

## Impact of Mathematics Anxiety on Undergraduate Mathematics Students in a Gulf Country

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### ABSTRACT

Mathematics anxiety has been established to negatively influence students' learning experiences in Mathematics. There is, however, no data available on this condition in undergraduate students in any of the Gulf countries in the region. This study therefore seeks to bridge the knowledge gap about how Mathematics anxiety influences learners in undergraduate Mathematics programmed in a GCC country. Researchers constructed a measurement scale comprising two sections: where the first section addresses Mathematics anxiety among undergraduate learners in the course of studying mathematics and the second section relates to the levels of anxiety exhibited by learners when taking assessments. The scale was modified from the original Mathematics Anxiety Rating Scale (MARS) model. The data obtained was analysed using descriptive statistics and one-sample t-test at 95% level of confidence. The results suggest that most learners exhibit high to extreme levels of anxiety while taking Mathematics assessments, whereas they showed moderate to low levels of Mathematics anxiety while studying Mathematics, although some of the learners did exhibit extreme anxiety levels while studying the subject.

**Keywords---** Anxiety, Foundation, Rating Scale, R-MARS, Undergraduate

introduced to depict learners' attitudinal challenges with mathematics [7].

One of the published data [8] proposed three distinct time frames within which mathematics anxiety was measured. Within the first-time period, most of the reviews were simply authors' conclusions and did not show any standardized mathematics anxiety measures. The focus within that time was devoted to the definition of mathematics anxiety [9]. This was later shifted to the assessment of attitudes towards mathematics [1]; followed by the development of standardized mathematics anxiety instruments, the Number Anxiety scale [7], Mathematical Anxiety Rating Scale [2], the Fennema-Sherman Mathematics Attitudes Scales [10], the Anxiety Towards Mathematics Scale [11], and the Mathematics Anxiety Questionnaire [12]. The Mathematics Anxiety Rating Scale (MARS) developed by Richardson and Suinn [2] is one of the most extensively used mathematics anxiety instruments. It was revised from its original form (which comprised of 98 items) to a Revised Mathematics Anxiety Rating Scale (R-MARS) [13], with 24 items.

Research data [6] has reported that as low as 7% of Americans have been *positively* impacted by mathematics anxiety right from the kindergarten through to college, whereas 66% of adults are said to be negatively affected and as such are dreadful of mathematics. The Primary school is thought to be the starting point of mathematics anxiety [14] [15] [16] [17] [18], where students are reported to exhibit a total dislike for mathematical contents, especially when instructed in basic skills in mathematics rather than in the ideas that generate the skills [14] [15] [16] [17] [18].

These adverse feelings tend to reduce learners' trust in their mathematical capabilities, causing them to be very apprehensive towards mathematics as they move on to high schools [14] [19] [16] [18]. Studies [20] have

### I. INTRODCUTION

Mathematical proficiency is essential for working in today's advancing technological era. The significance of mathematics goes beyond the academic domain and basic skills in mathematics are required for daily living. Mathematics anxiety, which impacts directly on Math's proficiency, is not a new concept but has been well-documented since the 1950s [1][2][3][4][5][6]. The term first appeared when some teachers of mathematics were observed while teaching, in the early 1950s and was

found that the willingness or reluctance of most college students to pick up and/or drop advanced mathematics courses may be attributed to their poor mathematics anxieties, probably dating back to their primary school era.

Mathematics anxiety, which is more than a dislike for mathematics, has been found to negatively influence students' attitudes, beliefs, and perceptions in mathematics [21]. It has been defined as a state of discomfort that occurs when an individual is required to perform mathematically [19], or the feeling of tension, helplessness, or mental disorganization an individual undergoes when requested to manipulate numbers and shapes [21][7]. One key research group in Mathematical Anxiety [22], defined it as "Feelings of tension, apprehension, or even dread that interferes with the ordinary manipulation of numbers and the solving of mathematical problems". Mathematics anxiety has, so far, been reported to result in a debilitated state of mind that could develop into a higher level of mathematics avoidance and phobia [17].

#### ***Mathematics Anxiety in Teachers and Learners***

Jackson and Leffingwell [4] suggested that mathematics anxiety could be observed among elementary school pupils in as early as their third or fourth grades if their teachers were prone to mathematics anxiety. The report also indicated that teacher behavior was a prime determinant of mathematics anxiety and is usually evident early in the primary school pupils. College students would have preferred not to select any mathematics-related courses when given the choice, since their individual mathematics anxieties often lead them to avoid the subject altogether [3]. As a result, the mathematical backgrounds of most elementary/primary school teachers tend to be weak in content knowledge and mathematical experiences [23] [24] [25].

Some elementary educators were identified as having a limited knowledge of mathematics as well as a limited knowledge of research in mathematics education, and as a result, were not able to teach mathematics due to their backgrounds and personal anxieties [23] [24] [25]. These limitations enabled them to implement only a restricted number of mathematical instruction strategies in their classroom environments [24] [26]. Data collected on students in teacher training colleges indicated that elementary education majors were usually identified as a largely female population, and this population was observed to have the highest level of mathematics anxiety and mathematics evasion behaviors compared to other college majors [3] [14] [27] [28]. It is believed [29] [30] that many teachers who exhibit mathematics anxiety not only influence, but inadvertently pass on their anxieties to the students they teach. Furthermore, it was learnt [31] that elementary/primary school teachers having high levels of mathematics anxiety spent less time planning mathematics lessons and instead used mathematics instruction time for non-mathematics related activities.

Brady and Bowd [32] also found that about 39% of prospective elementary school teachers reported that mathematics was the subject they least liked and were therefore uncomfortable teaching it [30].

Mathematics anxiety influences students' motivation to learn mathematics, since it is related to the feeling of being tensed or anxious while solving mathematical-related problems or working with numbers [2]. Students with mathematics anxiety may not necessarily suffer from other subject-related anxieties. In a study, Hembre [3] found that students enrolled in mathematics courses exhibited the highest level of mathematics anxiety compared to their undergraduate counterparts (in the humanities or social the sciences).

Many negative outcomes are linked with mathematical anxiety. For instance, students with high levels of mathematical anxiety ordinarily develop negative feelings towards mathematics. They are less inclined to pursue mathematics-related vocations and probably the most serious outcome of mathematics anxiety is a decreased level of accomplishment. In their review on students' performance in mathematics, Cates and Rhymer [33] found that students with more elevated levels of mathematics anxiety had significantly lower levels of computational capabilities in all ranges of numerical calculations. These low levels tend to reduce students' accomplishments in mathematics and probably adds to their negative attitudes towards the subject.

One of the major challenges researchers faced when measuring mathematics anxiety was related to society's influence on students' beliefs regarding mathematics. In a study [34] on the relationship between mathematics anxiety and social desirability, the researchers established that men, in colleges, are unlikely to report their feelings of anxiety toward mathematics than women, because men consider it socially unacceptable to experience mathematics anxiety. This finding suggests that researchers will have a more difficult time measuring the mathematics anxiety of male students than that of their female counterparts. In addition, the study reported that researchers and college administrators should be alert when using the mathematics anxiety measuring scale in circumstances that screen students for special mediation programs or other scholastic prospects since some students may be disregarded because of their reluctance to truthfully react to questions on mathematics anxiety.

One other component that contributes to students' mathematics anxiety is the kind of instructional strategies used in the classroom. An investigation [35] into how two instructional strategies, discovery and expository, impacted students' mathematics anxiety in an undergraduate core mathematics course revealed that students with higher levels of mathematics anxiety scored high marks on achievement test when taking expository-format course as opposed to a discovery-format course. Then again, students with lower levels of mathematics anxiety

performed better in the discovery course. The report established a connection between mathematics anxiety and confidence and indicated that students with more elevated levels of anxiety would show lower levels of confidence in mathematics and therefore would be less likely to perform well in mathematics-related courses. This is an indication that the level of confidence required on the part of a student to learn mathematical concepts is dictated by the instructional strategies.

Although very little data is available on how students' attributes, such as gender or high school experience, influence the development of mathematics anxiety, however researchers have only focused on the contribution of mathematics anxiety to students' performances. They initially believed that poor performance prompted students' feeling of mathematics anxiety and predicted that students with low achievement in mathematics would generate negative feelings and attitudes towards mathematics, causing them to maintain a deliberate distance from the subject later [3]. This level of apprehension could cause students to continue performing poorly, affirming their feelings and attitude towards mathematics. Once caught in this endless loop, it becomes difficult for students to reduce their mathematics anxiety without any sort of intervention.

Even though this evading cycle is evident among students with high mathematics anxiety, there is, however, no significant evidence to suggest that low performance contributes to mathematics anxiety [36]. To determine whether students' working memory influenced their levels of mathematical anxiety when they embarked upon mathematical tasks, Ashcraft and Kirk [37] found that mathematics anxiety interfered with the ability of the student's working memory to concentrate on mathematical tasks. They also reported that this working memory interference not only causes students to spend longer times when doing mathematical tasks but also reduces students' precision.

In addition to the observed working memory interference among students, they were also reported to have felt more anxious when doing assessments in mathematics within a given time frame [4]. Data from a qualitative study [38] which investigated students' mathematical performance under imposed time constraints indicated that students struggled under imposed time constraints. Even though they demonstrated a high level of understanding of the mathematical concepts during lessons and in homework assignments, they failed in class assessments due to the time constraints imposed on them to work. When the time restrictions were removed, students obtained excellent grades in their assessments and were able to complete the tasks within the original stipulated time. The research proposed therefore, that students' concerns about time constraints interfered with their ability to focus on the tasks in mathematics assessment and that being perturbed about the amount of

time left effectively reduced the extent of their working memory left to work on mathematical tasks assigned to them during assessments.

Considering the effect mathematics anxiety has on students, it is crucial to find out the causes of mathematics anxiety. Data [4] obtained from 157 undergraduates who presented reflections on their mathematical experiences from Primary schools through to colleges identified the different situations that had contributed to their heightened stress levels in mathematics. 27% of the students indicated that their first unpleasant encounters in mathematics were at the tertiary level, where learners reliably recognized that encounters with tutors/lecturers affected their emotions and states of mind toward mathematics. These encounters included lecturers'/tutors' disdainful remarks, negative attitudes and conduct toward students and lack of appreciation of students' levels of understanding. Different researchers have additionally reported that lecturers'/tutors' demeanors toward both students and the courses they teach, can impact students' responses [39].

## II. METHODOLOGY

### *Measuring Mathematics Anxiety*

The scale most widely used to quantify and investigate mathematics anxiety is the Mathematics Anxiety Rating Scale (MARS) [2]. Researchers presumed that the few people who did not ordinarily experience the negative effects of general anxiety were still influenced by mathematics anxiety. Richardson and Suinn [2] constructed the MARS to specifically examine mathematics anxiety. The reason for MARS was to enable researchers scrutinize mathematics anxiety and to propose mathematics anxiety alleviation strategies. The scale originally comprised of 98 items which addressed students' anxiety levels when dealing with mathematical concepts and playing with numbers. MARS has since been utilized by researchers to study the effect of mathematical anxiety on students and the effectiveness of mediation programs intended to alleviate this condition [40] [41] [42] [34] [43].

Researchers have utilized MARS and factor analysis to investigate the different measurements of mathematics anxiety. Rounds and Hendel [40] discovered two essential components of mathematics anxiety when utilizing the MARS instrument, which were the Mathematics Test Anxiety (MTA) and Mathematics Numerical Anxiety (MNA). The MTA factor addressed students' feeling of anxiety before, during, and after mathematics assessments (that is, items related to learning, studying, test taking), while the MNA factor considered manipulation of numbers, mainly in arithmetic (that is items pertaining to daily use of mathematical concepts and computations).

One major setback about the initial MARS instrument was the large number of items on the scale.

Some efforts were, therefore, made to review the instrument by excluding repetitive or apparently redundant items [40] [44] [13]. A significant number of attempts to abbreviate the MARS instrument was made by using suitable generalizability but neglected to examine how the items were adjusted. To create a shorter version of the MARS for use in different settings, a 30-item MARS scale was reconstructed [45], which was a revised version of the first MARS instrument based on the MTA and MNA variables.

#### **The Revised Mathematics Anxiety Rating Scale**

The measuring scale used in this study is an adaptation from Revised Mathematica Anxiety Rating Scale (R-MARS). The scale is made up of 24 questions which is scored on the 5-point Likert scale, where 1 represents “No anxiety” and 5 represents “Extreme anxiety”. It is a two-factor model scale, where the first factor is the Learning Math Anxiety, comprising the first 16 items that measure anxiety levels experienced by students when they embark on activities that relate to studying mathematics, including “Reading and interpreting graphs or charts”. The second factor, comprising 8 items, is the Math Evaluation Anxiety that measures the levels of anxiety experiences that students undergo when their mathematical skills are being evaluated (taking a final assessment).

MARS was originally developed by Richardson and Suinn [2] as a 98-item tool to diagnose and recommend treatments for mathematics anxiety. Initially, the tool portrayed one general factor. Later, however, factor analysis by Rounds and Hendel [40] classified the scale into two factors: which were MTA and MNA. The scale was, later, shortened to 24 items [46] to achieve reliability and validity. It still had two factors with similar reliability, validity numbers and an internal consistency of  $\alpha = 0.98$ . The first factor was labeled as the Mathematics Learning/Course Anxiety and the second as Mathematical Evaluation/Test Anxiety.

To date, there is no published data available on the levels of Mathematics Anxiety exhibited by learners in higher educational institutions across any of the Gulf countries. This study therefore, seeks to explore the prevalence of Mathematics Anxiety among undergraduate students in one of the Gulf countries using the R-MARS scale to measure learners’ levels of Mathematical anxiety. The study will modify and adapt the R-MARS to determine whether mathematics anxiety is prevalent among undergraduate students in Foundation Mathematics and to determine the impact of this condition on the performance of students enrolled in undergraduate Mathematics programme.

Data was obtained by employing the survey method. The R-MARS measurement scale was used by administering the revised and adapted R-MARS scale. The measurement scale was drastically revised to reflect the socio-cultural dynamics that prevail within the Polytechnic environment in order not to infringe on respondents’ fundamental rights and privacy. The R-MARS was adapted to follow the 5-point Likert scale. The measurement instrument was modified using Google plugins like Google forms to obtain a two-factor model scale. The two-factor model scale involved categorizing the questions on the measurement scale to reflect the impact of Mathematics anxiety while studying mathematics and the impact while taking assessments. After piloting the questionnaire, it was administered to the sampled students’ population. The measurement scale was administered to a sample size of 140 Foundation Mathematics students at the Polytechnic who were drawn from the three different categories of Foundation Mathematics courses. Both qualitative and quantitative data was collected in this study since the questionnaire generated both types of data. The data was further analyzed using non-parametric, chi-squared test and One-sample t-tests in SPSS.

### **III. RESULTS**

TABLE 1  
THE DIFFERENT LEVELS OF ANXIETY EXHIBITED BY FOUNDATION MATHEMATICS STUDENTS DURING THE LEARNING PROCESS

		Freq	Percent	Valid Percent	Cum Percent
Valid	No anxiety	833	33.1	33.1	33.1
	Some Anxiety	661	26.2	26.2	59.3
	Moderate Anxiety	562	22.3	22.3	81.6
	High Anxiety	285	11.3	11.3	92.9
	Extreme Anxiety	179	7.1	7.1	100.0
	Total	2520	100.0	100.0	

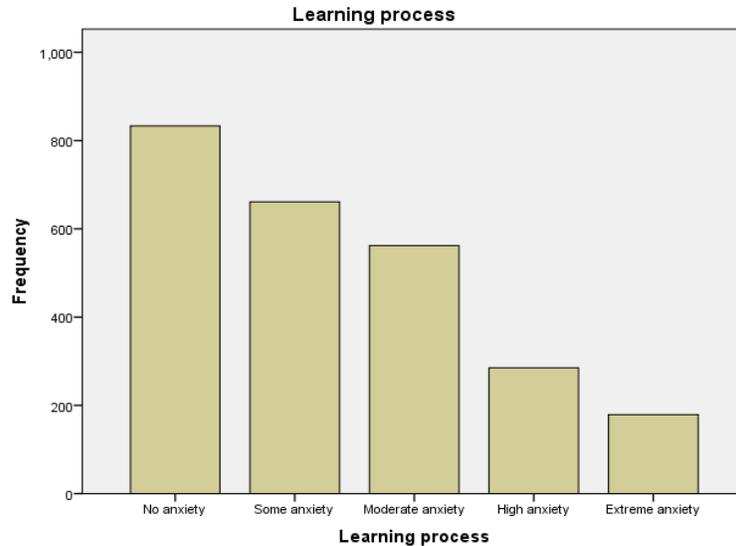


Figure 1. The histogram depicts the levels of anxiety exhibited by Foundation Mathematics students during the period of studying (Learning Process) Foundation Mathematics courses.

From Table 1, 2520 responses were obtained from all the 15 questions relating to the period of studying Mathematics courses, which is referred to as the Learning Process. Data obtained (Table 1 and Figure 1) show that over 66% of students exhibit some levels of anxiety up to extreme anxiety, an indication that only about 33% of students claim not to suffer any form of Mathematics anxiety when studying Foundation Mathematics courses. It is alarming to observe that a high percentage of students

exhibit various levels of mathematical anxiety when studying a Mathematics course, since one would have expected anxiety levels to be non-existent when students are engaged in the learning process. It is clear from the data obtained that 59.3% of students express low anxiety levels and around 18.4% express high levels of anxiety. This gives indication that most of the students investigated do not suffer from high level of anxiety throughout the studying stage.

TABLE 2.  
DIFFERENT LEVELS OF ANXIETY EXHIBITED BY FOUNDATION MATHEMATICS STUDENTS DURING EXAMINATIONS (ASSESSMENT PROCESS) IN THE MATHEMATICS COURSES

		Freq	Percent	Valid Percent	Cum Percent
Valid	No anxiety	165	19.6	19.6	19.6
	Some Anxiety	200	23.8	23.8	43.5
	Moderate Anxiety	173	20.6	20.6	64.0
	High Anxiety	132	15.7	15.7	79.8
	Extreme Anxiety	170	20.2	20.2	100.0
	Total	840	100.0	100.0	

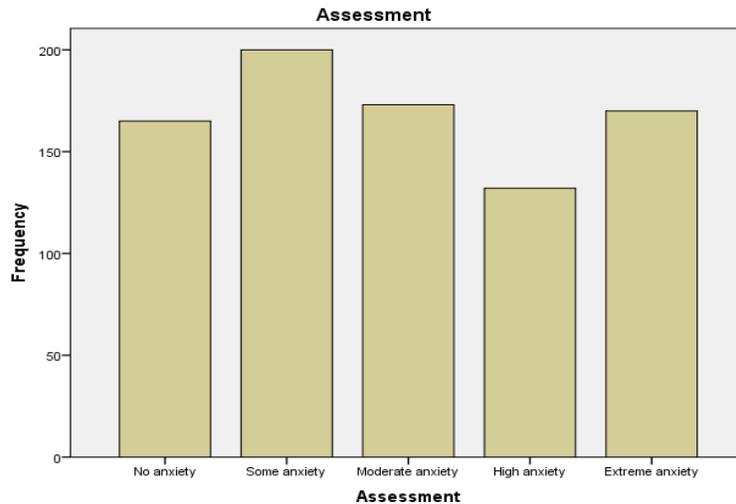


Figure 2: The histogram depicts the levels of anxiety exhibited by Foundation Mathematics students during the period of taking all types of assessments during the Foundation Mathematics courses (Assessment Process).

From Table 2, 840 responses were obtained from all the 9 questions relating to the period of taking Mathematics assessments, referred to as the Assessment Period. Data obtained from the study (Table 2 and Figure 2) show that over 80% of students exhibit various levels of Mathematical anxiety, from ‘some anxiety to extreme anxiety’. Around 20% each of the respondents exhibited ‘some anxiety, moderate anxiety and ‘extreme anxiety’; while around 15% of students exhibited high anxiety. There was a significant drop in the % of students showing ‘some anxiety’ to moderate anxiety and then a significant increase occurred from ‘high’ to ‘extreme anxiety’. This shows clearly that over 56% students exhibited moderate to extreme anxiety when taking assessments in Foundation Mathematics courses. It was obvious therefore, that during the assessment period, as high as 43.5% of students express low anxiety level and around 35.9% express extreme levels of anxiety.

This research further tested the following hypotheses:

- 1)  $H_0$ : Students suffer from high anxiety during course study process; and
- 2)  $H_0$ : Students suffer from high anxiety during assessment process

To test the two hypotheses, the researchers implemented the one sample t-test since the size of the sample was high enough to be considered as Normally Distributed.

Hypothesis 1 suggested that the level of Mathematical Anxiety in Foundation Mathematics students when studying Mathematics courses is high. To test the hypothesis, the results of the students’ levels of Mathematical Anxiety when studying mathematics courses were analyzed (in SPSS) using one-sample t-test, as indicated. These results are summarized in Table 3.

#### IV. HYPOTHESES TESTS

TABLE 3.

ONE-SAMPLE (T-TEST) NON-PARAMETRIC STATISTICAL ANALYSIS DATA INDICATING THE OUTCOME OF THE HYPOTHESIS 1 TEST PERFORMED ON DATA COLLECTED ON STUDENTS DURING MATHEMATICS LEARNING PROCESS

One-Sample Test					
Test Value = 3					
95% Confidence Interval of the					
Difference					
t	df	Sig. (2-tailed)	Mean Difference	Lower	
Learning process	-27.069	2519	.000	-.6683	-.717

As indicated in Table 3, the calculated p-value for the level of was found to be 0 ( $p = 0$ ), which was less than the significant p-value of 0.05. This shows that the mathematical anxiety levels of Foundation Mathematics students were generally low when they are engaged in studying courses in mathematics (that is, during the learning process). This suggests that the null hypothesis can be rejected at 95% level of confidence and therefore, students did not express high level of anxiety during the learning process.

Hypothesis 2 suggested that the level of Mathematics Anxiety in Foundation Mathematics students when they are taking any type of assessments is comparatively high. To test this hypothesis, the data obtained on the students' levels of Mathematics Anxiety when taking assessments in the Foundation Mathematics courses were analyzed (in SPSS) using one-sample t-test. The results are summarized in Table 4.

TABLE 4.  
TABLE SHOWS ONE-SAMPLE (T-TEST) STATISTICAL RESULTS INDICATING THE OUTCOME OF THE HYPOTHESIS 2 TEST PERFORMED ON THE DATA COLLECTED ON STUDENTS DURING MATHEMATICS ASSESSMENT PROCESS

One-Sample Test		Test Value = 3			
		95% Confidence Interval of the			
		Sig. (2-tailed)	Mean Difference	Difference Lower	
t	df				
Asses sment	-1.419	839	.156	-.0690	-.165

From the table (Table 4), the calculated p-value for the levels of mathematical anxiety found in students taking assessments in Foundation Mathematics courses was found to be ( $p = 0.156$ ), more than the significant p-value of 0.05 (at 95% confidence interval). This indicates that the mathematical anxiety levels of Foundation students during assessment periods were moderately high to extremely high. That is, the data suggests that the null hypothesis cannot be rejected at 95% level of confidence and therefore, students expressed high levels of anxiety during assessments.

The trend observed in the data available from this study may be due to the different categories of students represented in the cohort. It is likely that the data might be different if a higher proportion of the respondents were more mathematically inclined. A plausible explanation for this data was that respondents comprised of three different categories of students in Foundation Mathematics, which were the more abled ones (Mathematics 2 Technical), those who were quite able (Mathematics 2 General) and those with less ability (Mathematics 1). Furthermore, the study did not distinguish between the more abled students and the less able ones, as a result, a follow-up study should take into consideration the hierarchical categories of Foundation Mathematics students, since this will greatly influence the data obtained.

## V. CONCLUSION

It is obvious from the data reported that mathematics anxiety is prevalent among Foundation Mathematics students at the Bahrain Polytechnic and that the Revised Mathematics Anxiety Measurement Scale (R-MARS) has been successfully adapted and utilized to measure the levels of anxiety among the students. Students have been seen to exhibit higher levels of anxiety when taking Mathematics assessments, while they showed lower levels to no anxiety when engaged in leaning/studying Mathematics courses. Further studies, however, are recommended to investigate whether the development of mathematics anxiety in students might be influenced by students' physiological characteristics, like gender, ethnic background, learning experiences, as well as their socio-economic status.

No research data has is available now, to determined what period marks the onset of mathematical anxiety in students although some studies have suggested the onset to be during early childhood in the third grade [37]. This is probably because students have, so far, not been able to identify period of the onset and source of their anxieties. Besides, researchers have had difficulties in trying to distinguish between the start of mathematics anxiety in students compared to when students are simply less competent in mathematics as the level of difficulty in

the subject increases. These issues, therefore, can be addressed in further mathematics anxiety research studies. Going forward, researchers will propose support mechanisms to develop soft skills to address this condition and determine suitable mechanisms for students to mitigate the negative effect of anxiety on their performances.

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