

THE EFFECT OF MATHEMATICAL ANXIETY ON THE PERFORMANCE OF FIFTH-GRADE ELEMENTARY SCHOOL STUDENTS IN PERFORMING FRACTION OPERATIONS

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Abstract: Although it is known that adults have anxiety about mathematics, it turns out that elementary school students also have anxiety about mathematics. This research is a descriptive-qualitative research that aims to describes the influence of mathematics anxiety on the performance of fifth grade elementary school students, especially mathematics performance in using strategies in solving fraction problems. The subjects of this study were two fifth-grade elementary school students with different levels of mathematical anxiety and had relatively the same mathematical abilities. Data collection was conducted through semi-structured interviews based on the results of students' work in solving fractional operation problems. The study results showed that students with low mathematics anxiety (LMA) used numerical operation strategies to solve fraction problems, namely by manipulating number expressions into equivalent fractions in fraction comparison problems and still using numerical operation strategies to help determine the area of land division in word problems. Meanwhile, LMA subjects used a strategy that did not change, namely using spatial reasoning due to limited ability in using numerical operations to determine the comparison of fractions and divide the area of land in word problems. This shows that math anxiety affects students' strategies for solving fraction problems.

Introduction

In the world of education, anxiety is a major factor that hinders students' abilities and performance. Anxiety can have a negative impact on how a person feels when facing certain situations, such as exams, doing assignments, or attending lessons. Of the many anxieties that may occur in students (general anxiety, phobias, stress, social anxiety), the anxiety that students often face is math anxiety [29]. Mathematics anxiety is considered one of the factors that hinder students from understanding mathematical concepts of arithmetic (arithmetic operations), reasoning, and problem-solving related to everyday life. Math anxiety is defined as an uncomfortable state such as fear, tension, or experiencing pressure when doing math assignments or when facing math [25]. Math anxiety can also be defined as a condition that can disturb someone in manipulating numbers and solving math problems in everyday life [4, 38].

Math anxiety is caused by many factors including environmental factors (family and social life), gender, character, intelligence, and personality [7, 29]. [40] revealing the characteristics of someone who experiences mathematical anxiety is

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characterized by feelings that view mathematics as difficult and threatening, and attitudes that view mathematics as something ineffective and useless in solving everyday problems, have an attitude of resignation towards the consequences of their inability to understand mathematics, low motivation in learning mathematics, and look down on people who have good mathematical abilities. In addition, teachers' biased attitudes toward students are also considered a factor influencing mathematics anxiety [21]. Teachers often have attitudes that are at odds with students' attitudes, so they rarely pay attention and care about students during mathematics learning. As a result, students start to be indifferent towards mathematics lessons and learning activities in class.

Math anxiety has affected students in every country in the world. OECD [34] revealed that math anxiety can cause stress, worry, and feelings of helplessness in 15-year-olds. Furthermore, the results of OECD [34] shows that Indonesia has a math anxiety score below the average of the 39 participating countries (with a value range of 0.2-0.4) which ultimately has an impact on the mathematics achievement of Indonesian students which is below the average of 39 countries (with a value range of 350-400). This shows that mathematics anxiety makes a big contribution to influencing the performance of Indonesian children in understanding mathematics. The relationship between mathematics anxiety and mathematics performance is also in line with [1, 18, 55] which states that math anxiety will cause students to avoid anything related to situations related to math and this will have a negative impact on students' performance in doing math and will indirectly hurt the students' education and career path.

Math anxiety does not only occur in adulthood as reported by OCED, but math anxiety can begin to be experienced when someone is in elementary school [5, 17, 23] and usually, math anxiety starts at the age of 6-9 years [37, 53] and mathematical anxiety is often experienced by students in various mathematical materials, one of which is fractions [16, 43, 54]. Mathematics anxiety in fraction material often occurs when students solve fraction operation problems and word problems related to fractions [16, 42, 45, 54]. Students often use the concept of natural number operations (addition, subtraction, multiplication and division) to solve fractional number operations. Students are not yet able to differentiate the use of operational properties between natural numbers and fractions and still have biased knowledge about changes in the context of natural numbers to fractions [33, 50]. Student performance problems can also be seen in sorting fractional numbers which has an impact on performance in comparing fractions. Many students perform poorly in sorting fractions so students always sort fractions intuitively [44]. In addition, many students state that fractions (especially improper fractions) cannot be divided because the answer is not a whole number [43].

Math anxiety can also lead to decreased math achievement. Mathematics achievement refers to the abilities that students must have to achieve success in mathematics subjects. To master mathematics lessons, every student must have abilities such as numeracy skills [24], able to solve problems [51], solve applied problems related to everyday life [37], the use of strategies by students when solving mathematical problems that require complex calculations [14] such as arithmetic operations [2, 20, 41], comparison of fractions [1, 31, 32], solve story problems and complete number sentences [3, 52].

However, considering the pressure that requires students to complete the questions, Students who have math anxiety can always find various adaptive and simple strategies that they believe can solve the problem. Many students,

especially students with high math anxiety, use irrational or unconventional strategies because of their inability to manipulate numbers and solve problems [38]. In addition, students with high math anxiety used more unusual strategies than students with low math anxiety [2] and the strategy used is simple [41]. Many studies have examined the impact of mathematics anxiety on mathematics performance ([9, 10, 36, 48] especially fractions [16, 42, 54]. However, the research is quantitative, so it does not show direct evidence regarding the results of student performance in solving problems, so it is necessary to show direct evidence about how students perform in solving fraction comparison problems and story problems about the application of fraction concepts in everyday life. Therefore, this study will describe the performance of student with low mathematics anxiety (HMA) and student with high mathematics anxiety (HMA) accompanied by the work results of both subjects and interview evidence in completing fraction comparison operations and word problems about the use of fractions in everyday life.

Literature Review

Math anxiety

Math anxiety is a feeling of tension, fear of math, or apprehension that can interfere with math performance [39]. Mathematics anxiety can also be defined as a fear felt about mathematics based on how often students experience fear when studying mathematics, taking mathematics lessons, and doing mathematics assignments [22]. Ashcraft [1] also stated that mathematics anxiety can interfere with cognitive abilities and mathematics performance, resulting in impaired mathematics achievement and competence. Suárez-Pellicioni, et al. [46] adding math anxiety may cause an imbalance between the stimulus-driven attention system (bottom-up) and the goal-directed attention system (top-bottom). Math anxiety can cause students with high anxiety to be vulnerable to distractions and have difficulty focusing on tasks due to impaired information processing and impaired student math performance. Finally, students have low self-confidence in facing situations related to mathematics [11].

Instruments to measure mathematics anxiety have been produced by many experts, including: The Mathematics Anxiety Rating Scale (MARS) consisting of 98 items [39]. As a result of the breadth of measurement provided by the MARS items, many scholars have developed simpler instruments to measure math anxiety, including: The Revised Mathematics Anxiety Rating Scale (RMARS) [35] consisting of 25 items. The RMARS instrument is used to measure mathematics anxiety which includes anxiety in taking mathematics exams (15 items), anxiety in following math lessons (5 items) and anxiety in doing math assignments (5 items). The Abbreviated Math Anxiety Scale (AMAS) Hopko, et al. [19] consists of 9 items used to measure mathematics anxiety when inability in situations related to mathematics and is measured using a Likert scale (1= not at all, 2= a little, 3= medium, 4= quite dan 5= very). And then, math anxiety instrument Juniati and Budayasa [22] consisting of 16 items. This mathematics anxiety instrument is used to measure anxiety in learning mathematics (4 items), anxiety in taking mathematics course (5 items) and anxiety to mathematics test/quiz (6 items) and assessed using a Likert scale (1= never, 2= rarely, 3= often dan 4= always).

Research methods

Research Design

This type of research is descriptive qualitative research which aims to describe the influence of mathematics anxiety on the performance of fifth-grade elementary school students, especially mathematical performance in using strategies in solving fraction problems. Qualitative methods are very appropriate to use because they are very effective in exploring complex data to describe the performance of students with high mathematical anxiety and students with low mathematical anxiety, especially in the use of strategies in solving problems.

Sampling and Participants

Participants in this study were 58 5th-grade elementary school students in Mataram (Lombok, Indonesia). Sample selection was carried out in two stages, namely filling out the mathematics anxiety questionnaire and completing the mathematics ability test. Initially, all participants were given a mathematics anxiety questionnaire consisting of 16 statement items used to measure mathematics anxiety in terms of anxiety in learning mathematics (4 items), anxiety in taking mathematics course (5 items) and anxiety to mathematics test/quiz (6 items). Details of the statement items used to measure mathematics anxiety can be seen in the research article [22]. Based on the results of the anxiety questionnaire, all participants were divided into two groups, namely students with high mathematics anxiety (HMA) as many as 17 students and students with low math anxiety (LMA) as many as 41 people. Next, all participants were given a math ability test consisting of 10 math questions that had been validated for language and content aspects by experts. Based on the mathematical ability test, the mathematical ability level of all participants was obtained. In determining the sample, 2 samples were selected with the same level of mathematical ability, consisting of 1 sample with low mathematical anxiety (LMA) and 1 sample with high math anxiety (HMA). The sampling procedure can be seen in Figure 1.

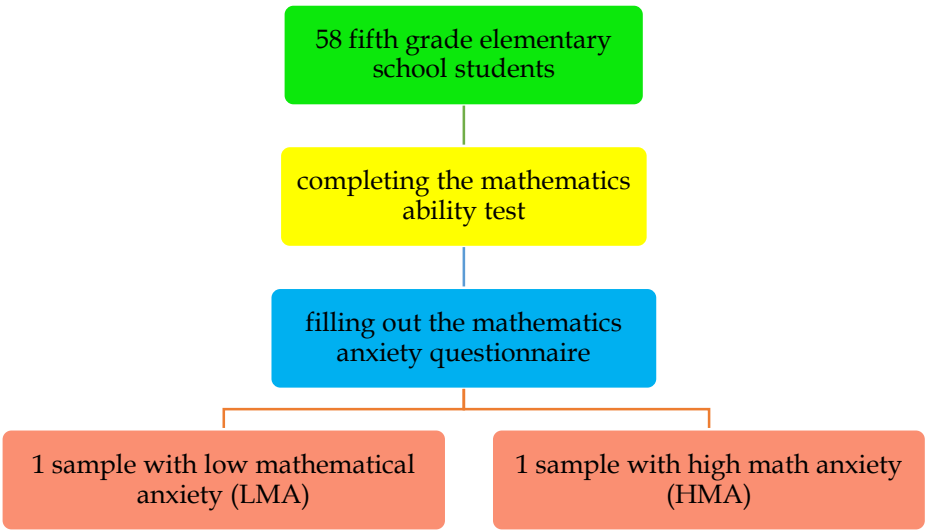


Figure 1: The sampling procedure

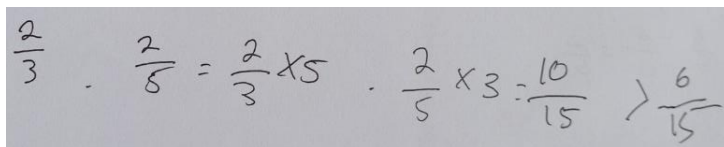
Data Collection and Analysis

Data collection was carried out through direct interviews using open questions aimed at obtaining data on mathematical performance using problem-solving strategies. The questions given to the subjects consisted of two questions, namely fraction comparison questions and story questions about the application of fractions in determining the area of land based on the instructed fraction values. After both subjects completed the test, an interview was conducted based on the answers they had given. Based on data obtained from test and interview results, then the data will be analyzed to obtain conclusions from this research.

Research results

Description for subjects with low levels of mathematics anxiety (LMA) and high levels of mathematics anxiety (HMA) in completing Fraction Comparison

In completing the fraction comparison, LMA student and HMA student were asked to determine the value of the larger fraction, namely two thirds and two fifths. The results of the work show that students LMA completed the fraction comparison test using the numerical operation process by manipulating fractional expressions into equivalent fractions. The results of LMA students in completing the fraction comparison test can be seen in Figure 2.



$$\frac{2}{3} \quad . \quad \frac{2}{5} = \frac{2}{3} \times 5 = \frac{10}{15} \quad . \quad \frac{2}{5} \times 3 = \frac{6}{15} \quad > \quad \frac{6}{15}$$

Figure 2. Results of LMA students' work in completing the fraction comparison test.

The following are the results of interviews with LMA subjects regarding the process of solving fraction comparison problems (R: researcher; LMA: low math anxiety students).

R : How do you determine the answer to this fraction comparison?

LMA : I made the denominators of both fractions the same. So that the denominators are the same, fifteen..three times five is fifteen..eh..two times five is ten..two times three is six...ten is greater than six so it is two-thirds greater.

R : Why do you use that method?

LMA : Yes.. to determine the value of the larger fraction I have to equate the denominators first then determine the value of the numerator of both fractions. I looked at the value of the larger numerator and made this sign (LMA designates the ">" sign) to determine the value of the larger fraction.

R : So which fraction is bigger?

LMA : Two thirds

Based on the test and interview results, it can be explained that the subjects used number operations to complete the fraction comparison test. In this case, LMA students use a strategy of manipulating two original fractions by changing the initial fractional expression by multiplying the fraction by a natural number (see Figure 1) so that the denominators of both fractions have the same value.

However, conceptually, it is also apparent that LMA students do not yet understand the operation of multiplying fractions, which means that when a fraction is multiplied by a natural number, there should be no change in the value of the denominator of the fraction. LMA students still wrote that there was a change in the value of the numerator and denominator of the fraction after being multiplied by a natural number. In the end, LMA students obtained two fractions that had the same denominator. To determine the value of the largest fraction, LMA subjects looked at the numerator value of the two fractions that had been transformed and put a ">" sign to conclude that the two-thirds fraction had a greater value than the two-fifths fraction.

In contrast to the strategies used by LMA students, HMA students use spatial reasoning strategies to determine the value of the larger fraction. The results of HMA students in solving fraction comparison problems can be seen in Figure 3.

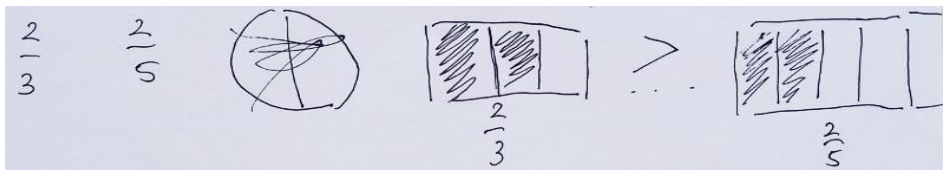


Figure 3. Results of HMA students' work in completing the fraction comparison test.

The following are the results of interviews with HMA subjects regarding the process of solving fraction comparison problems (R: researcher; HMA: high math anxiety students).

R : How did you determine that answer?

HMA : (subject moves his hand as if making a line)...I can't count in the usual way so I use pictures to solve it.

R : Can you explain how?

HMA : I made two images of the same size and I divided the images according to the denominator of the fraction. then I shaded the area according to the fraction... then I compared it... that's it

R : Then how do you determine which fraction is larger?

HMA : I see the area of these two images..which one is bigger, that is the larger fractional value...

The results of tests and interviews on fraction comparison conducted by HMA students show that HMA students use spatial reasoning strategies in solving fraction comparison problems. HMA students create two rectangles of relatively equal size to represent the two fractions instructed. Then HMA students divide the two quadrilaterals according to the denominator value of each fraction. Next, students shade the area divided according to the value of the numerators of the two fractions. Based on the area of the shaded area, HMA students determine the value of the larger fraction and put a ">" sign indicating that the value of the two-thirds fraction is greater than the two-fifths fraction. The interview results also showed that HMA students were unable to use numerical operations in solving fraction comparison problems. As a result, LMA students do not use numerical operations in solving problems.

Based on the results of the work and interviews of LMA and HMA students regarding fraction comparison questions, information can be obtained that anxiety affects the performance of both students in solving fraction comparison questions where LMA students use numerical operation strategies in solving the questions

[27, 30, 49] however, HMA students used more spatial reasoning strategies because they were not good at operating symbols [8, 48]. These results also show that LMA prefers to solve problems using numbers (operations such as addition, subtraction, multiplication, and division) compared to HMA [6]. Although the performance of LMA and HMA is different, the answer given is correct. This result is contrary to the research results [1, 31] which states that differences in anxiety will affect mathematical performance in solving fraction comparisons. The difference in strategies for determining the value of larger fractions shows that mathematical anxiety will affect individuals in manipulating numbers in solving problems [38, 47, 51]. Although the strategies used by LMA and HMA students are different, the performance results obtained by both students are correct. This shows that the performance results of LMA students are as good as HMA students. This result is inconsistent with [42] which states that HMA participants have significantly worse performance results than LMA participants when comparing fractions.

Description for student LMA and student HMA in solving word problems about fraction applications.

In solving word problems, LMA and HMA students are asked to represent land division based on the instructed fractional values. The problems given are as follows:
Mr. Ali has a rice field measuring 10 m x 10 m. One half of the land is planted with rice, one quarter of the size of the rice field is planted with chilies and the rest is planted with corn. Try to describe the division of the land area for each plant! (explain how you got the answer)!

In solving word problems, The first step taken by LMA students is to multiply the length of the side of the land and then determine the area of land for each plant. The results of the LMA students' work in determining the division of land area based on the instructed fractional values can be seen in Figure 4.

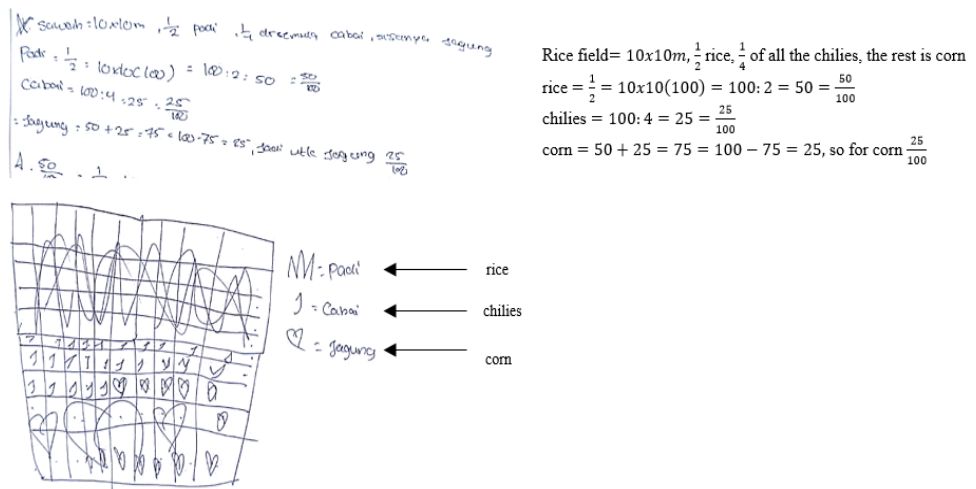


Figure 4. LMA results in representing land division

The following are the results of interviews with LMA students regarding the representation of land division in word problems (R: researcher; LMA: low math

anxiety students).

R : Try to explain how you got an image like this!

LMA : First I multiply the size of the land, which is 10 m x 10 m. Then... that is the fraction of one half, one quarter. So I changed the fraction so that the denominator is the same as the land area... Likewise, with the rest I changed it into fraction form... I Then I made a rectangle to represent the land area and divided the image into one hundred parts according to the land area.

R : Then how do you determine the shaded area?

LMA : I made symbols for each plant and I used the numerator value of the fractions and placed the symbols according to the numerator value of the fraction. Based on the results of the tests and interviews, information can be obtained that in determining the area of land for each plant, LMA students first multiply the size of the land given. Next, LMA students manipulate the instructed fractions by changing the fractional expression into an equivalent fraction whose denominator is the same as the area of the land. Then, based on the land area, LMA students draw a quadrilateral and divide the quadrilateral into 100 parts. To determine the shaded area, students take the numerator value of each fraction that is equivalent to the initial fraction.

In contrast with LMA students, HMA students used a fractional value comparison strategy to divide the land area for each plant. The results of HMA students' work in dividing the land area according to the instructed fractional values can be seen in Figure 5.

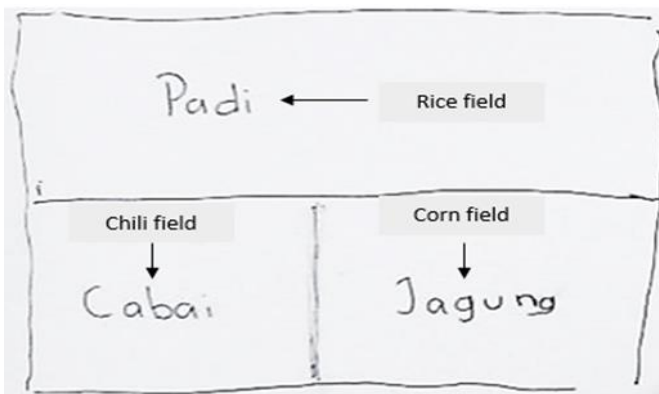


Figure 5. HMA results in representing land division

The following are the results of interviews with HMA students regarding the representation of land division in word problems (R: researcher; HMA: high math anxiety students).

R : Can you explain how you got this image?

HMA : I just look at the fractional value of each plant...and then I divide this rectangle.

R : How would you divide this rectangle and place each plant in the space you have divided?

HMA : first of all..I saw the fraction for rice..it was half..because half I divided this rectangle into two parts..and one part I made for rice plants...

R : Okay..what about the other plants?

HMA : Because the chili and corn plants have the same area, I divided the part that I did not mark into two equal parts, and in each part, I placed the plants that

had not been planted.

R : Why did you use images to solve this problem?

HMA : I don't know how to calculate the land area for each plant...

The results of the test and interviews regarding the representation of the word problems above show that HMA students are unable to use numerical operations in solving problems but use fractional value estimation strategies and spatial reasoning abilities. Students create a quadrilateral and then HMA students use estimated values of quantities to divide the area. HMA students are also able to compare fractional values so that they are able to determine the larger fractional value so that HMA students are able to divide the land correctly. Numerical disturbances and spatial reasoning weaknesses are thought to be characteristic of HMA [3] However, this study shows that HMA students use spatial reasoning to solve problems.

Discussion

The results of the work and interviews of LMA and HMA students regarding the comparison of fractions can provide information that anxiety affects the performance of both students in using strategies to solve word problems where LMA students prioritize number operation skills in the form of manipulating numbers [15, 27]. Meanwhile, HMA students use spatial reasoning in solving problems due to their inability to use calculations in solving problems [2, 32, 38]. The ability of HMA students to use spatial reasoning in solving problems is not in line with the opinion [3, 12] which states that an HMA experiences spatial reasoning weaknesses which result in using unconventional strategies to solve problems. Based on these, siswa LMA dan HMA memiliki kinerja yang berbeda dalam menyelesaikan soal cerita tentang pembagian lahan [29].

Based on the results of LMA and HMA performance in solving the two problems above, many interesting facts can be obtained regarding the performance of LMA and HMA students. LMA students perform mathematical performance by using numerical operation strategies and manipulating numbers to solve problems [31] Meanwhile, HMA students had the same mathematical performance in solving both problems, namely using spatial reasoning to solve problems caused by their inability to perform calculations or manipulate numbers [38, 51]. The use of the same strategy by HMA students in solving two fraction problems indicates that HMA students persist at a certain performance to solve many problems due to their limitations in using various strategies [26] and tend to use strategies that they find successful in solving problems [28].

The performance results of LMA and HMA students in representing land division also showed equally good results. This suggests that the impact of anxiety on performance outcomes depends simultaneously on the individual himself/herself and the demands of the task to be completed [25]. In addition, many researchers have revealed that HMA students have spatial reasoning weaknesses in solving problems [3, 12, 31]. However, the results of the study showed that mathematics anxiety did not affect the spatial reasoning abilities of HMA students [13].

Conclusion

The results of this study conclude that mathematics anxiety influences mathematics performance. The influence of mathematics anxiety can be seen in

the differences in the use of strategies used by LMA and HMA students in solving fraction comparison problems and story problems that use fraction representations with certain values. In solving fraction comparison problems and word problems, LMA students always use numerical operation strategies, namely by changing known fractional expressions into fractions that have the same value (equivalent). For fraction comparisons, LMA students look at the value of the numerator to compare the two fractions. Next, in the story problem about dividing land using the instructed fractional values, LMA students manipulate known fractional expressions into equivalent fractions that have the same denominator value as the land area and use the numerator value to determine the shaded area for each land area. However, LMA subjects still use spatial reasoning strategies that threaten to limit their ability to use numerical operations or manipulate numbers to solve fraction calculation problems and divide land areas using certain fraction values in story problems. Although the strategies used by LMA and HMA students were different, both students produced equally good performance results. This shows that the influence of mathematics anxiety only affects the use of performance strategies but does not affect performance results so mathematics anxiety does not affect all dimensions in mathematics.

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