obtained for the following sections of the questionnaire. Items measuring self-confidence had a Cronbach alpha value of 0.849, enjoyment of Mathematics had a Cronbach alpha value of 0.886, motivation had a Cronbach alpha value of 0.837, and value of Mathematics had a Cronbach alpha value of 0.92. A total reliability of 0.835 was obtained for all the items on the questionnaire. The reliability coefficients before the main data collection support the view of Sekeran, U. [17] who suggested that alpha value less than 0.60 is considered to be poor, those in the 0.70 range, acceptable, and those over 0.80 high. Therefore, with reference to the above the instrument was considered reliable and valid for the main data collection.

3.4. Data Collection Procedure and Analysis

Prior to the distribution of the questionnaire, permission was sought from the authorities of the senior high and senior high technical schools where the study was conducted. The senior high and senior high technical school administration's approval was required before contacting the students who were selected to take part in the study. The purpose of the study was explained to the participants (students), and those who were selected received questionnaires. It should be mentioned that the researcher gave the 331 respondents their surveys in person. A total of 25 minutes were provided to the respondents to respond to the items on the instruments. The female senior high school students answered all the questions with 100% accuracy. The process of editing, coding and statistical computing made up the data analysis step. To ensure easy identification, reduce errors, and facilitate coding, each questionnaire's items were serially labelled immediately following data collection. In order to look for any problems, such as outliers and missing values, frequencies were conducted. After the data had been compiled and edited, it was next analysed using the Statistical Package for Social Sciences (SPSS), version 26, to address questions that had only been partially or not at all addressed. It should be noted that tables, percentages, and frequencies were employed to analyse the respondents' background data. Inferential statistics, such as Spearman rank correlation, were used to analyse the quantitative data. To get accurate data on the students' achievement in Mathematics, the cumulative record (End-of-term scores) of each student captured under the study was adequately recorded which

gave the actual academic score of every student's achievement in Mathematics. This was executed because the researcher wanted to find out about the achievement of the female students and to establish whether such achievements could be linked to the attitudes of senior high school female students' towards the subject. The semi-structured interview of the study was tape-recorded verbatim and later transcribed. The researcher read and re-read the transcript to check the consistency between the audio recording and the transcribed data. The transcripts were given to a peer debriefer to comment on the appropriateness of the text regarding whether the information obtained represented exactly what the interviewees said during the interview. It was specifically intended for the debriefer, who had experience with qualitative research, to offer an extra, occasionally opposing perspective of the coding process and to urge the researcher to notice sensitising thoughts as they may influence the work [18]. The researcher was concerned with addressing a specific research question with this in mind; the researcher coded each segment of data that was relevant to the research question. The researcher generated initial codes by analysing the data paragraph by paragraph, the researcher did not code every piece of text because the researcher used open coding, which means the researcher did not have pre-set codes but developed and modified the codes as the researcher works through the coding process. The researcher worked through each transcript coding every segment of the text that seemed to be relevant to the research question. The researcher did this by hand initially, working through hard copies of the transcript with pens and highlighters. Thematic analysis technique is identified as an avenue to understanding issues more widely [19]. Similarly, thematic analysis in the form of identification, analysing, and reporting of patterns in the data collected during interviews [20]. The data obtained were then put into themes under the following factors: self-confidence, enjoyment of mathematics, motivation, and value of mathematics. The discussion on self-confidence included female students' confidence towards the learning of mathematics and how their level of self-confidence affects their mathematics achievement. The discussions on the enjoyment of mathematics included female students' enjoyment level towards the learning of mathematics and how it affects their mathematics achievement. Motivation looked at female students' interest in reading mathematics-related programmes at the tertiary level, and lastly, Value of mathematics was another factor. The transcripts were analyzed by the researcher and the debriefer under these themes independently and came to an agreement in terms of the findings.

4. Results and Discussion

This section deals with the discussion of data from the field to address the research question that was formulated to guide the study.

Research Question: What is the relationship between

female students' attitude and mathematics achievement?

The research question sought to find out from the respondents, the relationship between senior high school female students' attitude and mathematics achievement. Based on that, Spearman's rank correlation coefficient (ρ) was used to test for the type and degree of relationship that exists between

the two variables; self-confidence and mathematics achievement, enjoyment of mathematics and mathematics achievement, motivation and mathematics achievement, value of mathematics and mathematics achievement. The findings are presented in tables 1, 2, 3, and 4 respectively.

Table 1. Spearman Rank-order Correlation between Self-confidence and Mathematics Achievement.

		Mathematics-Achievement	
Spearman's rho	Self- Confidence	Correlation Coefficient	.132*
		Sig. (2-tailed)	.016
		N	331

*. Correlation is significant at the 0.05 level (2-tailed).

Table 1 shows the results after spearman's rank-order correlation was run to examine the relationship between self-confidence and mathematics achievement. There was a positive and significant correlation between self-confidence and mathematics achievement, $r = .13$, $n = 331$, and $P < 0.05$ (.016 < .05). In other words the finding shows that female senior high and female senior high technical school students who have high self-confidence towards the learning of mathematics are more likely to have positive learning achievement in mathematics. One of the explanations for the inconsistent findings regarding the relationship between attitude and mathematics achievement was that such a relationship existed only with respect to particular mathematics content areas [21, 22] and for specific affective variables [23]. Saha, S. [24] Affirmed Gender, Attitude to Mathematics, Cognitive Style, and Achievement in Mathematics. It was found that all three contribute to the statistically significant difference in achievement in mathematics. Similarly, the above finding was in disagreement with Owu-Annan, Assuah and Akayure [25], they found that female students in senior high and senior high technical schools have less self-confidence towards the learning of mathematics.

The researcher interviewed some of the female senior high and female senior high technical school students who were involved in the study on their level of self-confidence towards the learning of mathematics. In view of that, certain questions were asked, and the analysis is presented below. When the female senior high and female senior high technical school students were asked about how confident were they towards the learning of mathematics. Abena, a General Science student from a female senior high school, responded by saying, "Ok. When it comes to maths, I have a lot of confidence in me when am solving maths, when it comes to maths problems I have a lot of confidence in maths". Naa, a Home Economics student from a female senior high school, also answered by indicating that "I have high self-confidence when it's comes to mathematics but sometimes some of the questions that I have to solve seems to be difficult to me but when I tell myself that I can solve it am able to solve and get the answer correct". Efua, who is a General Science student from a mixed senior high school, also emphasised her self-confidence of mathematics by

responding to the question that, "Oh, my level of self-confidence towards mathematics is extremely high because mathematics is one subject that most student's fear but in actual fact is just about understanding to me, if you get the concept right you are eager to solve it and solving mathematics is interesting". Again Araba who is a student from the mixed senior high technical school and studying technical program asserted that, "I think I approach maths with high confidence from the beginning like much positivity and as time goes on even if it becomes hard sometimes I relax and I try to think about what the question is demanding from me to do then I tackle it but sometimes it brings me down". Sena, who is a General Art student from a mixed senior high school, also emphasised the level of her self-confidence of mathematics by responding to the question that, "Okay, mathematics has people say it is difficult something to me is not really difficult just that you just have to apply certain techniques in solving mathematics and if you understand it you can apply the techniques and you can solve it so my level of confidence in mathematics is not high and not all that low too". Again Effua, who is a student from the mixed senior high technical school and studying technical program asserted that, "Ok, I have low self- confidence in mathematics especially elective mathematics is a bit of a problem to me as well as certain topics in core-mathematics like business maths, mensuration and others". Ekuba, a student from a mixed senior high school and studying business program asserted that, "Mathematics for me is a very challenging subject and I really don't think I have that level of confidence in solving mathematics because I don't really put myself into it and I see it to be difficult". Also Yaa, who is a student from a female senior high school and studying a Visual Art program responded to the question that, "Sir, please I have a very low self-confidence when it comes to mathematics, this is because when our maths teacher give us a question and I work it and get the correct answer, but when I look at my friends work and she has different answer from mine and I cancel mine because I'm not really confidence about my answer then I will get my answer wrong". From the responses of the interviewees, it can be observed that both female senior high and female senior high technical school students have diverse self-confidence towards the learning of mathematics.

Table 2. Spearman Rank-order correlation between enjoyment of mathematics and mathematics achievement.

			Mathematics-Achievement
Spearman's rho	Enjoyment of Mathematics	Correlation Coefficient	.226**
		Sig. (2-tailed)	.000
		N	331

*. Correlation is significant at the 0.01 level (2-tailed).

Table 2 shows the results after spearman's rank-order correlation was run to examine the relationship between enjoyment of mathematics and mathematics achievement. There was a positive and significant correlation between self-confidence and mathematics achievement, $r = .22$, $n = 331$, and $P < 0.01$ (.000 < .01). In other words the finding shows that female senior high and female senior high technical school students who enjoy towards the learning of mathematics are more likely to have positive learning achievement in mathematics. The above findings are in consonance with [26] they postulated that students exhibit a positive attitude towards mathematics, but their attitude becomes less positive as the students move forward to higher levels of education. A significant positive weak correlation between students' attitude and achievement was established. Mathematics enjoyment and attitude significantly predicted students' achievement in their studies. However, little consensus existed among researchers regarding the influence of affective variables on gender and mathematics achievement. For example, some studies reported statistically significant effects of affective variables on the learning of mathematics [21, 23].

The researcher interviewed some of the female senior high and female senior high technical school students who were involved in the study on their level of enjoyment towards the learning of mathematics. In view of that, certain questions were asked, and the analysis is presented below. When the female senior high and female senior high technical school students were asked whether they enjoy learning mathematics. Abena, a General Science student from a female senior high school, responded by saying, "Yes, I enjoy whenever am solving maths I feel very happy and I don't sleep and when I'm solving some of the reading subjects I fell asleep but in mathematics no". Naa, a Home Economics student from a female senior high school, also answered by indicating that "Yes, I enjoy learning mathematics because

people always say, mathematics is difficult but I don't see it so". Efua, who is a General Science student from a mixed senior high school, also emphasised her enjoyment of mathematics by responding to the question, "Ok, for me I can solve mathematics at a noisy place and a cool place because I understand it"

Again Araba, who is a student from the mixed senior high technical school and studying technical program asserted that, "Yes, I enjoy learning mathematics, even though not always you would be willing to learn maths but I think anytime I take a book to learn mathematics I feel good within me but when I get some of the try questions wrong and my enjoyment mood changes". Sena, who is a General Art student from a mixed senior high school, also emphasised the level of her enjoyment of mathematics by responding to the question that, "Yes, mathematics is fun and I enjoy it a lot". Again Effua, who is a student from the mixed senior high technical school and studying technical program asserted that, "I really enjoy mathematics, because it's really interesting when you are solving and you are really into it and even when you are hungry you don't want to stop". Ekuba, a student from a mixed senior high school and studying business program asserted that, "I enjoy doing mathematics because that is what keeps me awake". Also Yaa, who is a student from a female senior high school and studying a Visual Art program responded to the question that, "No, not really because mathematics is difficult to me and I see it some way so even when I am in the class and the teacher is teaching I wish his lesson is over because I do not put myself in what he is teaching".

From the responses of the interviewees, it can be observed that both female senior high and female senior high technical school students were heterogeneous in their views about their enjoyment of mathematics towards the learning of the subject.

Table 3. Spearman Rank-order Correlation between Motivation and Mathematics Achievement.

			Mathematics-Achievement
Spearman's rho	Motivation	Correlation Coefficient	.070
		Sig. (2-tailed)	.202
		N	331

Table 3 shows the results after spearman's rank-order correlation was run to examine the relationship between enjoyment of mathematics and mathematics achievement. There was no significant correlation between motivation and mathematics achievement, $r = .07$, $n = 331$, and $P > 0.05$ (.20 > .05). In other words the finding shows that female senior high and female senior high technical school students have limited motivation towards the learning of mathematics

and that their level of motivation cannot be used to relate their mathematics achievement. The above finding is in line with Papanastasiou, C. [27], who affirmed that others indicated no relationship between attitude variables and mathematics achievement. Even among those studies that found a significant relationship, there was still controversy regarding the educational implications of the results. On the other hand, some researchers [28, 29] have cautioned against

dismissing the effects of affective variables on longer-term learning outcomes, despite the finding that most of the gender differences in mathematics were small. One of the explanations for the inconsistent findings regarding the relationship between attitude and mathematics achievement was that such a relationship existed only with respect to particular mathematics content areas [21, 22].

The researcher interviewed some of the female senior high and female senior high technical school students who were involved in the study on their motivation level towards the learning of mathematics. In view of that, certain questions were asked, and the analysis is presented below. When the female senior high and female senior high technical school students were asked what was their motivational level (high/Low) towards the study of mathematics. Joy, a Visual Art student from a senior high technical school responded that "hmm this maths thing I have a low level of motivation towards maths, this is because it is very difficult to understand". Dzifa, who is a Business student from a mixed senior high school asserted that "I have a high motivation for mathematics. When I see any male doing well in the subject I always try to compete with him and I also pass my maths test". Abiba, a Home Economics student from a female senior high school responded to the question, "I have low motivation in mathematics because all my friends do not

understand it so me too I do not learn it during preps time since we normally learn together". Again Esther, who is a student from the mixed senior high technical school and studying technical program asserted that, "when I look at the effort I put in mathematics I can say that I have high motivation towards mathematics this is because In order for me to go to university I must motivate myself to pass mathematics even though at times it's not easy". Also Golda, a General Science student from a female senior high school asserted that "my dad is a mathematics lecturer and so he always talks about mathematics to me, so I am always having the high motivation to do more to see what my dad usually tells me about mathematics". And finally, Mamuna who is a student from mixed senior high school responded to the question that, "I have high motivation now because my new core mathematics teacher teaches to my understanding and encourages us to practice more and when I practice I get the answers correct".

From the responses of the interviewees, they all have divergent opinions on their attitude level of motivation towards the learning of mathematics. This means that some of the interviewees do not recognize that motivation is a keen attitude factor to increase their level of mathematics achievement to enable them to progress in their academic life and make them reputable in society.

Table 4. Spearman Rank-order Correlation between the value of Mathematics and Mathematics Achievement.

		Mathematics-Achievement	
Spearman's rho	Value of mathematics	Correlation Coefficient	.113*
		Sig. (2-tailed)	.040
		N	331

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4 shows the results after spearman's rank-order correlation was run to examine the relationship between the value of mathematics and mathematics achievement. There were positive and significant correlations between the value of mathematics and mathematics achievement, $r = .11$, $n = 331$, and $P < 0.05$ ($.04 < .05$). In other words the finding shows that female senior high and female senior high technical school students who understand the value of mathematics are more likely to have positive learning achievement in mathematics. The above finding is in contrast with Hagan et al [30], they asserted that students have a positive attitude towards mathematics though they see it to be difficult it is important as they use it in their daily lives. And the relationship between attitude and students' mathematics achievement was very weak and negatively related. Again, Tamayo, S. [31], affirmed that mathematics attitude best predicts mathematics achievement. The findings of Arhin and Yanney [32] collaborate with the above findings that students believe mathematics has relevance in one's life and one's academics; and also a high or strong relationship exists between students' interest in studying mathematics and academic achievement.

The researcher interviewed some of the female senior high and female senior high technical school students who were

involved in the study on the value of mathematics in their lives and their future career paths. In view of that, certain questions were asked, and the analysis is presented below. When the female senior high and female senior high technical school students were asked why they think Mathematics is relevant/irrelevant. Abena, a General Science student from a female senior high school, responded by saying, "mathematics is relevant because you can learn mathematics in other subjects". Naa, a Home Economics student from a female senior high school, also answered by indicating that "It is relevant because every job that you will do require mathematics". Sena, who is a General Art student from a mixed senior high school, also emphasised the relevance of mathematics by responding to the question, "Mathematics is relevant because it helps us in all the subjects we study, especially science". Again, Effua who is a student from the mixed senior high technical school and studying technical program asserted that "Mathematics is relevant because if you do not pass in the final WASSCE you cannot progress to the university and any other tertiary institutions in Ghana and abroad".

From the responses of the interviewees, they all consider mathematics very relevant to their academic pursuits and their future developments. This means that all the interviewees

recognize the relevance of mathematics in their lives.

5. Limitations

The generalizability of the findings is constrained by the use of data from a sample of senior high school and senior high technical school form three (3) female students. Although the female senior high school and female senior high technical school students in their third year were the most practical for the study, including female students in senior high school and senior high technical school form one (1) and form two (2) could have improved the extension of the findings and the conclusions. Again, there is no evidence to suggest that the study, which involved senior high and senior high technical school form three (3) students from one municipality in the central region, is representative of the situation in the entire nation or of a different setting.

6. Conclusion

From the results of the current study, the following conclusions are made. Self-confidence, enjoyment of mathematics, and value of mathematics have a positive and significant relationship with mathematics achievement whiles motivation has no relationship with mathematics achievement.

7. Implication for Teaching and Learning

Based on the findings, the implication of the study to teaching and learning is that there should be counselling sections for female students to help increase their motivation towards the learning of mathematics. Female students should solve more mathematics problems to eradicate fear and boost their self-confidence in learning mathematics. The government and other stakeholders of teacher education programs should continuously train the teachers in effective ways to bridge the gender gap between male and female students' mathematics achievement.

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