



Semarak International Journal of STEM Education

Journal homepage:
<https://www.semarakilmu.my/index.php/sijste/index>
ISSN: 3030- 5152



Mathematics Anxiety among Architecture Students at Polytechnic Sultan Idris Shah: A Preliminary Study as An Attempt to Strengthen Mathematics Education in TVET Institution

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ARTICLE INFO

Article history:

Received 1 February 2024

Received in revised form 10 March 2024

Accepted 11 March 2024

Available online 16 April 2024

Keywords:

Anxiety; academic; ability; mathematic; learning; education

ABSTRACT

Mathematics is the basis for numerous technical skills imparted in Technical and Vocational Education and Training (TVET) institutes. As one of the TVET institutions, Polytechnic recognizes the importance of mathematics courses in its curriculum. Engineering, computer science, architecture, and manufacturing courses rely heavily on mathematical principles and concepts. Despite the importance of mathematics, the issue of underperformance in Elementary Mathematics courses among architecture students has been a significant issue for Polytechnic institutions. Some architecture students may require assistance understanding the direct applicability of specific mathematical topics to their field of study. They may perceive mathematics courses as arduous, demanding, intricate, and challenging to succeed in. The presence of negative thoughts significantly led to the development of mathematical anxiety. This anxiety can hinder their ability to solve problems and perform to their full potential in mathematics courses. Therefore, this study investigates the correlation between mathematics anxiety and problem-solving skills among architecture students. The study utilizes a quantitative research design, employing a questionnaire and a problem-solving test. This study used convenience sampling to select 45 Diploma in Architecture students who took Elementary Mathematics in semester one. The data collected is analysed using descriptive and correlation analyses. The study results indicated that mathematics anxiety is present among architecture students. Furthermore, a significant negative correlation was observed between mathematics anxiety and the mathematical problem-solving abilities of architecture students enrolled in elementary mathematics courses. It indicates that their abilities to solve mathematical problems decreases as their mathematics anxiety increases. Consequently, mathematics anxiety is a factor that influences the problem-solving abilities of students. Hence, educators must strive to understand mathematics anxiety and implement innovative pedagogical approaches to overcome their anxiety. Ultimately, the insights gained from the research will contribute to the current body of literature concerning mathematics anxiety and its ramifications for problem-solving within architecture education.

1. Introduction

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As Malaysia endeavours to become a developed nation, the government has set a target of establishing a professional workforce with technical-vocational-education-and-training (TVET) qualifications at 60%. Polytechnics and higher education institutions in Malaysia offer technical and vocational education and training (TVET) programs at the diploma level [1-4]. There are 36 Polytechnics under the Ministry of Education Malaysia, offering courses approved by the Malaysian Qualification Assurance (MQA). Within polytechnics, various mathematics courses are available to enhance and foster students' comprehension of the educational standards within their chosen program of study. A solid mathematical foundation is a crucial requirement for students to effectively utilize their acquired knowledge in their selected area of study [5,6]. Students' success in polytechnic education significantly depends on their ability to connect mathematics with technical and vocational domains. Polytechnic education is vital in supplying skilled workers for a country's economic and technological advancement [3,4,7]. Mathematics courses in technical and vocational education and training (TVET) institutions play a crucial role in providing students with the foundational mathematical knowledge and skills necessary for success in their chosen technical or vocational field. Elementary Mathematics is a mandatory subject designed explicitly for first-semester Architecture students. The significance of mathematics in architecture has been acknowledged throughout history. Various initiatives have been implemented to enhance and facilitate the progress and recovery of architecture students in mathematics during each academic term in polytechnic institutions [8-10]. However, many students require assistance in comprehending fundamental mathematical concepts. The primary challenges students encounter are the lack of cognitive abilities and the inability to acquire the necessary skills to solve mathematical problems. Students who find mathematics challenging may make errors during tests or examinations [10-14]. Although mathematics is highly significant, students may perceive mathematics courses as challenging, complex, and difficult to excel in. Negative thoughts significantly contribute to the emergence of mathematical anxiety. Mathematics anxiety is an affective state characterized by negative emotions.[10,15,16]. Certain areas of study, particularly STEM majors and degrees related to professional experience, are associated with higher levels of negative emotions compared to others. Architecture and engineering students, in particular, often experience high levels of stress, depression, and anxiety. Research has shown that students who are concerned about managing mathematics tend to have lower academic performance. Mathematically anxious students also experience reduced sense of competence, which further contributes to their poor performance [10, 17-20]. Thus, they require assistance in solving mathematical problems and understanding mathematical topics.

The capability to solve problems is an essential element to be taken into account while studying mathematics. Problem-solving skills are essential for all mathematical analyses because they enable students to develop their aptitude for problem-solving, problem comprehension, mathematical model construction, and solution discovery [21-23]. Research shows that students who experience anxiety while learning math may have difficulty in comprehending mathematical information, thereby affecting their ability to solve math problems [23-26]. Although there is a considerable body of literature on mathematics anxiety and its influence on overall student achievement, there is a shortage of studies, especially examining mathematics anxiety among architecture students in technical and vocational education and training (TVET) institutions [1,10,13,27-29]. This study on mathematics anxiety among architecture students at Polytechnic Sultan Idris Shah aims to bridge the gap in mathematics education within technical and vocational education and training (TVET) institutes. By focusing on this student cohort and their challenges in elementary mathematics courses, this study aimed to address the mathematics' anxiety level among students and to inform targeted interventions to alleviate mathematics anxiety and enhance problem-solving skills. This

research gap is significant as it enhances the current understanding of mathematics anxiety and holds practical implications for mathematics instruction in TVET institutions [4, 30]. By filling this research void, the results of this study can enhance the current body of knowledge and bolster the quality of mathematics education in TVET institutions, eventually benefiting architecture students and their future professional endeavours. Consequently, determining the level of mathematical anxiety among students and establishing a correlation between mathematical anxiety and problem-solving abilities are the objectives of this research.

2. Methodology

This study used quantitative methods to investigate math anxiety and its correlation with problem-solving skills among 45 Diploma in Architecture students in an Elementary Mathematics class. Participants were chosen through convenience sampling. Figure 1 shows the research framework that underpin the study. Mathematics anxiety questionnaire and mathematical problem-solving skills test were used to collect data. The questionnaire comprised 20 questions adapted from the Math Anxiety Questionnaire [5,13,31,32] and modified to align with the research scope. Table 1 shows the anxiety score range adapted to guide the interpretation of the level of mathematical anxiety among students. The test included five problem-solving questions. The questionnaire items were arranged using the five-point Likert scale, ranging from strongly agree (5) to strongly disagree (1). The collected data was analysed through descriptive and correlation analysis to gain insight into the level of mathematical anxiety and its correlation with problem-solving skills among architecture students. Table 2 shows the size of correlation and the interpretation used to underpin the analysis [12,23,33].

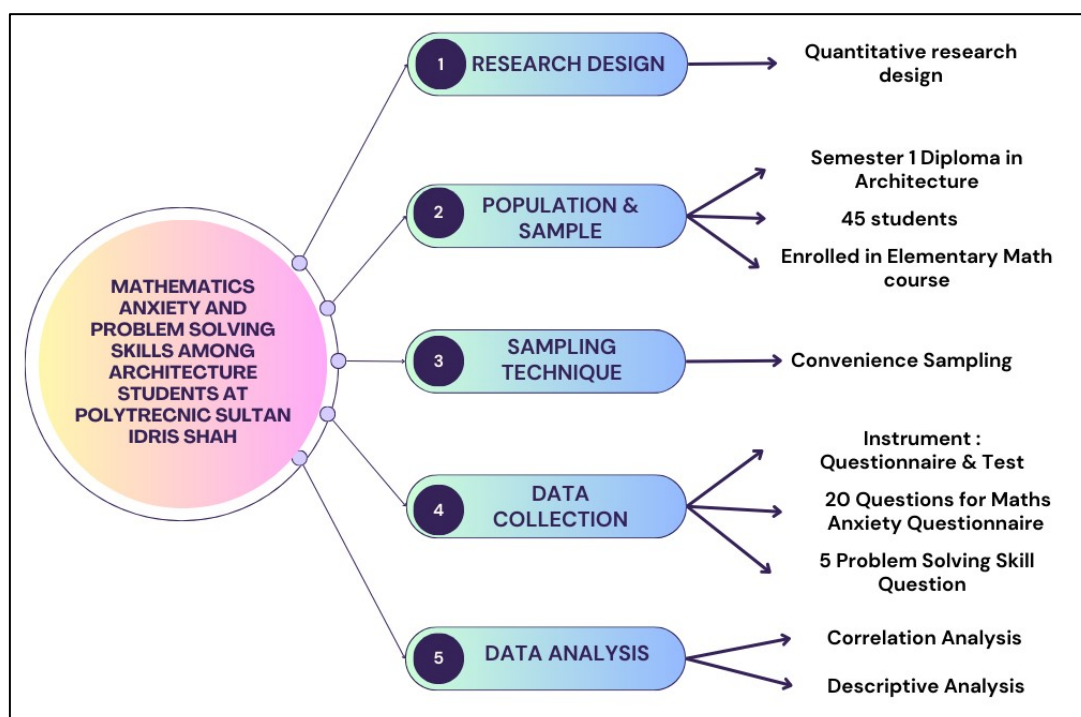


Fig.1. Research Framework

Table 1
Anxiety score range and level of anxiety

Anxiety Score Range	Level of Anxiety
4.51-5.00	Very High
3.51-4.50	High
2.51-3.50	Moderate
1.51-2.50	Low
1.00-1.50	Very Low

Table 2
Size of correlation and interpretation

Size of Correlation	Interpretation
.90 to 1.00(-.90 to -1.00)	Very high positive (negative) correlation
.70 to .90 (-.70 to -.90)	High positive (negative) correlation
.50 to .70(-.50 to -.70)	Moderate positive (negative) correlation
.30 to .50(-.30 to -.50)	Low positive (negative) correlation
.00 to .30(-.00 to -.30)	Negligible correlation

3. Results

3.1 Demographic profile

This study pertained to first-semester Architecture students enrolled in Elementary Mathematics courses, where two variables were analysed for demographic purposes, namely gender and SPM mathematics grade.

3.1.1 Gender profile

The gender profile was presented through descriptive findings showcased in Table 3, indicating that out of the total 45 students, 11 (24%) were female, and 34 (76%) were male. These results align with previous research that has identified a higher number of male students enrolled in Architecture programs [8,9].

Table 3

Gender		
Gender	Frequency	%
Male	34	76
Female	11	24

3.1.2 SPM mathematics grade

According to the results presented in Table 4, almost all of the respondents, 98% to be exact, have successfully passed the SPM Mathematics examination with a minimum grade of E. However, out of 45 students who took the SPM Mathematics test, only 33% achieved the highest grade of A, while 9% managed to secure a B grade. Moreover, 22% received a C+ or C grade, and 20% obtained

a D or E grade, with the remaining 16% failing the subject. These findings suggest that SPM Mathematics plays a critical role in engineering and architecture courses and serves as a reliable predictor of course marks for Mathematics courses where students underachieve. Furthermore, the students' academic performance during the initial semester of the course is heavily influenced by their mathematical background prior to admission into the institution. [34, 35].

Table 4

SPM mathematics grade

SPM Maths Grade	Frequency	%
Distinction (A+, A, A-)	15	33
High Credit (B+, B)	4	9
Credit (C+, C)	10	22
Pass (D, E)	9	20
Fail (G)	7	16

3.2 Anxiety Level

The aim of this study was to evaluate the extent of math anxiety experienced by students in the field of Architecture by utilizing the mean scores of mathematics anxiety. Based on the Figure 2, it was observed that out of the 44 students who participated in the survey, nine students (20%) reported high levels of mathematical anxiety. Similarly, 21 students (47%) experienced moderate levels of math anxiety, whereas 13 students (29%) reported low levels of such anxiety. Interestingly, only one student (2%) experienced very low levels of math anxiety. Research has shown that math anxiety is a prevalent phenomenon among students when they are learning mathematics in the classroom. These findings are indicative of the existence of math anxiety among Architecture students and are consistent with the prevalence of anxiety among students in mathematics subjects [5,11,13,28,36].

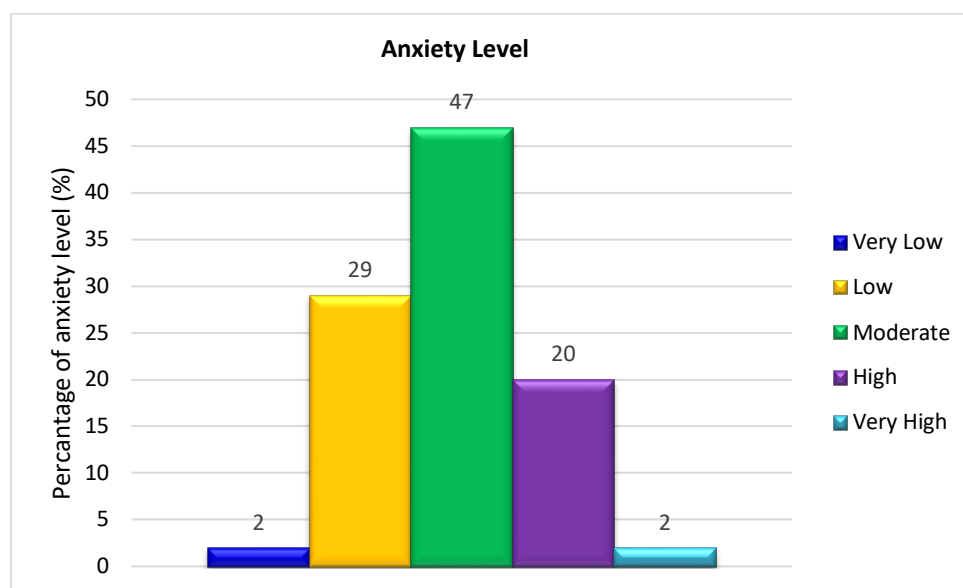


Fig. 2. Mathematical anxiety score among students

3.3 Correlation between Mathematics Anxiety and Problem-Solving Skills

According to Table 5, there is a significant negative correlation between Mathematics Anxiety and mathematical problem-solving ability. The data suggests that as Mathematics Anxiety levels increase, the ability of students to solve mathematical problem decreases. Conversely, when Mathematics Anxiety levels are low, mathematical problem-solving ability increases. The study indicated a significant inverse relationship between Mathematics Anxiety and mathematical problem-solving ability, with $r (= -0.67)$, $p = 0.000$ ($p < 0.05$). This finding suggests that students with higher levels of anxiety are more likely to experience low achievement in mathematics, whereas students with lower anxiety levels are more likely to achieve higher results in mathematics. [10, 13, 25, 28, 37].

Table 5
Correlations between problem-solving skill and mathematics anxiety

Correlations			
		MA	PS
MA	Pearson Correlation	1	-.673**
	Sig. (2-tailed)		.000
	N	45	45
PS	Pearson Correlation	-.673**	1
	Sig. (2-tailed)	.000	
	N	45	45

4. Discussion

Technical and Vocational Education and Training (TVET) institutes in Malaysia are committed to generating a highly skilled workforce that can meet the demands of the labour market. They achieve this by allocating substantial resources towards vocational education and training, equipping students with the technical skills necessary to succeed in their chosen fields. Additionally, students are encouraged to excel in core subjects such as mathematics, which is of paramount importance in polytechnic institutions [26,38,39]. Mathematics educators in polytechnic institutions always strive to emphasize solving mathematical problems, which helps students develop the ability to think critically and become well-rounded individuals. By providing students with the tools, they need to succeed, TVET institutes are contributing to the development of a prosperous and thriving Malaysian economy. However, despite its importance, many students often find it challenging to learn and master mathematics in class [5,10,40]. One of the significant factors contributing to this difficulty is mathematics anxiety. It is essential to understand the mathematics anxiety levels on students' problem-solving skills to help them master mathematics successfully.

By addressing mathematics anxiety, educators can empower students to become more confident in their problem-solving abilities and achieve success in this vital subject. Hence, the current study examines the extent of mathematics anxiety among first-semester architecture students. The study also sought to establish the correlation between problem-solving skills and mathematics anxiety. According to the results, Architecture students' mathematics anxiety level is at a moderate-high level. This finding supported the previous studies, which reported that students at higher education levels

were experiencing mathematical anxiety at moderate to high levels and confirmed the existence of mathematical anxiety among students [12,36,41,42]. It is imperative to address extreme mathematics anxiety among students, as it can lead to adverse outcomes. Previous research indicates that a significant proportion of Malaysian students experience a moderate degree of mathematics anxiety. As such, addressing this issue is of utmost importance to ensure academic success and mental well-being [5,37,43]. It is noteworthy that the level of anxiety a student experiences towards a specific subject can have a direct impact on their academic achievement. As a result, students who experience high levels of math anxiety are inclined to exhibit reduced engagement in mathematics classes, possess lower self-perceived mathematical abilities, and perceive minimal or no practical significance of mathematics in their day-to-day lives [12,15,28,31,36]. The results of the study indicate a significant negative correlation between mathematics anxiety and the mathematical problem-solving abilities of students enrolled in Elementary Mathematics courses.

These findings are consistent with previously conducted research, which also reported a negative impact on students' problem-solving skills when they experience mathematics anxiety [13,15,23,31]. As the study indicates that students who exhibit elevated levels of math anxiety tend to demonstrate lower proficiency in solving mathematical problems, conversely, students who experience math anxiety to a lesser extent tend to show an improved proficiency in solving mathematical problems. The finding is in line with previous research that has demonstrated a moderate negative correlation between mathematical Anxiety and mathematical problem-solving skills, thereby suggesting that students with high levels of Mathematics Anxiety are likely to perform poorly in mathematics [7,15,16,27,41,43]. Given the strong negative correlation between mathematical anxiety and the ability to solve mathematical problems, it is imperative for educators to underscore the value of problem-solving skills in mathematics. The study's findings are expected to stimulate additional research into mathematics anxiety, particularly in the context of approaches to alleviating or reducing mathematics anxiety among students in higher education. One potential avenue for future research involves investigating students' approaches and recommendations for managing mathematics anxiety in the classroom. In light of this, an intervention has been planned for the year 2024 to delve into an innovative game-based teaching approach designed to alleviate mathematical anxiety among architecture students

5. Conclusion

Mathematics anxiety is a feeling of fear and tension that can make it difficult to work with numbers and engage in math learning. This research provides a significant contribution as 1) the study reveals the extent of mathematical anxiety experienced by architecture student, 2) the study demonstrates a strong negative correlation between problem-solving skills and mathematics anxiety and 3) the research findings propose that the integration of academic coping mechanisms within the teaching and learning of mathematics can effectively mitigate anxiety levels among both students and educators. Further research is recommended to assess the impact of academic coping strategies or interventions on mathematical anxiety during the learning process. The findings are valuable in raising students' awareness of mathematical anxiety and promoting their psychological well-being throughout their educational journey. By utilizing this information, students can gain insight into their mental well-being and effectively employ coping mechanisms to overcome academic anxiety. The study's findings also offer supplementary insights for educators and institutional counsellors to recognize students' negative emotions, provide support, and employ suitable strategies to mitigate these emotions during the teaching process.

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