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Students' Mathematics Self-Efficacy and Anxiety as Correlates to Academic Performance

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ABSTRACT

Mathematical aptitude reflected in academic performance is known to be based upon the attitudes of students in approaching the subject. This study aimed to determine how mathematics self-efficacy and anxiety affect academic performance. The researchers used the descriptive-normative survey and documentary analysis of existing records with the stakeholders, the Grade 7 students. Data were analyzed using the Pearson Product-Moment Coefficient of Correlation, t-test, and Chi-Square. Results showed that students had an average level of mathematics self-efficacy regarding understanding and applying the concepts of the subject. However, they also had high anxiety when working with Mathematics tasks or less confidence in achieving high marks or grades. The study concluded that the higher the students' level of Mathematics self-efficacy, the lower their level of Mathematics anxiety. Conversely, the higher the students' level of self-efficacy and the lower their mathematical anxiety, the higher was their academic performance. It implied that education programs addressing the enhancement of Mathematics self-efficacy and reducing Mathematics anxiety among students would not only reshape their perception of the subject's difficulty but also improve their academic performance as they move up in the secondary level.

Keywords **-** academic performance, mathematics anxiety, self-efficacy, quantitative method, Philippines, Asia

INTRODUCTION

Mathematical concepts consciously or unconsciously have been integrated by everyone in solving problems, communicating, and a range of daily undertakings. Despite the significant roles that Mathematics plays for individual and national progress, there has always been poor performance in the subject. Trends in Mathematics and Science Study (TIMSS, 2003) showed that the Philippines ranked 42nd out of 46 participating countries in high school Mathematics. It means that the quality of the country's Mathematics education has deteriorated.

Students' Mathematics academic performance can be attributed to several factors. Suinn and Edwards (1982) argued that more than half of the variance in academic achievement in Mathematics can be explained by variables other than cognitive abilities, particularly by affective variables. One which received increased attention is the role of Mathematics self–efficacy. Mathematics self-efficacy is an individual's beliefs or perceptions concerning his/her abilities in Mathematics. Bandura (1993) proposed that students with high levels of self-efficacy seem to be more motivated to learn and are more likely to persist when presented with challenging tasks. May (2009) stated that poor Mathematics self-efficacy in students often decreases their motivation to learn and eventually can lead to low Mathematics performance. It is therefore suggested that educators must also consider self-efficacy factors in fostering students' Mathematics literacy.

Albert Bandura introduced the self-efficacy as the main concept of his Social Cognitive Theory. Bandura defined self-efficacy beliefs as the thoughts or ideas people hold about their abilities to perform those tasks necessary to achieve the desired outcome. Bandura (1993) perceived self-efficacy as contributing to cognitive development and functioning. Students' beliefs in their efficacy to regulate their learning and to master academic activities determine their aspirations, level of motivation, and academic accomplishment. With Bandura's definition of self-efficacy, Mathematics self-efficacy would mean one's judgment of his or her capabilities to form and implement courses of action in Mathematics.

Another factor which influences mathematics achievement is Mathematics anxiety. It is merely defined as fear of Mathematics. According to Ashcraft (2002), highly Mathematics-anxious individuals are characterized by a strong tendency to avoid the subject, which ultimately undercuts their mathematical competence. Mathematics anxiety disrupts cognitive processing by compromising on-going activity in working memory. A study conducted by Siebers (2015) found out that low Mathematics anxiety students scored higher in Mathematics achievement and high Mathematics anxiety students scored lower on Mathematics achievement.

Mathematics remains as the most feared subject in the curriculum despite the high value placed by mathematical literacy in most educational systems. Since then, Mathematics anxiety has been inherent to many students. One considered general assumption is the precise nature of the subject.

Sigmund Freud, in his Psychoanalytic Theory, defined anxiety as an unpleasant feeling and can cause emotional distress (Puteh and Khalin, 2016). According to May (2009), "anxiety is a mind-body reaction that occurs instantaneously, and its effects are felt physiologically, behaviorally, and psychologically all at the same time" (Siebers, 2015). For this reason, anxiety may negatively affect one's performance, behavior, and physiology.

Eysenck (2008) holds that there are differences between people who are high and low in trait anxiety in the information that they have stored in long-term memory. Eysenck further stated that people with different levels of anxiety also vary regarding the content of the memory.

Freud's and Eysenck's theories suggest that mathematics anxiety, as a feeling of tension or fear in Mathematics, may interfere with Mathematics achievement. Through this, teachers are guided on where and how to make necessary adjustments to ensure optimum learning in Mathematics.

Robert Gagne's (1965) Cognitive Learning Theory posits that students' learning, considering their developmental stages and the subject matter, is best attained by following the controlled, external, and sequential instructional events. John Dewey's (1910) Experiential Learning states that experience is the best way or best source of learning. For this reason, to ensure better learning, it is necessary to make sure that students are provided with various involvements that will boost their self-efficacy and diminish their anxiety.

Lev Vygotsky, in his Sociocultural Cognitive Theory, states that cognitive development is dependent on one's interaction with those around him. Vygotsky (1934) believed that an individual learns or acquires new skills and information with the zone of proximal development (ZDP) through adult guidance (parents and teachers).

Mandler's discrepancy theory (1989) holds that negative attitude towards Mathematics such as fear or anxiety is a result of frequent failures or interruptions of planned actions. Repeated emotional reactions can result in the formation of an overall schema about Mathematics, which obtains permanence (Nicolaidou and Philippou, 2002). Since highly Mathematics-anxious individuals are essentially doing two things at once when they do math (i.e., attending to their fears and doing the activities/tasks), their learning performance suffers. Mathematics anxiety itself causes people to perform poorly in the subject than their abilities warrant.

People with high efficacy approach difficult tasks as challenges to be mastered rather than avoiding threats. Self-efficacy beliefs are shaped by mastery experiences through interpretation of one's performances on particular tasks (Bandura, 1993). Outcomes perceived as positive tend to increase students' confidence in their abilities and thus strengthening their efficacy beliefs. On the contrary, outcomes perceived as negative tend to lower self-confidence hence weakening the associated efficacy beliefs. Some theories and studies have suggested that mastery experiences are the strongest influence on student self-efficacy beliefs (Hutchison, Follman, Sumpter, and Bodner, 2006).

Bandura (1993), as concurred by Clutts (2010), holds that perceived affective self-regulatory efficacy can raise one's self-efficacy to manage academic development, resist pressure, and become sociable. Kranzler and Pajares (1997) hypothesized that students' judgments of their capabilities (self-efficacy) influence the academic choices they make, the effort they invest in academic tasks, and the extent to which they persevere when faced with academic challenges. He revealed that Mathematics self-efficacy had been found to be a stronger predictor of Mathematics-related outcomes.

Moreover, Bandura argued that students who have a low sense of efficacy to manage academic demands are especially vulnerable to achievement anxiety. If failures weaken students' sense of efficacy, they become anxious. But if their perceived efficacy is unshaken by failures, they remain unworried. The belief of students in their capability to master

academic subjects predicts their succeeding academic attainments. Bandura further argued that students' level of scholastic anxiety bears little or no relationship to their academic performances.

Mathematics anxiety is related to several characteristics. Conventional wisdom suggests that it is somewhat higher among women than men. The gender difference is rather small but may be particularly apparent in highly selected groups (like college students), and may be partly attributable to a greater willingness on the part of women to disclose personal attitudes (Ashcraft, 2002).

Eysenck and Calvo's (1992) model of general anxiety effects, called processing efficiency theory holds that "general anxiety disrupts on-going working memory processes because anxious individuals devote attention to their intrusive thoughts and worries, rather than the task at hand." In the case of Mathematics anxiety, such thoughts probably involve preoccupation with one's dislike or fear of Mathematics, one's low self-confidence, among others. Mathematics anxiety lowers Mathematics performance because paying attention to these intrusive thoughts acts as a secondary task, distracting attention from the Mathematics task.

When students are anxious about Mathematics, they typically perform at a level that is below than their actual abilities. Their Mathematics anxiety not only causes them to underperform in Mathematics but also to avoid it, and Mathematics-related careers (Beilock and Maloney, 2015). Lack of confidence when working in mathematical tasks was considered as the cause of Mathematics anxiety (Zakaria and Norodin, 2008). Ashcraft and Faust (1994) believed that highly Mathematics-anxious individuals will be less fluent in computation, less knowledgeable about Mathematics, and less expected to discover varied strategies and relationships within the Mathematics domain.

There has been increased interest in how individuals' self-efficacy and anxiety affect or relate each other. According to Pajares & Kranzler (1995), self-efficacy had a strong direct effect on anxiety, which in turn had a weak direct effect on performance. Females reported higher anxiety than males, but the genders did not differ in ability, self-efficacy, or performance. Girls were reported to have lower Mathematics self-efficacy beliefs even when they performed at similar or higher levels than boys (Kitsantas, Cheema & Ware, 2011).

Some studies give intellectual insights and comparison of the past findings to the present investigation.

Liu and Koirala (2009) found out through their study on the effects of Mathematics self-efficacy on Mathematics achievement of high school students that Mathematics self-efficacy could be a significant positive predictor of Mathematics achievement. This finding shows that students who were confident of their performance in Mathematics tended to have better Mathematics achievement. They recommended that efforts are required for promoting Mathematics self-efficacy for high school students. It indicated that self-efficacy could be increased through employing appropriate instructional strategies such as helping students set their learning goals, providing suitable and clear feedbacks, encouraging them to study harder, and using high achieving high learners as models.

A study conducted by Nicolaidou and Philippou (2002) revealed the significant relationships among attitude towards Mathematics self-efficacy and performance. However, the study discovered that correlation between Mathematics self-efficacy and performance is stronger than the correlation between attitude towards Mathematics and performance. Students with the positive attitude towards Mathematics have high self-efficacy beliefs in a specific domain and achieve better. Their study concluded that attitude towards Mathematics and Mathematics self-efficacy are predictors of performance, and, consistently with their previous findings, the predictive power of self-efficacy was found to be stronger than the corresponding power of attitude towards Mathematics. Though they noticed that self-efficacy and performance of their male respondents are higher than female's, they found no significant difference between the variables as to gender.

Moreover, the study of Siegle and McCoach (2007) found a significant relationship between self-efficacy and achievement. A similar study was also conducted by Zarch and Kadivar (2006) which concluded that self-efficacy made a powerful independent contribution to the prediction of performance.

Zakaria and Nordin (2008) studied the effects of Mathematics anxiety on matriculation students as related to their motivation and achievement. They found out that students with high Mathematics anxiety scored significantly lower in their achievement. There exists a negative relationship between Mathematics anxiety and achievement. They suggested that teachers must be aware of the effects of anxiety on students' achievement and motivation. It was recommended that teachers should make an effort to lessen anxiety, develop teaching strategies that help highly anxious students.

A parallel study was also conducted by Pourmoslemi, Erfani, & Firoozfar (2013) to Iranian students. They found out that Mathematics anxiety relates to performance because there is a negative correlation between Mathematics anxiety and Mathematics achievement. Siebers (2015) investigated the relationship between Mathematics anxiety and students' achievement of middle school students and a significant negative relationship between Mathematics anxiety and Mathematics performance was confirmed. It agrees with the finding of the study of Puteh and Khalin (2016) which revealed a significant and negative relationship between students' achievement and their levels of Mathematics anxiety.

Clutts (2010), in his study on Mathematics self-efficacy of college students, found out that age was not a significant predictor of Mathematics self-efficacy. Ajai & Imoko (2015) looked into the gender differences in Mathematics self-efficacy, anxiety, and academic performance. Their study revealed that male and female students that were taught Algebra using problem-based learning did not significantly differ in achievement and retention scores, thereby revealing that male and female students are capable of competing and collaborating in Mathematics. It is evident that students' achievement and retention in algebra are not dependent on gender. Pourmoslemi, Erfani, & Firoozfar (2013) found out that while females scored higher in Mathematics achievement test than males, there was no significant difference between males and females. Results of the studies conducted by Goodwin, Ostrom, and Scott (2009) and Clutts (2010) revealed no significant gender differences in mathematics self-efficacy.

A study of Ameen, Baig, and Khaliq (2016*)* investigated that there was a significant mean difference regarding students' Mathematics anxiety concerning their gender. It is concluded that women have higher Mathematics anxiety than men. The findings of the study of Puteh and Khalin (2016) also concluded that there is no significant difference between the levels of Mathematics anxiety of female students compared to the male students.

Pascua (1993) claimed that the goal of basic Mathematics education is "to provide opportunities for individuals to develop skills and attitudes needed for effective participation and prepare them for further education and the world of work so that they make worthwhile contributions to the society at large."

Teachers play a vital role in attaining a quality education. Therefore, the teacher should plan and organize learning activities that would best

achieve quality learning. Moreover, the teacher must also acknowledge that learning is not only influenced by cognitive factors alone but by affective factors too. It should be put into consideration that learning experiences must deviate from fear or anxiety and boost students' confidence or self-efficacy. Such moves will lead to quality learning.

It is deemed necessary to determine the degree of how mathematics self-efficacy and anxiety affect academic performance. It is also important to understand how Mathematics self-efficacy and anxiety relate to each other since both influence academic performance. Hence, this motivates the researchers to undertake this study.

METHODOLOGY

The study used the descriptive normative survey and documentary analysis of existing records in the academic performance of students. It employed purposive sampling technique. The Grade 7 students of Catungawan National High School for the School Year 2016-2017 were the respondents of this study.

The instrument was patterned from a standardized questionnaire on Mathematics self-efficacy and anxiety – the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) by Diana K. May (2009) of the University of Georgia. The researchers used a modified four (4) - point Likert scale with the following parameters for the levels of Mathematics self-efficacy and anxiety.

Table 1. Mathematics self-effficacy and Mathematics anxiety rating guide

Symbol	Description	Meaning	Weight	Parameters / Interpretation		
				Scale	Symbol	Description
A	Always	The condition is felt all the time.	4	3.25 – 4.00	VHSE	Very High Self-Efficacy
O	Often	The condition is felt most of the time.	3	2.50 – 3.24	HSE	High Self-Efficacy
S	Sometimes	The condition is felt at certain times.	2	1.75 – 2.49	ASE	Average Self-Efficacy
N	Never	The condition is never felt.	1	1.00 – 1.74	LSE	Low Self-Efficacy

The data were analyzed and interpreted through projections based on the numbers using Pearson Product-Moment Coefficient Correlation, t-test, and Chi-square.

Table 2. Profile of the students

N=93

Items	F	%	Rank
Age (in years)			
12-13	65	69.89	1
14-15	26	27.96	2
16-17	2	2.15	3
Sex			
Male	47	50.54	1
Female	46	49.46	2

There were 65 (69.89%) students aged 12-13 years old, 26 (27.96%) were 14-15 years old, and two (2.15%) were 16-17 years old. Forty-seven (50.54%) of the students were male while 46 (49.46%) were female.

Table 3. Students' level of Mathematics anxiety

N = 93

Mathematics Self-Efficacy Items	A (4)	O (3)	S (2)	N (1)	WM	DV	Rank
1. I feel confident enough to ask questions in my mathematics class.	2	16	60	15	2.05	ASE	11
2. I believe I can do well on a mathematics test.	2	21	60	10	2.16	ASE	9
3. I believe I can complete all of the assignments in my mathematics subject.	10	18	52	13	2.27	ASE	6
4. I believe I am the kind of person who is good in mathematics.	2	19	56	16	2.08	ASE	10
5. I believe I will be able to use mathematics in my future career when needed.	39	30	20	4	3.12	HSE	1

6. I believe I can understand the content in a mathematics subject.	5	32	49	7	2.38	ASE	3
7. I believe I can get an “A” when I am in a mathematics subject.	6	8	22	57	1.60	LSE	13
8. I believe I can learn well in a mathematics subject.	5	31	46	11	2.32	ASE	4
9. I feel confident when taking a mathematics test.	2	15	61	15	2.04	ASE	12
10. I believe I am the type of person who can do mathematics.	3	24	54	12	2.19	ASE	8
11. I feel that I will be able to do well in future mathematics subjects.	6	29	46	12	2.31	ASE	5
12. I believe I can do the mathematics in a mathematics subject.	3	29	50	11	2.26	ASE	7
13. I believe I can think like a mathematician.	0	6	40	47	1.56	LSE	14
14. I feel confident when using mathematics outside of school.	18	32	39	4	2.69	HSE	2
Composite Mean					2.22	ASE	

Based on the table, the students’ Mathematics self-efficacy has a composite mean of 2.22 which was interpreted as Average Self-Efficacy. Items 5, 14, and 6 had the highest weighted means of 3.12, 2.69, and 2.38, respectively. Items 5 and 14 were interpreted as High Self-Efficacy while item 6 is interpreted as Average Self-Efficacy. It means that the students believed that they will be able to use Mathematics in their future career when needed, they were confident when using Mathematics outside of school, and that they can understand the content in a Mathematics subject. Items 9, 7 and 13 had the least weighted means of 2.04, 1.60 and 1.56 respectively. Item 9 was interpreted as Average Self-Efficacy, the least among Average Self-Efficacy while items 7 and 13 were interpreted as Low Self-Efficacy. It means that the students did not have much confidence when taking a Mathematics test and that they had less confidence in themselves in getting an “A” in Mathematics subject, and they had lesser belief that they could think like a mathematician. The composite mean of 2.22 which was interpreted as Average Self-Efficacy means that the Grade 7 students had an average belief that they can organize, execute or complete a variety of tasks in Mathematics.

The students had an Average level of Self-Efficacy. According to Bandura (1993), such level of mathematics self-efficacy has developed from students' mastery and vicarious experiences, social persuasions, and physiological states.

Table 4. Students' level of Mathematics anxiety

N = 93

Mathematics Anxiety Items	A (4)	O (3)	S (2)	N (1)	WM	DV	Rank
1. I get tense when I prepare for a mathematics test.	20	29	38	6	2.68	HA	5
2. I get nervous when I have to use mathematics outside of school.	7	20	36	30	2.04	AA	15
3. I worry that I will not be able to use mathematics in my future career when needed.	17	21	49	6	2.53	HA	8
4. I worry that I will not be able to get a good grade in my mathematics subject.	26	27	39	1	2.84	HA	1
5. I worry that I will not be able to do well on mathematics test.	24	21	46	2	2.72	HA	4
6. I fell stressed when listening to mathematics instructors in class.	11	19	48	15	2.28	AA	13
7. I get nervous when asking questions in class.	13	16	57	7	2.38	AA	12
8. Working on mathematics homework is stressful for me.	10	12	61	10	2.24	AA	14
9. I worry that I do not know enough mathematics to do well in future mathematics subject..	9	27	50	7	2.41	AA	11
10. I worry that I will not be able to complete every assignment in a mathematics subject.	12	32	45	4	2.56	HA	7
11. I worry that I will not be able to understand mathematics.	13	19	58	3	2.45	AA	10
12. I worry that will not be able to get an "A" in my mathematics subject.	28	27	30	8	2.81	HA	3
13. I worry that I will not be able to learn well in my mathematics subject.	13	23	53	4	2.48	AA	9
14. I get nervous when taking a mathematics test.	19	28	42	4	2.67	HA	6
15. I am afraid to give an incorrect answer during my mathematics class.	23	36	28	6	2.82	HA	2
Composite Mean					2.53	HA	

The table reflects that the Mathematics anxiety composite mean of 2.53 is interpreted as High Anxiety. Based on the indicators, items 4, 15, and 12 had the highest weighted means of 2.84, 2.82, and 2.81, respectively, which were all interpreted as High Anxiety. This finding means that the students highly worried that they will not be able to get a good grade in Mathematics, they were much afraid to give an incorrect answer during their Mathematics class, and they highly worried that they will not be able to get an "A" in their Mathematics subjects. The three least rated items are items 6, 8, and 2 which were all interpreted as Average Anxiety. This means that the students averagely felt stressed when listening to Mathematics teachers in class, working on Mathematics homework is averagely stressful for them, and they were averagely nervous when they used Mathematics outside of school. The students' level of Mathematics anxiety had a composite mean of 2.53 interpreted as High Anxiety. This implied that the students possessed a high level of tension, fear, or apprehension when working with numbers or accomplishing tasks in Mathematics.

According to Mandler's (1990) discrepancy theory, a negative attitude towards Mathematics such as fear is a result of frequent failures or interruptions of planned actions in Mathematics. Their repeated reactions to those failures or interruptions may result in the formation of an over-all schema about Mathematics, which may become relatively permanent. Moreover, the Grade 7 students' high level of Mathematics may be the result of students' lack of confidence when working with Mathematical tasks as explained by Zakaria and Norodin (2008). This means that the students highly worried that they will not be able to get a good grade in Mathematics, and they were much afraid to give an incorrect answer during their Mathematics class.

Table 5. Students' academic performance in Mathematics

Level of Performance	F	%	Rank
Outstanding (90 - 100)	8	8.60	4
Very Satisfactory (85 - 89)	12	12.90	3
Satisfactory (80 - 84)	19	20.43	2
Fairly Satisfactory (75 - 79)	51	54.84	1
Did Not Meet Expectations (below 75)	3	3.23	5
Total	93	100.00	
Mean = 79.90 (Fairly Satisfactory)			

The Grade 7 students' mean academic performance was described as Fairly Satisfactory. It means that the students had a limited/ minimum knowledge and skills in Mathematics. The result of the current study somehow agreed with the TIMSS finding as it appeared that the Grade 7 students struggled to achieve a "Satisfactory" rating against the country's set standards.

Table 6. Summary of correlation

Students' Level of Mathematics	r-value	Critical Value	Result	Decision
Self-Efficacy and Anxiety	-0.56335	±0.20396	Significant	Reject Ho
Self-Efficacy and Academic Performance	0.71382	±0.20396	Significant	Reject Ho
Anxiety and Academic Performance	-0.5205	±0.20396	Significant	Reject Ho

There was a significant negative correlation between students' levels of Mathematics self-efficacy and anxiety. It means that the higher the students' Mathematics self-efficacy, the lower their mathematics anxiety, or the lower the students' Mathematics anxiety, the higher their Mathematics anxiety. This finding is also supported by Ashcraft (2002) who stated that highly Mathematics-anxious individuals espouse negative attitudes toward Mathematics and hold negative self-perceptions about their Mathematical abilities (mathematics self-efficacy).

There was a significant positive correlation between students' levels of Mathematics self-efficacy and academic performance. This result means that the higher the students' Mathematics efficacy, the higher their academic performance is. This result was supported by Thorndike's concept of self-efficacy as a variable generally found to be a powerful predictor of academic performance. Kranzler and Pajares (1997) explained that the students' judgments of their capabilities influence the academic choice they make, the effort they invest in academic tasks, and the extent to which they persevere when faced with academic challenges, thus, significantly affecting their academic performance.

A significant negative correlation was seen between students' level of Mathematics anxiety and academic performance in Mathematics. This finding means that the higher the students' Mathematics anxiety, the lower their academic performance, or the lower the students' Mathema-

tics anxiety, the higher their academic performance. It agreed with the parallel studies of Puteh and Khalin (2016), the study of Pourmoslemi, Erfami & Firoozfar (2013), as well as the study of Siebers (2015), wherein all of them confirmed that Mathematics anxiety relates to Mathematics performance.

It further showed that there was no significant difference between male and female students' level of Mathematics self-efficacy and mathematics anxiety. This finding means that male and female students had an average level of Mathematics self-efficacy and both of them had a high level of anxiety. This result agreed with the studies conducted by Goodwin, Ostrom, and Scott (2009) and Clutts (2010) which revealed that there was no significant gender difference in Mathematics self-efficacy. However, this result negated the results of studies (Betz & Hackett, 1983; Pajares & Miller, 1994; Randhawa, Beamer, & Lundberg 1993; Skaalvik and Rankin, 1994), which revealed that males had significantly higher levels of Mathematics self-efficacy than female students. The finding runs counter to the findings of Ameen, Baig, Khaliq (2016) and Schulz (2005) which revealed that a significant mean difference exists with women having higher Mathematics anxiety than men.

CONCLUSION

The students had an average level of Mathematics self-efficacy and high level of Mathematics anxiety. This result means that the students had an average belief that they can organize, execute or complete a variety of tasks in Mathematics. On the other hand, they normally felt stressed when listening to math teachers in class, working on math homework, and became nervous when they had to use Mathematics outside of the school. Regardless of sex, Mathematics self-efficacy had the same level. It also held true that sex was not a predictor of Mathematics anxiety. The students had satisfactory performance in Mathematics. They possessed minimum or limited knowledge and skills in Mathematics.

Students with higher Mathematics self-efficacy had lower Mathematics anxiety and had higher academic performance, while those students with lower Mathematics self-efficacy had higher Mathematics anxiety and had lower academic performance. Thus, boosting the students' confidence and Mathematics self-efficacy and lessening Mathematics anxiety may improve their academic performance.

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