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Students' Mathematics Anxiety and Its Correlation with Achievement and Career Path

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ABSTRACT: *Mathematics is a core subject that students of all ages must study since primary school. However, in recent years, students' anxiety about mathematics has garnered the attention of different parties. Therefore, this study aims to examine the level of students' anxiety in learning mathematics and its correlation with students' achievement and their career path after SPM. This study adopted the quantitative research design, precisely the survey method, which uses a questionnaire as a research instrument. In this regard, the study respondents comprised 193 Form 4 students from Muar district, Johor. The Revised Implicit Theories of Intelligence Scale and Career Choice Math Intensity questionnaires were modified to measure students' level of anxiety about mathematics and its correlation with students' mindset and career path after SPM. Mid-year test scores were used to measure students' math achievement. The results show that students' level of mathematics anxiety is at a moderate level (mean=2.92; sd=0.57). In addition, there is a significant correlation between mathematics anxiety and student achievement (r=-0.602; p<0.05), as well as a correlation between anxiety level and students' mindset (r=0.27; p<0.05). The study found that there is a significant correlation between the level of anxiety about students' career path after SPM for dimensions of careers involving art (r=0.18; p<0.05) and social studies (r=0.18: p<0.05). This study can raise awareness among educators and schools by highlighting and dealing with the issue of mathematics anxiety to improve students' achievement and career paths.*

KEYWORDS - *anxiety, mathematics, achievement, career path*

I. INTRODUCTION

The curriculum structure of mathematics education in Malaysia has undergone several phases of change according to the current global educational needs. In this regard, mathematics is a core subject that students of all ages must study. Er Xiao and Roslinda (2021) describe mathematics as a difficult subject because it involves a dynamic interaction between students' characteristics and other physical and socio-cultural environmental factors. Mathematics is a subject that is often considered problematic as it involves advanced calculations and is irrelevant to daily life (Mamat & Abdul Wahab, 2022). Due to the perception of mathematics being divergent, abstract, and difficult, students start to lose interest and feel afraid and anxious to learn the subject.

This crisis is further worsened by the decline in Malaysia's achievement in the Program For International Student Assessment (PISA) 2022, which shows a decrease in the average score in the domain of mathematical literacy, with an average score of 400 in 2018 to 409 in 2022 (OECD, 2022). The decline in the country's achievement in PISA 2022 clearly proved that students' achievements, specifically in mathematics, are at a less than satisfactory level, and there is a significant gap compared with highly prestigious countries such as Hong Kong, Japan, Korea, Macao, Singapore and Chinese Taipei.

According to Spangler (2020), mathematics is a subject that brings stress, anxiety, despair, and boredom. Mathematics anxiety exists among students, especially for those who often get low and unsatisfactory

mathematics achievements. Individuals who experience math anxiety will feel stressed and anxious when performing calculations involving numbers and solving math problems, whether in daily life or during learning sessions (Chan & Roslinda, 2021). Hunt and Zakaria (2018) stated that students who experience anxiety in mathematics will feel anxious and demotivated when doing number-related calculations both in daily life and during learning sessions in the classroom.

Mathematics anxiety is defined as stress and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in various types of normal life and academic situations (Ahmed, 2018). In addition, mathematics anxiety also refers to students' negative responses, such as stress, sweating, shivering, and feeling anxious when faced with situations that require mathematical solutions in their lives (Wang et al., 2015). Students will feel stressed and anxious when given tasks that involve math calculations in the classroom. According to Skaalvik (2018), mathematics anxiety is one of the most common types of academic anxiety in school. Based on the PISA 2022 report (OECD, 2022), approximately 30% of 15-year-old students in 65 countries experience high levels of math anxiety. In this regard, mathematics anxiety is negatively associated with math performance, which can lead to avoidance of math-related tasks (Skaalvik, 2018). However, this situation can be controlled if students have a stance on their thinking style. A study by Hong and Lin (2012) found that students with a growth mindset had higher math achievement scores and had the opportunity to venture into a broader range of math-related careers compared to students with a fixed mindset.

In line with Degol et al. (2018), who stated that students with a fixed mindset are more likely to give up or avoid completing a task because they are afraid and worried because they do not master the concept required for the task, individuals who have a fixed mindset and are not confident in their ability in mathematics will choose to be cold and lose their interest in venturing into the career in the future. Past studies (Hunt & Zakaria, 2018; Er Xiao & Roslinda, 2021; Chan & Roslinda, 2021) have examined the correlation between student anxiety and mathematics achievement. However, less focus has been given to how these two elements influence students' future career paths. Students with mathematics anxiety are likely to avoid careers in fields that require mathematical skills (Schmidt et al., 2017; Bakar et al., 2019). Therefore, this study is conducted to fill the gap left by previous researchers. The feedback obtained from this study can be used as a benchmark in identifying anxiety and helping students make appropriate career paths.

II. LITERATURE REVIEW

Richardson and Suinn (1972) defined mathematics anxiety as a feeling of anxiety, worry, fear, and stress experienced by a person when faced with a situation of manipulating numbers or solving problems related to mathematics in education or in daily life. Individuals who experience math anxiety can be identified through physical changes in a person, such as sweating, shivering, and a high pulse rate (Norwaheda & Siti Mistima, 2023). These symptoms will affect a person's thinking to such an extent that they cannot recall, interpret, and synthesize, and the process of making generalizations will be disrupted (Akmalia & Ulfah, 2021). They tend to give up easily. This shows the psychological effect of mathematics anxiety because they think mathematics is a source of stress.

According to Peng and Roslinda (2021), students with mathematics anxiety tend to have limited working memory compared to those with less anxiety about math. Students experiencing constant math anxiety tend to be forgetful and have low self-confidence when solving math-related problems. The constant increase in math anxiety will cause students to have a negative perception of mathematics, which subsequently has an impact on math achievement (Norwaheda & Siti Mistima, 2023). Yao et al. al. (2021) stated that this will indirectly affect achievement and both education and career selection.

According to Deringol (2018), students lose self-confidence when faced with mathematics because feelings of fear and anxiety surround them. This situation will encourage students to lack focus and not be able to

fully concentrate on learning mathematics in the classroom. As a result, they cannot complete drills or answer exam questions perfectly because they have to spend much time recalling the necessary concepts. Indirectly, their math performance will also be affected. Students' achievement will decline as their anxiety increases(Chan & Roslinda, 2021). Moreover, Peterman and Ewing (2019) stated that mathematics anxiety is becoming increasingly worrying among students due to the mathematics learning methods used to teach them.

Diagram 1: ***Debilitating Anxiety Model***

Source: Carey et al. (2016)

Based on the Debilitating Anxiety Model from Carey et al. (2016), a high level of math anxiety during the learning process will cause students' math achievement to decrease over time. The working memory of students with math anxiety is limited, and they need a relatively long time to recall concepts that have been learned. As such, they will take the fastest steps to answer the math question regardless of whether the answer given is right or wrong (Chan & Roslinda, 2021). This will indirectly affect their achievement in mathematics subjects. In addition, students who have math anxiety can also be associated with a growth mindset and a fixed mindset. Such a mindset also contributes to their future career path due to their anxiety and mindset towards mathematics. They are likely to choose a career that does not involve the subject of mathematics because of having a negative experience with the subject.

Previous studies (Ramirez et al., 2013; Luo et al., 2014; Wang et al., 2015; Zakaria et al., 2016) involving math anxiety with student achievement have been conducted among primary school, secondary school, and tertiary-level students. Findings from Ramirez et al. (2013) and Wang et al. (2015) on math anxiety among primary school pupils showed a negative correlation between anxiety and mathematics achievement. However, anxiety has a direct impact on mathematics achievement for high school students and students in higher education (Luo et al., 2014; Wang et al., 2015; Zakaria et al., 2016; Md Desa et al., 2016). Nevertheless, some students who obtain excellent results in mathematics also show symptoms of anxiety (Dowker et al., 2016). In this regard, mathematics anxiety can be positively or negatively related to students' mathematics achievement.

Students with a fixed mindset consider mistakes long-term failures and often believe they are not intelligent enough (Samuel & Warner, 2021). Chen et al. (2018) examined the correlation between mindset and attitude towards mathematics among college students in China and found that students with a growth mindset have a more positive attitude towards mathematics and are more likely to engage in adaptive learning activities such as seeking help and making more effort than students with a fixed mindset. They believe that abilities and talents can be developed and improved through effort, feedback, and improved learning methods. This belief encourages individuals to increase efforts to achieve their goals and to be more motivated and persistent in facing challenges or difficulties, particularly in mathematics.

III. METHODOLOGY

Research Design

This study was conducted using the quantitative research design, specifically the survey method. The survey method is the most appropriate method to collect data from a large population through sampling techniques. As asserted by Cresswell (2015), quantitative methods allow researchers to test the objectives of the study and the correlation between the variables involved. The findings of the quantitative study allow the findings to be analyzed inferentially to make generalizations about the objectives of the study.

Research Sample

This study's population consists of secondary school students aged 16 in the district of Muar, Johor. A total of 193 respondents were selected as a sample in this study. School selection was made based on several considerations, such as study duration and school accessibility. The sample selected produced research findings that were highly reliable and valid.

Research Instrument

This research project used a questionnaire as an instrument for data collection to obtain information from the respondents. Data was collected by distributing the hard copies of the questionnaire instruments to the respondents involved. The set of questionnaire instruments used in this study was divided into five parts. Part A contains the demographic information of the respondents and the results of the mid-year examination (PPT), which was used as a benchmark for the respondents' mathematics achievement. Part B, on the other hand, consists of 20 items about students' anxiety about mathematics adapted from the PISA 2022 student questionnaire (OECD, 2022), while part C consists of items about students' mindset. The questionnaire from Noor Atiqah et al. (2023) was adapted from The Revised Implicit Theories of Intelligence Scale by Dweck et al. (1988) to fit the mathematical context. This instrument contains 4 questions to measure respondents' growth mindset and 4 questions to measure their fixed mindset using a five-point Likert scale. Next, part D and part E consist of items on the student's education and career path after SPM adapted from Career Choice Math Intensity by Eidlin Levy et al. (2021) using a scale of 1-10.

Pilot Test

A pilot test was conducted on 30 sample respondents consisting of students aged 16 prior to the actual study. Based on the pilot test conducted, the researcher found that the respondents were able to read and understand all the items in the research instrument clearly, and the time allotted for the respondents to answer all the questions was sufficient. The results showed that the items in the instrument have an overall Cronbach's Alpha value of 0.856. Hence, the reliability of this instrument is at a good level and can be retained for the next step.

Data Analysis

The analysis was conducted using the Statistical Package for the Social Science (SPSS) software version 30 to obtain the frequency and demographic percentages of the respondents. The mean and standard deviation were used to examine the level of student mathematics anxiety. Table 1 shows the interpretation of the mean score for the 5-point Likert scale used to assess the level of mathematics anxiety among students.

Table 1:Mean Score Interpretation

Mean Score	Interpretation
4.01 to 5.00	High
3.01 to 4.00	Moderately High
2.01 to 3.00	Moderately Low
1.00 to 2.00	Low

Source: Nunnally and Bernstein (1994)

Next, the Pearson Correlation test was used to identify the correlation between two variables, namely students' mathematics anxiety level with their achievement in mathematics, students' mathematics anxiety level with the student's mindset, and students' mathematics anxiety level with their career path after SPM. The correlation coefficient, *r*, is a value used to measure the strength of the correlation between two variables. The interpretation of the positive and negative correlation between the variables is shown in Table 2.

Table 2: Correlation Coefficient Interpretation

Correlation Coefficient	Interpretation
± 0.70 – 1.00	Strong

± 0.30 – 0.69	Moderate
± 0.00 – 0.29	Weak

Source: Jackson (2006)

IV. FINDINGS

Respondents' Demography

Table 3: Distribution of Students Based on Gender, School Location, and Mathematics Achievement

Demography	Category	Number	Percentage (%)
GENDER	Male	87	45.1
	Female	106	54.9
SCHOOL LOCATION	Urban	83	43.0
	Rural	110	57.0
MATHEMATICS ACHIEVEMENT	Fail	78	40.4
	Pass	24	12.4
	Fair	63	32.6
	Good	16	8.3
	Excellent	12	6.2

As shown in Table 3, the frequency and percentage analysis for the 193 respondents, who were demographic respondents consisting of 16-year-old students, shows that 87 (45.1%) are male students and 106 (54.9%) are female. In regard to the school category, 82 respondents (43%) were from urban schools and 110 (57%) from rural schools. Next, for their achievement in mathematics subjects,78 respondents (40.4%) failed their test, 24 (12.4%) achieved a passing score, 63 students (32.6%) achieved a fair score, 16 students (8.3%) achieved a good score, and only 12 students (6.2%) achieved an excellent score in their test.

Level of Students' Mathematics Anxiety in Mathematics

Table 4: Level of Students' Mathematics Anxiety in Mathematics

Construct	Mean	Standard Deviation	Interpretation
Examination	2.81	0.58	Moderately Low
Application	2.75	0.90	Moderately Low
Classroom	3.01	0.68	Moderately High
Feeling	3.18	0.43	Moderately High
Mathematics Anxiety	2.92	0.57	Moderately Low

The survey instrument distributed divided items on anxiety into four constructs: exam, classroom, feelings, and mathematics application. The study found the mean and standard deviation for the constructs of examination (mean=2.81; sd=0.58), classroom (mean=2.75; sd=0.90), feeling (mean=3.01; sd=0.68), and application construct (mean=3.18; sd=0.43). Mathematics anxiety, as a whole, is at a moderately low level (mean=2.92; sd=0.57).

The Correlation Between The Level of Mathematics Anxiety and Mathematics Achievement

In order to analyze the findings corresponding to the study objectives, the Pearson Correlation test was used to identify the correlation between the level of students' mathematics anxiety and students' achievement in mathematics.

Table 5: The Level of Students' Mathematics Anxiety and Students' Achievement In Mathematics.

	STUDENTS' MATHEMATICS ANXIETY	
	r	p
Mathematics Achievement	-0.602	0.001*

**. Significant at 0.05

The result in Table 5 indicates a significant correlation between mathematics anxiety and student achievement in mathematics ($r=-0.602$; $p<0.05$). This means that students who have a low level of anxiety in mathematics will have a higher achievement in mathematics. This shows that students' anxiety in mathematics has a moderate, significant negative correlation with students' achievement in mathematics.

The Correlation between The Level of Mathematics Anxiety and Students' Mindset

In order to analyze the findings against the objectives of this study, the Pearson Correlation test was used to identify the correlation between the level of students' mathematics anxiety and their mindset.

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Table 6: The Level of Mathematics Anxiety and Students' Mindset

	STUDENTS' MATHEMATICS ANXIETY	
	r	p
Students' Mindset	0.27	0.001*
Fixed mindset	0.46	0.001*
Growth mindset	-0.26	0.001*

** Significant at 0.05

The results in Table 6 show a weak but significant correlation between the level of mathematics anxiety and students' mindset ($r=0.27$; $p<0.05$). This correlation shows that students experiencing mathematics anxiety are more likely to have a fixed mindset ($r=0.46$; $p<0.05$). On the other hand, students with low mathematics anxiety tend to have a growth mindset ($r=-0.26$; $p<0.05$).

The Correlation between The Levels of Mathematics Anxiety with Students' Career Path After SPM

In order to analyze the findings correlation to the objectives of this study, the Pearson Correlation test was used to identify the correlation between the level of students' mathematics anxiety and their career path after SPM.

Table 7: Level of Mathematics Anxiety and Students' Career Path After SPM.

	STUDENTS' MATHEMATICS ANXIETY	
	r	p
Arts	0.18	0.013*
Investigative	-0.51	0.001*
Enterprising	0.15	0.036*
Conventional	0.13	0.069
Social Studies	0.18	0.015*
Realistic	-0.11	0.119

**. Significant at 0.05

Based on Table 7, the findings indicate a weak but significant positive correlation between the level of students' mathematics anxiety and the dimensions of career path involving arts ($r=0.18$, $p<0.05$) and social studies ($r=0.18$; $p<0.05$). This shows that students experiencing mathematics anxiety are more likely to venture into careers related to creative arts and social studies. Meanwhile, there is a moderate, significant negative correlation between the level of mathematics anxiety and the investigative career dimension ($r=-0.51$; $p<0.05$). This shows that students with low mathematics anxiety are more likely to engage in careers involving research and analytical skills. On the other hand, the study found no significant correlation between the level of mathematics anxiety and conventional ($r=0.13$; $p=0.069$) and realistic ($r=-0.11$; $p=0.119$) career dimensions.

V. DISCUSSION

Based on the study findings, the respondents, in general, have a moderately low level of mathematics. In this light, while mathematics anxiety has not reached a high level, this should not be allowed to continue. Norwaheda and Siti Mistima (2023) stated that mathematics anxiety could have various effects on students, such as reducing self-confidence, less interest in venturing into the STEM field, and limiting students' working memory capacity. Anxiety about mathematics can also cause stress and hinder students' ability to focus in the classroom, further affecting their achievement in exams and tasks (Ryan et al., 2022). Furthermore, students with high levels of mathematics anxiety will tend to avoid completing tasks homework and engaging in math-related classroom activities.

Next, there is a significant negative correlation between the level of anxiety and students' achievement in mathematics. Students with a lower level of math anxiety recorded better math achievement, while students with a higher level of anxiety obtained less encouraging results. This finding is in line with past studies (Mustaffa, 2017; Yahya & Amir, 2018; Azizah et al., 2019) that found students who have low anxiety about mathematics obtain higher achievement. This is associated with students with a low level of anxiety and high cognitive level towards mathematics who can take full advantage of the mathematical concepts they acquire more comprehensively. On the other hand, a higher level of mathematics anxiety will lead to increasing pressure, affecting students' interest and confidence. This can have a detrimental impact on their achievement in the subject (Cumhur et al., 2019).

Based on the study's findings, students experiencing high levels of mathematics anxiety are most likely to have a mindset, while students with low mathematics anxiety possess a growth mindset. In other words, students experiencing math anxiety believe that their abilities are stagnant and difficult to change. On the other hand, students with low mathematics anxiety have confidence that their ability can grow through effort in learning. This difference proves that students with a growth mindset are more likely to achieve better academic performance because they are more concerned with continuous efforts toward change in improving their abilities. In the field of mathematics education, growth mindset interventions provide opportunities for students to develop a more positive view of mathematics, increase their confidence in learning and excel in the subject, and adopt a more flexible and open approach to solving problems (Noor Atiqah et al., 2023).

Analysis shows that students' mathematics anxiety also has an impact on students' career paths after SPM. Students with higher anxiety towards mathematics tend to choose artistic and social career dimensions. D'agostino et al. (2022) argued that mathematics anxiety may encourage students to pursue career path that are considered less focused on mathematics and more inclined to careers that involve creativity or interpersonal skills. Moreover, Adelson and McCoach (2011) stated that students with low mathematics anxiety think the mathematical concepts learned are suitable for current and future purposes and related to their school, career, and daily life needs. However, mathematics anxiety can be mitigated with early support and exposure to future careers from teachers, the school, and the surrounding community. With this method, students can make the right choice and prioritize the subject of mathematics if they are interested in venturing into different professional opportunities that involve the subject.

VI. RECOMMENDATIONS FOR FURTHER STUDIES

Based on the research findings discussed, there are several recommendations for further studies to expand this study's research scope. First, this study only involved a limited number of 193 Form 4 students in Muar district as samples. Therefore, further research can be carried out on a broader scale so that the results of this study can be generalized to all students in Malaysia. In addition, as this study adopted the quantitative approach by using a questionnaire as the research instrument, future studies can use qualitative methods such as interviews and observations of respondents to obtain more detailed results. In addition, researchers can conduct research using other independent variables affecting students' achievement in mathematics. Future researchers are also recommended to conduct a study on interventions that can be taken to address the issue of mathematics anxiety among students, such as by implementing interventions like the Junior Teacher Program in schools.

VII. CONCLUSION

In conclusion, this study proves that students' anxiety towards mathematics affects their performance in the subject. In the context of this study, students' mathematics anxiety plays an important role in their performance, as well as their choice of career path. In this regard, selecting appropriate and continuous alternative methods can reduce students' anxiety in mathematics. Thus, this study is expected to be used as a reference material, especially for schools and teachers to ensure that teaching and learning mathematics can be implemented to reduce mathematics anxiety and improve mathematics achievement and career selection.

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