A CORRELATIONAL STUDY OF MATHEMATICS SELF-EFFICACY AND ANXIETY WITH MATHEMATICS ACADEMIC ACHIEVEMENT OF GRADE 12 STUDENTS AT A PUBLIC HIGH SCHOOL IN YUNNAN, CHINA

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Abstract: This study aimed to determine whether there was a significant relationship of mathematics self-efficacy and anxiety with mathematics academic achievement of Grade 12 students at a public high school in Yunnan, China. A quantitative correlational research design was chosen to examine the relationship between these three research variables. The participants were 106 students conveniently sampled from the Grade 12 Science Program at the target school, during the academic year 2021-2022. The Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ; May, 2009) was adopted and used to measure the levels of the participants' mathematics self-efficacy and mathematics anxiety. The mathematics final exam scores were collected from the participants to measure their mathematics academic achievement. From the data analysis, it was found that the overall level of mathematics self-efficacy held by Grade 12 students at the target school was moderate, their overall level of mathematics anxiety was low, and there was a significant, positive and moderately strong relationship between their mathematics self-efficacy and mathematics academic achievement. Moreover, a significant, negative and moderately strong relationship between mathematics anxiety and mathematics academic achievement of Grade 12 students at the target public high school was found, and a significant, moderately strong multiple correlation among participants' mathematics self-efficacy, mathematics anxiety and mathematics academic achievement was obtained. Recommendations are provided for students, teachers, school principal and administrators, and future researchers, based on the research findings obtained from this study.

Keywords: Mathematics Self-Efficacy, Mathematics Anxiety, Academic Achievement, Mathematics Education, High School Education.

1. INTRODUCTION

Self-efficacy is defined as the degree of confidence people have in their ability to use the skills they need to perform a given task (Bandura, 1997). The level of self-efficacy determines how much effort a person will exert and whether the resultant action, in the face of an obstacle, is to give up or persist (Bandura, 1977). Self-efficacy is a non-intellectual factor that has received a great deal of research attention, which widely permeates the generation and development of students' learning mindsets, triggers emotional states, and influences their choices of activities and environments.

Anxiety is defined as an unpleasant emotional state that causes a person to feel nervous, uneasy, worried and fearful in the face of an impending, potentially dangerous or threatening situation that exceeds the reality of the situation (Hembree, 1990).

Many researchers have examined the role of self-efficacy in the field of education, particularly the importance of students' self-efficacy on academic achievement. A student with a high level of self-efficacy tends to have a high level of academic achievement, motivation, persistence in completing tasks, responsibility for himself or herself and his or her actions, an intellectual growth perspective, and a better use of learning strategies (Sheng, 2018). Self-efficacy has also been documented as a significant predictor of academic achievement (Al Demerdash, 2020; Zuo & Tan, 2002). Furthermore, anxiety can often lead to reduce the level of self-efficacy in people (Bandura, 2012). Students with high levels of mathematics anxiety show negative attitudes toward mathematics, and grow in negative self-perceptions of their mathematics abilities, which in turn might negatively influence their own mathematics self-efficacy (Ashcraft, 2002).

The first author has been able to observe the following issues at the target public high school in Yunnan, China.

• Students seemed to have low confidence in doing mathematics classroom exercises and homework independently. This can be interpreted as an indication of low mathematics self-efficacy.

• Some students seemed to feel nervous when the teacher asked them questions in mathematics class, and so worried about getting low scores in their mathematics examinations. This can be interpreted as an indication of a high level of mathematics anxiety.

• Students' mathematics academic achievement was lower than in other subjects. This can be interpreted as an indication of a low level of mathematics academic achievement.

Therefore, the researchers decided to conduct a study to identify whether there was a significant relationship of mathematics self-efficacy and anxiety with academic achievement of Grade 12 students at a public high school in Yunnan, China.

Research Objectives

The following were the specific research objectives developed for this study.

1. To determine the level of mathematics self-efficacy of Grade 12 students at a public high school in Yunnan, China.

2. To determine the level of mathematics anxiety of Grade 12 students at a public high school in Yunnan, China.

3. To determine the level of mathematics academic achievement of Grade 12 students at a public high school in Yunnan, China.

4. To determine whether is a significant relationship of mathematics self-efficacy and anxiety with mathematics academic achievement of Grade 12 students at a public high school in Yunnan, China.

Theoretical Framework

This study was guided by two major theories: the social cognitive theory (Bandura, 1997), and the mathematics anxiety construct (Hembree, 1990).

Social Cognitive Theory

The social cognitive theory is a framework that explains how behavior and learning occurs, under the influence of interaction with other people and the environment. This theory is grounded on four concepts: reciprocal determinism, outcome expectations, self-efficacy, and observational learning. Self-efficacy refers to the belief in the ability to control events that affect one's life (Bandura, 1997). Bandura (1997) suggested the following four sources as having an influence on the formation of self-efficacy: mastery experiences (i.e., people's prior experiences toward a specific task), vicarious experiences (i.e., learning acquired by people through observing and social modelling), social persuasion (i.e., competence attained by comparison to peers or encouragement from significant others such as parents, teachers or peers) and physiological states (i.e., the sense of competence resulting from emotional states such as stress and tension, that may affect people's performance and judgments of their ability to finish tasks). These factors influencing self-efficacy might contribute to a different self-evaluation of one's abilities, depending on what they mean to each individual.

Mathematics Anxiety Construct

Mathematics anxiety is a general fear of exposure to mathematics, including classes, homework, and tests, which is related to general anxiety and test anxiety (Hembree, 1990). Mathematics anxiety is an unpleasant emotional state, characterized by uneasiness, nervousness and fear, that individuals experience when dealing with numbers, using mathematics concepts, learning about mathematics, or taking mathematics tests (Chen & Geng, 2002). It is associated with a poor mathematics academic achievement, meanwhile it is inversely related to positive attitudes toward mathematics and is directly relevant to avoidance of the subject (Hembree, 1990).

Conceptual Framework

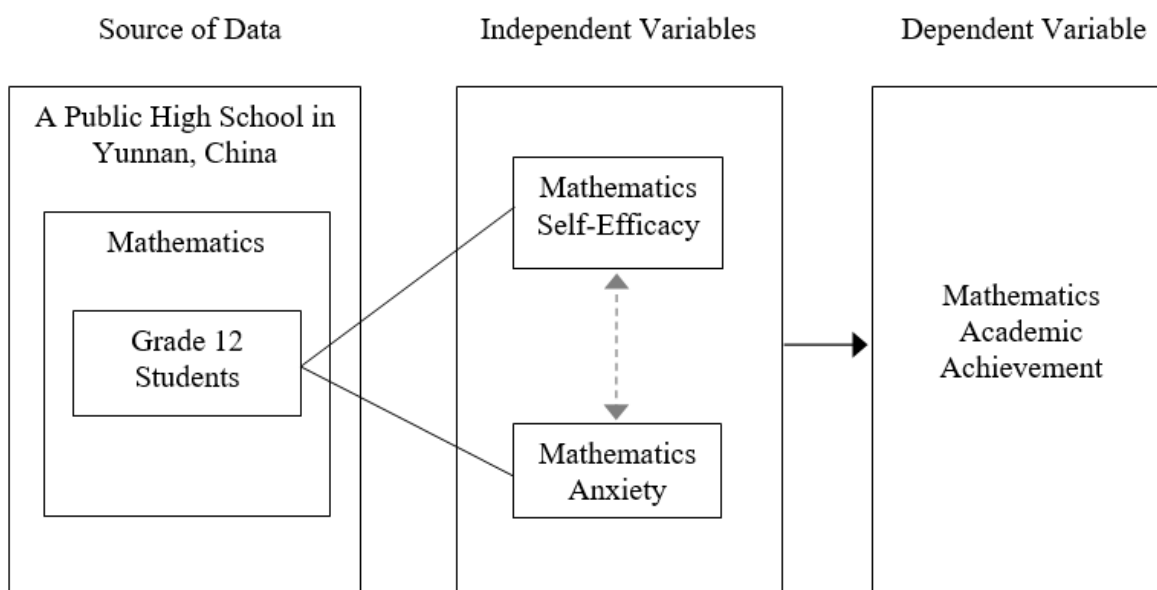Figure 1 depicts the conceptual framework of the study.

Figure 1: Conceptual Framework of the Current Study

2. LITERATURE REVIEW

In this section, some previous studies related to the research variables addressed in this study are reviewed and summarized.

Chen (2003) reported on the accuracy and predictability of mathematics self-efficacy beliefs of 107 Grade 7 students from four Catholic parish schools in Nashville, Tennessee, United States. The research found that girls had a slightly high level of mathematics self-efficacy, while boys had a high level of mathematics self-efficacy. Moreover, a significant, positive moderately strong relationship between mathematics self-efficacy and mathematics academic achievement was found for both groups. Mathematics self-efficacy played a direct role in predicting students' mathematics academic achievement.

Luo et al. (2009) conducted a quantitative study that investigated the relationship between mathematics anxiety, mathematics academic achievement, mathematics interest, self-efficacy, gender differences, and grade differences among 311 students at a middle school attached to a university in Western China, from Grade 7 to Grade 12. The study revealed that both male and female students were found to have a high level of mathematics self-efficacy, as well as a slightly low level of mathematics anxiety. The correlation between mathematics academic achievement and mathematics self-efficacy was statistically significant and positive, with a correlation coefficient of .43, which is moderately strong. The correlation between mathematics academic achievement and mathematics anxiety was statistically significant and negative, with a correlation coefficient of -.41, which is moderately strong. The results showed that the higher the students' mathematics academic achievement, the lower their mathematics anxiety. The lower the students' mathematics academic achievement, the more mathematics anxiety they showed. This confirmed that mathematics anxiety usually occurs among low-achieving students in Western China.

Huang (2006) administered a study sample of 415 students from a senior high school in Hebei Province, China, to examine the relationship between mathematics anxiety and mathematics self-efficacy and senior high school students' mathematics academic achievement. The findings indicated that there was a negative and weak correlation between mathematics anxiety and mathematics academic achievement.

Zhou et al. (2014) selected 285 elementary school students in Grades 2-6 in Beijing, China, to explore the relationship and interaction mechanisms between children's mathematics anxiety, mathematics metacognition, and mathematics academic achievement. The results indicated that the level of mathematics anxiety was low in both male and female students. Moreover, there was a very weak negative relationship between mathematics anxiety and mathematics academic achievement for both groups.

Methodology/Procedure

In this section, details on the study's population, sample and research instruments are provided.

Population and Sample

The target population of this study was all the 615 Grade 12 students enrolled in the 12 regular classes of the Science Program for the Term 1, academic year 2021-2022, at a public high school in Yunnan, China, by the time of the data collection. Two classes were conveniently selected from the 12 Grade 12 Science Program regular classes, with a total of 106 students participating in this study. These classes were purposively selected because the mathematics teachers expressed their willingness to participate in this study.

Research Instruments

This study was conducted using the following research instruments: the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ; May, 2009) and the Mathematics Final Exam for Term 1.

Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ). The Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) was used to measure Grade 12 students' levels of both mathematics self-efficacy and mathematics anxiety. This 28-item questionnaire (see Table 1), originally developed by May (2009), was adopted by the researcher in this study. In this instrument, 13 items (i.e., Items 1, 4, 7, 9, 10, 12, 13, 16, 19, 20, 21, 23 and 28) correspond to mathematics self-efficacy and 15 items (i.e., Items 2, 3, 5, 6, 8,11, 14, 15, 17, 18, 22, 24, 25, 26 and 27) correspond to mathematics anxiety. The items are measured on a 5-point Likert-type scale ranging from l (*never*) to 5 (*usually*). The mean scores from the Likert scale ratings were interpreted using a continuum from "very low" to "very high".

Table 1: Items in the Mathematics Self-Efficacy and Anxiety Questionnaire

Item No.	Item statement
1	I feel confident enough to ask questions in my mathematics class.
2	I get tense when I prepare for a mathematics test.
3	I get nervous when I have to use mathematics outside of school.
4	I believe I can do well on a mathematics test.
5	I worry that I will not be able to use mathematics in my future career when needed.
6	I worry that I will not be able to get a good grade in my mathematics course.
7	I believe I can complete all of the assignments in a mathematics course.
8	I worry that I will not be able to do well on mathematics tests.
9	I believe I am the kind of person who is good at mathematics.
10	I believe I will be able to use mathematics in my future career when needed.
11	I feel stressed when listening to mathematics instructors in class.
12	I believe I can understand the content in a mathematics course.
13	I believe I can get an "A" when I am in a mathematics course.
14	I get nervous when asking questions in class.
15	Working on mathematics homework is stressful for me.
16	I believe I can learn well in a mathematics course.
17	I worry that I do not know enough mathematics to do well in future mathematics courses.

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18	I worry that I will not be able to complete every assignment in a mathematics course.
19	I feel confident when taking a mathematics test.
20	I believe I am the type of person who can do mathematics.
21	I feel that I will be able to do well in future mathematics courses.
22	I worry I will not be able to understand the mathematics.
23	I believe I can do the mathematics in a mathematics course.
24	I worry that I will not be able to get an "A" in my mathematics course.
25	I worry that I will not be able to learn well in my mathematics course.
26	I get nervous when taking a mathematics test.
27	I am afraid to give an incorrect answer during my mathematics class.
28	I believe I can think like a mathematician.

Mathematics Final Exam. The Mathematics Final Exam corresponding to Term 1, academic year 2021-2022, was used to measure the level of Grade 12 students' mathematics academic achievement at a public high school in Yunnan, China. The scores were interpreted as follows: excellent (132-150); very good (112-131); good (92-111); satisfactory (72-91); and need for improvement (< 72).

Research Findings

The research findings obtained from the data collection and analysis are presented below, organized by research objective.

Findings From Research Objective 1

Table 2 shows the mean scores, standard deviations and interpretations of the level of mathematics self-efficacy, for all the individual items and the overall scale, held by the Grade 12 students at a public high school in Yunnan, China, who participated in this study.

Table 2: Mean Scores, Standard Deviations and Interpretations of the Mathematics Self-Efficacy for the Participants in This Study

Item No.	Item statement	M	SD	Interpretation
1	I feel confident enough to ask questions in my mathematics class	2.73	1.16	Moderate
4	I believe I can do well on a mathematics test	3.37	1.03	Moderate
7	I believe I can complete all of the assignments in a mathematics course	2.97	1.22	Moderate
9	I believe I am the kind of person who is good at mathematics	2.98	1.27	Moderate
10	I believe I will be able to use mathematics in my future career when needed	3.14	1.17	Moderate
12	I believe I can understand the content in a mathematics course	3.75	.83	High
13	I believe I can get an "A" when I am in a mathematics course	3.64	1.12	High
16	I believe I can learn well in a mathematics course	3.84	.97	High
19	I feel confident when taking a mathematics test	3.12	1.19	Moderate
20	I believe I am the type of person who can do mathematics	3.53	1.01	High
21	I feel that I will be able to do well in future mathematics courses	3.48	1.05	Moderate
23	I believe I can do the mathematics in a mathematics course	3.77	1.04	High
28	I believe I can think like a mathematician	2.25	1.26	Moderate
	Overall	3.27	1.11	Moderate

Findings From Research Objective 2

Table 3 shows the mean scores, standard deviations and interpretations of the level of mathematics anxiety, for all the individual items and the overall scale, held by the Grade 12 students at a public high school in Yunnan, China, who participated in this study.

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Table 3: Mean Scores, Standard Deviations and Interpretations of the Mathematics Anxiety for the Participants in This Study

Item No.	Item statement	*M*	*SD*	Interpretation
2	I get tense when I prepare for a mathematics test	2.67	.96	Moderate
3	I get nervous when I have to use mathematics outside of school	1.77	.94	Low
5	I worry that I will not be able to use mathematics in my future career when needed	1.92	.81	Low
6	I worry that I will not be able to get a good grade in my mathematics course	2.84	1.09	Moderate
8	I worry that I will not be able to do well on mathematics tests	2.91	1.11	Moderate
11	I feel stressed when listening to mathematics instructors in class	2.25	.93	Low
14	I get nervous when asking questions in class	2.43	1.11	Low
15	Working on mathematics homework is stressful for me	2.41	1.11	Low
17	I worry that I do not know enough mathematics to do well in future mathematics courses	2.50	1.05	Moderate
18	I worry that I will not be able to complete every assignment in a mathematics course	2.39	1.13	Low
22	I worry I will not be able to understand the mathematics	2.28	.92	Low
24	I worry that I will not be able to get an "A" in my mathematics course	2.61	1.23	Moderate
25	I worry that I will not be able to learn well in my mathematics course	2.51	1.11	Moderate
26	I get nervous when taking a mathematics test	2.58	1.04	Moderate
27	I am afraid to give an incorrect answer during my mathematics class	2.55	1.22	Moderate
	Overall	2.44	1.06	Low

Findings From Research Objective 3

The findings regarding the level of mathematics academic achievement of the Grade 12 students participating in this study are reported in Table 4.

Table 4: Overall Mean Score, Standard Deviation, and Interpretation of the Mathematics Academic Achievement for the Participants in This Study

N	Minimum	Maximum	*M*	*SD*	Interpretation
106	67	143	108.40	14.22	Good

Findings From Research Objective 4

Table 5 displays the bivariate correlations between mathematics self-efficacy and mathematics anxiety with mathematics academic achievement of Grade 12 students at a public high school in Yunnan, China.

Table 5: Bivariate Correlations Between Mathematics Self-Efficacy, Mathematics Anxiety and Mathematics Academic Achievement for the Participants in This Study

Variables		1	2	3
1.	Mathematics self-efficacy	–		
2.	Mathematics anxiety	-.63* (<.001)	–	
3.	Mathematics academic achievement	.46* (<.001)	-.53* (<.001)	–

Note. *denotes a statistically significant relationship (statistical significance level set at *p* = .05, two tailed). *p*-values appear within parentheses below the correlation coefficients.

Since both independent variables were significantly correlated with the dependent variable, further calculation of the multiple correlation coefficient was needed. A significant, moderately strong multiple correlation among mathematics self-efficacy, mathematics anxiety and mathematics academic achievement of Grade 12 students was obtained, $R = .56$, $R^2 = .31$, $F(2, 103) = 22.93$, $p < .001$. Therefore, the combination of mathematics self-efficacy and mathematics anxiety have a moderately strong multiple explanatory and predictive power for the participants' mathematics academic, as well as it accounts for 31% of the variance of the participants' mathematics academic achievement.

3. DISCUSSION

The following three sections provide a discussion of the research findings of the current study, by relating them to the findings reported in previous research studies.

Mathematics Self-Efficacy

From the data analysis, it was found that the Grade 12 students at a public high school in Yunnan, China, had a moderate level of mathematics self-efficacy. This finding is similar to those reported in previous studies (e.g., Chen, 2003; Luo et al., 2009). Chen (2003) identified that among 107 Grade 7 students in four Catholic parish schools in Nashville, Tennessee, United States, female students had a slightly high level of mathematics self-efficacy, while male students had a high level of mathematics self-efficacy. Luo et al. (2009) found that both male and female students from a middle school attached to a university in Western China, had a high level of mathematics self-efficacy.

Mathematics Anxiety

The findings of this current study also indicated that the Grade 12 students at a public high school in Yunnan, China, had a low level of mathematics anxiety. This finding is the same as that reported by Zhou et al. (2014), in whose study both 285 male and female elementary school students in Grades 2-6 in Beijing, China, were found to have a low level of mathematics anxiety.

Moreover, this finding is also similar to the one of Luo et al. (2009), who found that the students at a middle school attached to a university in Western China, both male and female, had a slightly low level of mathematics anxiety. This could be due to the possibility that mathematics anxiety typically occurs among students with low academic achievement (Luo et al., 2009). The researchers also analyzed the participants' mathematics academic achievement at the target school, and the results showed that the participants' level of mathematics academic achievement was good. In such a case, participants tended to be perceived as capable in mathematics, meaning that participants had less fear, stress and worry about their ability to solve mathematics problems correctly in the classroom in their normal lives. People with high level of mathematics anxiety end up with lower mathematics ability and achievement compared to people without mathematics anxiety (Ashcraft, 2002).

The Relationship Among Students' Mathematics Self-Efficacy, Mathematics Anxiety and Mathematics Academic Achievement

One finding of this study was that there was a significant positive and moderately strong relationship between mathematics self-efficacy and mathematics academic achievement of Grade 12 students at a public high school in Yunnan, China. This finding is consistent with the ones reported by Luo et al. (2009) and Chen (2003). Luo et al. (2009) found that a statistically significant and positive correlation between mathematics academic achievement and mathematics self-efficacy with a correlation coefficient of .43, which is moderately strong, among 311 students from a middle school attached to a university in Western China. Chen (2003) indicated that there was a significant, positive moderately strong relationship between mathematics self-efficacy and mathematics academic achievement of 107 Grade 7 students from four Catholic parish schools in Nashville, Tennessee, United States.

Another finding of this study revealed that there was a significant negative and moderately strong relationship between mathematics anxiety and mathematics academic achievement of Grade 12 students at a public high school in Yunnan, China. This is supported by Luo et al. (2009), who found that the correlation between mathematics academic achievement and mathematics anxiety was statistically significant and negative, with a correlation coefficient of -.41, which was moderately strong among 311 students in a middle school attached to a university in Western China. In addition, this finding is in line with that of Huang (2006). Huang's (2006) study found a significant negative weak correlation between

mathematics anxiety and mathematics academic achievement among 415 students in a high school in Hebei Province, China. However, this finding is slightly different from that of Zhou et al. (2014), who reported a very weak negative relationship between mathematics anxiety and mathematics academic achievement among 285 elementary school students in Grades 2-6 in Beijing, China.

4. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are provided for students, teachers and future researchers.

Recommendations for Students

The findings of this study showed that the Grade 12 students at a public high school in Yunnan, China, had an overall moderate level of mathematics self-efficacy, and hence Grade 12 students at the target school moderately believe they could learn mathematics well and do well in mathematics courses. However, some items were rated lower by the participants (e.g., "I feel confident enough to ask questions in my mathematics class" [Item 1], "I believe I can complete all of the assignments in a mathematics course" [Item 7], "I believe I am the kind of person who is good at mathematics" [Item 9], "I believe I can think like a mathematician" [Item 28]). Therefore, the researchers suggest that it is important for students to trust and respect each other and maintain each other's self-esteem. When students have a question, they usually do not want to ask the teacher directly, but will ask their classmates first. This may be because small groups of peers can provide acceptance and a sense of belonging, giving individuals the strength to gain support and increase their self-confidence. Thus, peers will only share learning resources together if they trust each other. Positive and successful interactions between peers can only occur if they respect each other's total. If high-achieving students are reluctant to help low-achieving students for fear of affecting their own grades, it will very much affect the self-esteem of low-achieving students and will not help them develop a good mathematics self-efficacy.

In addition, the findings of this study also indicated that Grade 12 students at a public high school in Yunnan, China, had an overall low level of mathematics anxiety. Nevertheless, the items about tests were rated higher by the participants (e.g., "I worry that I will not be able to get a good grade in my mathematics course" [Item 6], "I worry that I will not be able to do well on mathematics tests" [Item 8]). In this regard, the researchers suggest that students could relax by participating in more extracurricular activities in the period leading up to the test, as students are usually nervous because of the approaching test.

Recommendations for Teachers

In order for students to feel more confident in asking questions in class, teachers should provide more opportunities for students to interact in mathematics class, listen carefully to students' questions, encourage them to actively ask questions and give appropriate responses and praise after they ask their own questions. Making students feel that they are being noticed is tantamount to encouraging students' self-awareness, which will assist them to understand themselves better, and when they notice something about themselves, it is tantamount to encouraging students to appreciate themselves, and their mathematics self-efficacy would increase. Teachers should also frequently organize students to form study groups where students can come together to help each other, discuss and explore problem solving together.

In order to alleviate students' worries and anxieties about tests, teachers could organize and increase extracurricular activities for students, encourage them to participate in activities to relax in the period before the tests, and provide appropriate counseling for students when necessary.

Recommendations for Future Researchers

Data for this study were collected from Grade 12 students in only one school in China. Based on the limitation of access, it is suggested that future researchers can conduct studies on a larger scale to make the results more generalizable to more general groups of students. Moreover, the combination of mathematics self-efficacy and mathematics anxiety was found to explain the 31% of the variance of the participants' mathematics academic achievement, and hence there is a 69% of the variance explained by other factors. not considered in the current study. There are many factors that can influence mathematics academic achievement, in addition to the two proposed in this study, such as: motivation, attitude, and learning approaches (Azar at el., 2010; Pajares & Graham, 1999). It is suggested that future researchers consider and explore these factors affecting mathematics academic achievement in depth in future studies.

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