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Anxiety about mathematics among university students: A multi-dimensional study in the 21st century

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Abstract

The aim of this research was to examine university students' anxiety about mathematics, teaching mathematics in the 21st century and the views on mathematics teachers. A total of 100 students studying in 10 different departments of the Faculty of Economics and Administrative Sciences of a private university in the 2018–2019 academic years participated in this study. The data were collected by demographic questions, semi-structured open-ended questions consisting as well as questions about mathematics teaching in the 21st century prepared by the researchers and through the 'Mathematics Anxiety Scale'. According to the results, there were significant differences in terms of the mathematics anxiety level of students who graduated from high school those have low average maths grades. Meanwhile, an average level of anxiety was observed data collected from the students by using 'Mathematics Anxiety Scale'. Most students emphasised the fear of success and feeling stressful as the reasons for anxiety about maths.

Keywords: Mathematics anxiety, university students, fear, stress.

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1. Introduction

Mathematics is an agent that facilitates people's understanding of the world, thus allowing them to improve their lives and create ideas. Therefore, in all the reforms applied in modern education, the most important target is to create a system that can help learners learn better by understanding mathematics. However, one of the factors affecting this target negatively is the anxiety learners experience in regard to mathematics (Peker & Ulu, 2018).

Anxiety is a feeling and experience an individual goes through at certain times. This feeling affects life negatively and often causes uneasiness, leading to a feeling of fear of weak performance (Kose, Yilmaz & Goktas, 2018).

Mathematics anxiety is defined as an experience of negative feelings. It affects numerical and mathematical thoughts negatively. It is true that anxiety affects performance in mathematics. It has been observed that individuals with anxiety experience exhibited low performance, were less self-confident and less motivated in basic tasks, mental calculations and mathematics problems (Sokolowski, Hawes & Lyons, 2019). As Ahmed (2018) argues, mathematics anxiety is one of the most common among academic anxiety types experienced at school. It can be defined as 'a feeling of strain and nervousness hindering the manipulation and solution of numbers.'

A report in the 2012 International Program of Student Evaluation revealed that an average of 30% of the students with 15 years of learning in 65 countries exhibited high level anxiety about mathematics (OECD, 2015). Researchers stress that skipping maths classes is closely related to anxiety. Ahmed (2018) emphasises that realising the development of anxiety about mathematics, which particularly becomes a problem in adolescence, is a key factor in achieving targets.

In a study by McDonough and Ramirez (2018), it was argued that individuals with high anxiety are more likely to forget mathematical concepts. 'Anxiety about mathematics is an indication of fear and stress' (Wang, Shakeshaft, Schofield & Malanchini, 2018). In their studies, Jose et al. (2017), Wang et al. (2018) and Emily & Libertus (2018) found a negative correlation between mathematics anxiety and motivation. In other words, high anxiety about maths causes low levels of motivation and performance in the subject. In their study, Lauer, Esposito & Bauer (2018) argued that women experienced higher anxiety about maths than men.

Anxiety about maths is observed in certain situations. Although studies have been conducted to define this problem, they are not sufficient (Jose et al., 2017). Nir Majdar (2018) reached the conclusion that 6th year students had a high level of anxiety towards the end of the school year but had a lower level of anxiety in the 7th year. According to the researchers, this was because after the 5th year, maths topics become harder, which subsequently increases anxiety. Justicia-Galiano, Martin-Puga, Linares & Pelegrina (2017) reported similar findings in their study. Einar (2018) pointed to the fact that in order to overcome this anxiety, the students with high level anxiety developed strategies to protect themselves.

Today, efficacy in mathematics has become an important issue for every individual in both their professional and social lives. However, it is unfortunately true that tasks requiring mathematical knowledge and the stress and disappointment related to maths are the triggers of anxiety, which urges both educationalists and researchers to reconsider their approach so as to overcome long-term problems that hinder individual success at school and reduce quality of life. Several researchers have studied the negative effects caused by anxiety about mathematics (Kucian, McCaskey, O'Gorman Tuura & von Aster, 2018).

2. Aim of research

This study aims to examine university students' anxieties about mathematics to determine any differences in terms of gender, primary-secondary-high school culture, average grades for

mathematics, and the attitudes of maths teachers, specifically their views about 21st century mathematic teachers and their teaching and expectations and to understand the emergence of anxiety and its functions. In short, the study will investigate the factors that cause anxiety and the actions students take to overcome them.

3. Research focus

In their studies, McDonough and Raminaz (2018), Wang et al. (2018) and Justicia-Galiano et al. (2017) found that variables, such as the type of high school, teachers' attitude, lack of self-confidence and motivation, stress experienced in maths classes and disappointment increased anxiety. The significance of this study is that it deals with the key variables in the anxiety university students experience, evaluates their features and the steps to be taken to prevent anxiety about mathematics.

4. Methodology of research

4.1. General background of research

In order to examine university students' anxiety about mathematics through different variables, a mixed method research design, one of the descriptive research methods, was employed in this study. This research includes an integrated approach of both qualitative and quantitative models, which involves the collection, analysis and combination of qualitative and quantitative data (Nagy & Biber, 2010).

4.2. Participants

The participants were composed of students studying at the Faculty of Economics and Commercial Sciences of a private university in the 2018–2019 academic year. The distribution of the 100 participants studying in 10 different departments was; Economics (*N* = 4), Business (*N* = 23), Accountancy (*N* = 19), Foreign Trade (*N* = 7), Computer Programming (*N* = 11), Computer Information (*N* = 1), Management-Informatics Systems (*N* = 3), Banking and Finance (*N* = 25), EU Relations (*N* = 4) and Banking-Insurance (*N* = 3). A total of 44 (44%) of the participants were female and 56 (56%) were male. In order to obtain the qualitative data, 25 other students studying in these departments were asked open-ended questions.

4.3. Instrument and procedures

The 'Mathematics Anxiety Scale' and demographic questions were asked to identify students' anxiety about mathematics. The 14-item 'Mathematics Anxiety Scale' was adapted from Betz's (1978) 10-item Scale, developed by Bai et al. (2009). The same scale used to measure university students' anxiety about maths was adapted into Turkish by Akcakin, Cebesoy and Inel (2015). This scale consists of 14 items that measure the unknown structure of positive and negative factors causing anxiety about maths. The scale, a five-point Likert type, has two dimensions, negative (eight items) and positive (six items). Examples of the positive items include 'I think I'll need maths in the future' and 'There should be more maths classes'. In terms of the negative items, examples are 'I'm not sure about my skills in solving maths problems' and 'Mathematics is a hard subject for me.' The grading order of the Scale for negative factors is: 'Totally disagree' (1), 'Disagree' (2), 'Not sure' (3), 'Agree' (4) and 'Strongly agree' (5). The grading of the positive items is the reverse of these scores. A high score in the scale indicates high anxiety. The reliability and validity of the scale developed by Bai et al. (2009) were assessed and the Cronbach alpha reliability coefficient was found to be 0.91. Both factors of the Scale explained 67% of the variance. The Cronbach's Alpha reliability coefficient of this study was calculated as 0.86, which indicates high reliability. Meanwhile, open-ended questions were written by

the researchers to determine the views and expectations of students about 21st century maths teaching and maths teachers.

4.4. Data analysis

The SPSS package programme was used in the analysis of quantitative data and frequencies were used in explaining demographic data. As for reporting the scale items, the average and standard deviation of every item was calculated. After conducting the Kolmogorov–Smirnov test, a normal distribution of the data was observed ($p > 0.05$). Two unrelated sampling averages were compared through independent sampling *t*-test, and one-way analysis of variance (ANOVA) test was used to compare the averages of more than two unrelated samplings (Buyukozturk, Cakmak, Akgun, Karadeniz & Demirel, 2017). In the classification of the qualitative data obtained from the semi-structured open-ended questions, content analysis was performed, and frequencies and percentages were calculated.

5. Findings

Certain steps were followed to understand students' anxieties better and to determine their different stages of developing. Anxieties were examined for any differences in terms of gender, average grades in mathematics in primary, secondary and high school, the subject teacher's attitude and the type of primary, secondary and high school. Following this, the averages of the 'Mathematics Anxiety Scale' and responses to open-ended questions were classified.

In the ANOVA test, a significant difference was not observed between university students' primary school maths averages 'marks out of ten' system 5–6 (average), 7–8 (good), 9–10 (excellent) and their scores related to maths anxiety ($F_{2–97} = 1.172$; $p > 0.05$). Similarly, according to the result of the ANOVA, a significant difference was not noted between secondary school maths average scores in the 'marks out of ten' system 5–6 (average), 7–8 (good), 9–10 (excellent) and their scores related to maths anxiety ($F_{2–97} = 1.577$; $p > 0.05$). This finding indicates that, regardless of their average scores in maths in primary and secondary school, their anxiety levels in maths remain the same.

According to the results of the one-way ANOVA, a significant difference was observed between university students' average maths scores at high school and their level of anxiety about maths at university ($F_{2–97} = 5.489$; $p < 0.05$). Based on the results of the Tukey test from the *post-hoc* tests, a significant difference was observed in favour of the students with low score averages compared to the students' maths anxiety with average and high scores.

The one-way ANOVA test did not reveal any differences in students' anxiety levels related to their teachers' being disciplined, positive-interested, pressuring and having indifferent attitudes in primary school maths classes ($F_{3–96} = 0.613$; $p > 0.05$). The same analysis for secondary school ($F_{3–96} = 1.422$; $p > 0.05$) and high school ($F_{3–96} = 0.511$; $p > 0.05$) did not reveal any significant differences. In this respect, these two results show that students' anxiety levels in both issues are at the same level.

A significant difference was noted in the level of maths anxiety in terms of the type of high school (General high school, Science high school and Vocational high school) ($F_{2–97} = 3.861$; $p < 0.05$). The Tukey test result showed a significant difference in the level of maths anxiety in favour of the vocational high school graduates compared to the graduates from general high schools and science high schools. A significant difference was observed in the level of anxiety in favour of students from general high schools compared to science high school graduates.

Table 1. University students' average scores in the mathematics anxiety scale

No	Item	*N*	Mean	SD	Evaluation result
1	I'm interested in maths	100	3.20	1.189	'I'm not sure'
2	I feel nervous in exams	100	3.56	1.43	'I agree'
3	I'll use maths in the future	100	4.02	1.1	'I agree'
4	I can't think well in maths	100	2.80	1.189	'I'm not sure'
5	I need maths in daily life	100	3.87	1.219	'I agree'
6	I'm not good at solving maths problems	100	2.69	1.323	'I'm not sure'
7	I feel hopeless in solving problems	100	2.65	1.209	'I'm not sure'
8	Maths is difficult	100	2.77	0.256	'I'm not sure'
9	I feel fine in maths classes	100	2.75	1.373	'I'm not sure'
10	I need more maths classes	100	2.93	1.327	'I'm not sure'
11	I feel bad in maths classes	100	2.44	1.208	'Don't agree'
12	I enjoy maths	100	3.11	1.27	'I'm not sure'
13	Maths is fun	100	3.31	1.268	'I'm not sure'
14	I'm confused in maths	100	2.83	1.491	'I'm not sure'

In the 'anxiety scale' in Table 1, it can be observed that the students were mostly indecisive in several items. However, they responded to the questions; 'I feel nervous in maths exams', 'I think I'll be using maths in the future', 'I think maths is essential in daily life' with 'Agree' and their answer to the question, 'I feel nervous in maths classes' was 'I don't agree'. A significant difference was not noted according to the independent *t*-tests revealed between the demographic questions to be answered as 'YES' and 'NO', such as: 'I feel stressed in maths classes', 'I feel stressed before maths classes', 'I feel stressed after maths classes', 'Maths classes at university make me feel stressed', 'The thought of maths in my life makes me feel stressed' and the mathematics anxiety average scores ($p > 0.05$). This indicates that the anxiety level of the students who are worried or are not worried about maths in their lives and the ones who feel stressed before, during or after maths classes remain the same.

In order to understand the function of anxiety about maths, how it changes, how to prevent this, and the qualifications of 21st century maths teachers then the following open-ended questions were asked. The responses in frequencies and percentages were given in Table 2.

Table 2. Views of university students explaining maths anxiety

QB1. How can you define Maths anxiety?	*N*	%
Annoyance within the family	1	4
Unable to learn maths	4	16
Lack of self-confidence in maths classes	4	16
Difficult maths problems	8	32
Forgetfulness	10	40
Forgetfulness in exams	15	60
Fear of failure in maths	20	80
Feeling stressed	25	100

As can be observed in Table 2, all the students defined maths anxiety as 'stress', nearly all defined it as 'fear of failure in maths' and one student defined it as 'causing problems within the family'. Some other responses included 'unable to learn maths, lack of self-confidence, difficult maths problems', 'forgetfulness in class and in exams'.

Table 3. Views of university students' strategies for overcoming maths anxiety

QB2. How do you overcome anxiety	*N*	%
I try to enjoy maths	5	20
I sit in the back of the classroom	6	24
I try not to think about maths	6	24
I try to solve different questions	8	32
I talk to the teacher	8	32
I solve a lot of problems	15	60
I study with my friends	20	80
I study regularly	25	100

Table 3 reveals that students try different ways of overcoming maths anxiety. The response with *the highest frequency is 'studying regularly', followed by answers such as 'studying with friends, solving a lot of questions, trying to enjoy maths, trying to solve different questions, trying to ignore maths, sitting in the back in the classroom, and talking to maths teacher'.*

Table 4. Views of university students related to the increase in anxiety in regard to maths in line with the rapid developments in Information Technology

QB3. Do rapid developments in Information Technology increase your mathematics anxiety?	*N*	%
Yes	11	44
No	14	56

In response to the question regarding whether the rapid changes in Information Technology have increased anxiety about maths or not, as Table 4 reveals, 56% of the students responded 'No' and 44% responded 'Yes'.

Table 5. Students' views about being good at maths

QB4. Do you think you should be good at maths? Why?	*N*	%
The students who said 'Yes'	22	88
For high average	2	8
I always want to be successful	3	12
I think I should improve myself in maths	5	20
Maths is everywhere	18	72
An important subject	20	80
I need it in my department	24	96
The students who said 'No'	3	12
There is no need to be good at maths in this Technology age	1	4
My background is weak. I cannot do it even if I want to	1	4
We have a few maths classes in the department	1	4

As can be observed in Table 5, 22 students out of 25 placed emphasis on being good at maths by saying, 'it is an important subject in the department, it is used in everyday life, we always wish to succeed and have high averages'. Three students presented an opposing view, arguing, 'There are only a few maths classes in the department, we cannot succeed even if we want to because we do not have a good background in maths and we do not need it in today's technology age'.

Table 6. University students' views about maths classes to help lessen maths anxiety

QB5: How should maths be taught to lessen anxiety in university?	*N*	%
We should be allowed to use electronic calculators	2	8
The passing-grade should be lower	5	20
There should be selective courses	7	28
Class periods should be shorter	10	40
There should be basic maths	23	92
There should be ample activities	25	100

Table 6 shows the students' views about how maths teaching can help lessen maths anxiety. As the students emphasised, there should be a sufficient number of activities in maths, starting from simple to more complicated. In addition, they stressed the need for optional short-term extra classes and argued that using electronic calculators would lessen anxiety. Views about teachers' strategies for reducing anxiety are shown in Table 7.

The students raised different views about the subject question above. Most of them emphasised that the teachers should be *'positive', 'they should provide ample exercises', 'they should not bore students during the lesson', 'they should start from the simple to more difficult', 'they should give a lot of examples', 'they should assign homework', 'they should make students enjoy maths', and 'they should not be too demanding and insistent'.*

Table 7. Students' views about teachers' strategies for reducing anxiety

QB6: What should maths teachers do to lessen anxiety?	*N*	%
They should not be too demanding and insistent	3	12
They should assign a lot of homework	6	24
They should make us enjoy maths	7	28
They should show us how maths can be enjoyable	36	36
We should work on ample examples	10	40
They should go from the simple to the more difficult	10	40
They should not bore the students	11	44
There should be a lot of revision	18	92
They should be positive	25	100

6. Discussion

A significant difference was not observed in the level of students' anxiety in terms of gender, average maths scores in primary-secondary school, the type of primary-secondary school, and maths teachers' attitude in primary-secondary school. The fact that students in science high schools exhibit lower anxiety levels compared to other types of high schools is considered to be a result of the necessity to take entrance exams to be admitted to science high schools. The same findings were observed in studies by Uysal and Selisik (2016) and Emily and Libertus (2018). A significant difference was not observed in terms of the teacher' attitudes (disciplined, overly demanding, indifferent and uninterested) in primary-secondary-high schools.

It can be observed in the 'Anxiety Scale' that most of the answers were 'Not sure'. On the other hand, the participants responded with 'Agree' to the items; 'I feel nervous in maths exams', 'I think I'll need maths in future' and 'I think maths is related with my daily life'. In terms of the answers to the demographic questions, most of the students admitted that they were not stressed before and after maths classes and thinking of maths did not cause stress. Although maths in university classes did not cause them stress, the results are very close to each other in terms of values. Although it is assumed that maths classes in university programs do not cause stress, the findings are very close to each other in terms of values. Although it is assumed that maths classes in university programs do not cause stress, the findings are very close to each other in terms of values.

In the answers to the semi-structured open-ended questions, the students defined anxiety as 'being unsuccessful in maths', 'feeling stressful', 'forgetfulness in class and exams', 'not being able to learn maths' and 'difficult problems and lack of self-confidence'. These findings are supported by the results in a study by Kucian et al. (2018). Students try different ways to overcome anxiety, such as 'Studying properly', 'Studying with friends', 'Solving a lot of problems', 'Trying to enjoy maths', 'Trying to solve different problems', 'Trying not to think of maths', 'Sitting in the back of the classroom', 'Talking to the maths teacher'. These results are in parallel with the findings in Einar's study (2018). Meanwhile, most of the students expressed that rapid developments in Information and Technology did not increase anxiety. Almost all the students admitted that they have to be good at maths.

The reason for the need to be good at maths, as the students with 'Yes' answers explained, is because it is an important departmental subject, it is used everywhere, they want to be successful and achieve a high average. The reason why some students answered with 'NO' is that they do not have many maths classes in the department, they do not have a good background in maths, and they do not believe that maths is necessary in today's technology age.

The students raised views about lessening anxiety, emphasising that there should be basic maths and learning should start from the simple to the more difficult. They also added that it should be an elective, short-term course with extra class-hours. Using electronic calculators, as they pointed out, lessens anxiety. The students raised different views about the teachers' way of teaching. They mostly stressed that teachers should be positive, do a lot of revision, should not bore the learners, should start from the simple to the more difficult, should give a lot of examples, should assign homework, should make maths enjoyable, and should not be overly demanding or insistent. These findings support those reported in Papanastasious's study (2002).

7. Conclusions

It has been found out that university students' maths anxiety levels are average and similar in terms of the average maths scores in primary and secondary school, maths teachers' attitudes in primary-secondary-high school and the type of primary-secondary school. Similarly, students' anxiety levels are similar in terms of primary-secondary-high school maths teachers. According to the type of high schools, vocational high school, the graduates of general high school and science high school students exhibited the highest levels of anxiety. High school students exhibited the lowest anxiety levels.

Another finding revealed that most of the students did not experience stress before or after maths classes or thinking about maths in their everyday lives. The students overcame maths anxiety by studying regularly. The rapid developments in Information and Technology did not increase their anxiety levels and they are aware of the importance of being good at maths.

The students emphasised that maths teaching should include sufficient activities starting with the simple to the more complicated, they should be assigned homework, they should enjoy maths, teachers should not be too demanding, there should be short-term extra class hours, and they should be allowed to use electronic calculators.

8. Recommendations

In this research, university students' anxiety about maths was investigated and the determinant variables were examined. In the light of the results of this study, the following suggestions are made to university maths teachers and to the instructors.

- More examples can be provided and homework can be assigned to lessen anxiety
- Maths can be transformed into a fun activity to make learners enjoy it
- Anxiety can be lessened by being positive, but not overly demanding
- One-to-one communication can be provided to help lessen anxiety
- It can be underlined that maths teachers, who have a key role, should be positive, do a lot of revision, and this should be introduced in BA Programs
- Considering that anxiety starts in early childhood and continues throughout people's lives, more studies can be carried out to emphasise the importance of maths teachers' attitudes towards learners and the subject
- More research can be conducted to help learners find ways to overcome anxiety
- Maths courses can be rearranged according to faculties and departments and can be started as basic maths
- Based on the high schools that graduates attend, they can be guided in choosing majors accordingly.

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