

## Online teaching and students' perceived level of math anxiety during covid-19 pandemic

Alina-Elena Grecu\*

### Abstract

*This study explores how teachers' perceptions of students' math anxiety changed during online learning imposed by the Covid-19 pandemic. Using the focus group method of qualitative research for a group of selected math teachers, we have looked into the following questions: How was the students' perceived level of math anxiety in online classes? What differences and what similarities have the teachers noticed in comparison with the face-to-face learning? The results of the study show that the phenomenon of math anxiety is decreasing and is becoming less significant than in face-to-face education. Moreover, our research showed that the frame description of how teachers perceived the students' math anxiety implies two different processes: the students' engagement in online learning (SEO) and the students' digital competences (DC). It seems that students' digital competences has a positive effect on learning mathematics, a fact that leads to students' experiencing less anxiety. Also, the phenomenon of math anxiety may be caused by the lack of students' engagement in online learning. Students who don't have digital skills, tend to avoid participating in online mathematics classes.*

**Keywords:** emergency remote teaching and learning; perceived level of math anxiety; digital competences; comparison; student engagement.

### 1. Introduction

Online education has become very important nowadays due to COVID-19 pandemic that started in 2020. So, schools and teachers had to adapt to new educational circumstances (Kofoed et al, 2021). In order to give more insight in the way teachers perceived the online mathematics teaching in the secondary school, the present research investigates students' math anxiety and the factors influencing their anxiety in certain Romanian schools.

Math anxiety is commonly defined as an unpleasant feeling associated with doing math (Hembree, 1990). Ashcraft and Krause (2007) explain math anxiety as a "feeling of tension, apprehension, or fear that interferes with math performance". In other words, when students suffer from math anxiety, they seem to be unable to focus on solving math problems because they get worried about the tasks given by their teachers (Beilock & Carr, 2005).

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\* Assistant professor, PhD. Candidate, University of Bucharest, Faculty of Educational Sciences, Bucharest/Romania, Email [alina-elena.grecu@fpse.unibuc.ro](mailto:alina-elena.grecu@fpse.unibuc.ro)

Mathematics anxiety is not only a psychological phenomenon that limits the ability to solve mathematics problems, but also a phenomenon by which those who suffer from mathematics anxiety can experience physical reactions similar to pain (Paiva et al., 2021). As a result, those affected by these problems, avoid mathematics classes and do not develop careers in which good mathematical skills are essential (Ashcraft & Ridley, 2005). Spielberg (1972) showed the distinction between math trait anxiety and math state anxiety. Trait anxiety is defined as an individual's tendency to feel anxious, whereas state anxiety is perceived as an individual's feelings of anxiety in different stressful situation. The studies undertaken by Wigfield and Meece (1988) among secondary school students showed that the phenomenon of mathematics anxiety has two different dimensions: cognitive and affective. The cognitive dimension, perceived as "worry", emphasizes the concern regarding the performance achieved and the possible consequences in case of failure, whereas the affective dimension, perceived as "emotionality", reveals the traces of nervousness and apprehension in test situations. Current scientific studies assess the phenomenon of math anxiety using items such as "How anxious are you when you have to solve a worksheet by yourself" or "How worried are you that you won't follow the math lesson" (Carey et al, 2016).

It has been demonstrated that the phenomenon of math anxiety has educational consequences on mathematics education (Aiken, 1970; Aschraft & Moore, 2009). Unfortunately, approximately 20% of students suffer from high math anxiety (Aschraft & Ridley, 2005). Researchers have shown that individuals with math anxiety perform more poorly than their low math anxious colleagues in math-related educational tasks (Mendoza et al, 2021; Ludwig, 2021).

The 2012 PISA tests investigated the phenomenon of mathematics anxiety among students, asking students to report whether they worry that math lessons will be difficult for them, whether they become stressed when doing math homework, whether they feel helpless when they have to solve math problems or if they worry about getting low grades in math (OECD, 2012). The results of the 2012 PISA tests showed that an important proportion of 15-year-olds expressed feelings of emotional stress when facing mathematics. Thus, 59% of students stated that they often tend to get worried when it comes of their participating in math classes; 33% of students admitted that they become tense and fidgety when they start to do their math homework; 31% of students reported that they get nervous when they try working on math; 30% declared they feel helpless when it comes of solving math problems and 61% said that they concern about getting low marks in math. In Romania, the phenomenon of mathematics anxiety is even more impactful: 75% of students declared that they feel anxious when dealing with mathematics (OECD, 2012).

The COVID-19 impacted negatively students' mathematics achievement. Another dramatic consequence of the pandemic is students' deteriorating mental health, a fact that also leads to their math anxiety. (Hammerstein et al., 2021; Paiva et al, 2021).

A review by Panagouli (2021) reveals a selection of 42 papers published before July 2021 in which he analyses school performance reported by teachers and parents. Most of these studies show a major decrease in mathematics results compared to the years before the pandemic; six of them mention the phenomenon of students' math anxiety.

Recently, Svaleryd et al. (2022) has published a new survey that confirmed learning difficulties and mental health challenges among students.

In online classes during the pandemic, only 11% of students experienced low levels of math anxiety, most students admitted moderate levels of anxiety (Delima & Cahyawati, 2021). Also, the results of the 2012 PISA tests showed that students who use the Internet a lot have a lower sense of satisfaction with life than students who spend less time online (OECD, 2012). The same happens with the use of mobile phones (Hawi & Rupert, 2016) and with the use of video games (Manzoni et al., 2011). In this context, it is very important to investigate the phenomenon math anxiety in online learning.

On the other hand, Takács et al. (2021), has shown that successful outcomes regarding students' online learning depend on: students and teachers' digital competences, well-adjusted study materials, behavioral engagement of student, accessibility and responsiveness of teachers. Taking into account all these results, the interrogative approach of the focus group explores the link between this four factors and math anxiety. The teachers and students' digital competences (DC) were defined as "skills, knowledge, creativity, and attitudes that everybody needs in order to use digital media for learning" (Rokenes & Krumsvik, 2014). Computer games have been regarded as important means for mathematics education because they have the potential to provide an attractive and funny learning environment (Oblinger, 2006).

The student engagement concept (SE), defined by Alexander W. Astin's work (1999) "Student involvement: A developmental theory for higher education", refers to "physical and psychological energy that the student devotes to the academic experience". Student engagement is characterized by behavior engagement, cognitive engagement as well as emotional engagement, following Bloom's educational goal classification (Fredricks et al., 2004). Student engagement in mathematics classes influences the learning results (Qiping Kong, 2003).

Student engagement in online learning (SEO) is "engagement when using online learning platform to learning, including behavioral engagement, cognitive engagement and emotional engagement" (Min Hu et al., 2016). The students' engagement had a positive effect on learning effectiveness whether in face-to-face activities or technology-mediated activities (Hu & Hui, 2012). Thurston et al. (2021) showed that there are three factors that influence SEO, namely: "access to household material and technological resources, school programming and instructional strategies, and family social capital".

## 2. Research objectives and questions

This research is based on the focus group method. The purpose of this study is to emphasize the teachers' point of view about math anxiety, to reveal different opinions on the main theme and to point out in which way the teachers became participants in the debate for the focus group. We explore the question: how was the phenomenon of math anxiety perceived by teachers in online education? The central objective is to identify the teachers' perception of math anxiety in the emergency remote online classes. Another objective is to investigate the relationship between student engagement in online learning (SEO), the teachers and students' digital competences (DC) and mathematics anxiety.

## 3. Materials and Methods

The focus group method was the main method used for this research. The instruments with which data were collected, were given by the focus group guide.

### 3.1. Participants.

The focus group was conducted with the participation of 11 secondary teachers of mathematics: 5 teachers from rural areas and 6 from urban areas. The research took place in June 2020, in the last weeks of school, via Zoom, with a duration of 90 minutes. The approval for conducting this research was given by the Scientific Research Ethics Committee of the University of Bucharest. The teachers were selected from the group of mathematics teachers participating in a training course in mathematics education, organized by the Faculty of Mathematics and Informatics, in Buşteni. All the selected teachers have outstanding results in their careers. Also, the teachers involved in this research were concerned with the phenomenon of anxiety caused by mathematics and also had some information about this phenomenon from the specialized literature.

### 3.2. Focus group guide.

The interrogative approach for the focus-group contains 10 carefully formulated questions to obtain relevant data for the study. The questions used for this research were: opening questions, transition questions, key questions and ending questions.

The question session debate for the teachers' focus group had the following ten questions:

1. Would you like to tell me your initials, your grade, your level of teaching and if you teach in a rural or urban area? (Opening Question)
2. How would you characterise your students' behavioral engagement in online courses? (Transition Question)
3. Have you noticed any students with math anxiety during online teaching? (Key Question)
4. Could you mention a case of a student dealing with math anxiety? (Key question)
5. What is the most important cause for students' math anxiety from your point of view? (Key Question)
6. How could you help a student struggling with math anxiety? (Key question)

7. What differences and what similarities have you noticed in comparison with the physical teaching? (Key Question)
8. Our intention is to find out more information about students' perceived level of math anxiety. Do you think we have skipped some other important questions? Is there something you would add? (Ending question)
9. What would you like to know about this phenomenon when we have finished this study? (Ending question)

The questions were developed taking into account the existing information about this math anxiety phenomenon in the specialized literature (Dowker et al., 2016). They are as follows:

Question 1 highlights relevant data (degree, level of teaching, urban or rural area) about teachers.

Question no 2 concerns the involvement of the students in online classes.

Question no 3 and 4 focus on the students' math anxiety.

Question 5 wants to highlight the cause of students' math anxiety

Question 6 aims to describe the way the teacher helps the child dealing with math anxiety.

Question 7 wants to highlight the differences and the similarities in comparison with the face-to-face teaching.

Question 8 and question 9 aims to draw opinions and expectations from teachers about math anxiety.

### 3.3. Coding and data analysis.

Focus group analysis is an intentional process with a clear purpose. The long table method was used. The data analysis was based on the audio and video recordings of the focus groups and their transcription, taking into account the words used by the participants, the context in which they were said, the precision of the answers, the importance of the topics, their frequency, the emotional intensity shown and the specificity of responses (Krueger & Cassey, 2005).

The chosen data was coded (Saldana, 2013) inductively in a first round of categories. In a second round, themes and subthemes were expressed. This information is presented in tabular form.

The students referred to by the teachers in this focus group are typical secondary school students, students who have confessed that they struggle with the phenomenon of mathematics anxiety.

During the discussions, it was found that in the teachers' perspective, there are no gender differences in terms of mathematics anxiety: both girls and boys may be afraid of mathematics. This conclusion is also validated by the Pisa 2012 tests: although, globally, there are countries where the phenomenon of math anxiety is more impactful among girls, in Romania, no significant effects of this gender differentiation were found (OECD, 2012).

From the teachers' perspective, it can be concluded that the students' behavioral engagement had both productive and counterproductive elements, which can lead to math anxiety. Math anxiety is decreasing when students are involved in classwork, when they ask questions and when they do their homework.

In an attempt to stimulate student engagement in class, teachers strived to create relevant, interesting, and enjoyable instructional opportunities. A teacher stated: "I used engaging educational platforms such as My Koolio (<https://www.mykoolio.com/>) and Brio (<https://brio.ro/>), and thus my students said that mathematics could be fun to deal with". Another teacher also remarked on the students' math anxiety "there were students who no longer answered class because of the fear of giving incorrect answers with their microphone turned on". Several teachers stated that every class, there were students who had their camera and microphone turned off, avoiding answering the teachers' questions. This fact could also be a proof of their math anxiety.

*Table 1 Investigating question 2 from the focus group*

Question 2	Topic	Subtopic	Category
"How would you characterise your students' behavioral engagement in online courses?"	Negative aspects of the students' engagement	Non-video Non-audio Online games	The students' engagement in online courses (SEO)
	Positive aspects of the students' engagement	Involvement Answer Questions during classes Doing homework The joy of using online platforms	

Regarding the phenomenon of math anxiety, teachers say they have noticed this phenomenon in students, describing more a form of cognitive anxiety, manifested by students by anticipating failure or avoiding participation in online classes. Thus, a teacher stated: "there were situations in which some of the students avoided answering my questions, then, when they heard the correct answer, they said that they thought the same but were afraid that their answer was wrong".

They also identify the student's lack of digital skills (DC) as a potentiating factor in math anxiety. The teachers noticed that "some of the students did not upload the math assignments on time, accumulating gaps in math, because they did not know how to use Classroom".

Table 2 Investigating question 3 and question 4 from the focus group

Question 3 and questions 4	Topic	Subtopic	Category
"Have you noticed any students with math anxiety during online teaching?"	Math Anxiety	Characteristics of anxiety about mathematics Differences from general anxiety	Perceived Level of Math Anxiety (PLMA)
"Could you mention a case of a student dealing with math anxiety?"	Cognitive math anxiety	Fear of working Avoiding online connection Turning the web cameras off	Perceived Level of Math Anxiety (PLMA)
	Negative emotions towards mathematics	Worry	

The main causes of math anxiety, teachers listed, in particular, the lack of math knowledge caused by poor students' engagement (SEO) and digital skills of the students (DC). Thus, compared to classical education, the lack of digital skills stands out as the cause of the anxiety caused by mathematics: "there are students who do not know how to upload homework correctly, take pictures of them and then avoid handing them in to their teachers; they avoid connecting to certain educational platforms because they do not have the necessary digital skills".

The answers of the teachers highlight the link between general anxiety and anxiety caused by mathematics, but also the specificity of mathematics anxiety: "they are talkative and involved students but anxious about mathematics", remarked a leading professor; link also confirmed by specialized literature (Ní Fhloinn, 2021; Lanius et al, 2022). Another cause mentioned by teachers is that of the pressure exerted by parents: "there are parents who only want grades of 10 (the best mark in Romanian system) for the student to be admitted to prestigious high schools".

Table 3 Investigating question 5 from the focus group

Question 5	Topic	Subtopic	Category
What is the most important cause for students' math anxiety from your point of view?	Causes of math anxiety	Lack of math knowledge Lack of general skills The general anxiety of the student Failure to do homework The pressure exerted by parents	Perceived Level of Math Anxiety (PLMA)

Among the strategies to reduce math anxiety, teachers listed teaching strategies, school counselors and school psychologists' advice and educational platforms that have attractive, animated content. Ramírez et al. (2018) showed that cognitive-behavioral

therapy has a positive impact on the phenomenon of anxiety caused by mathematics. The use of literature in teaching mathematics might be another strategy to reduce mathematics anxiety (Furner, 2018). The teachers' answers are thus supported by the specialized literature: "I tell the students about how certain theorems were discovered in order to stop being stressed".

*Table 4 Investigating question 6 from the focus group*

Question 6	Topic	Subtopic	Category
How could you help a student struggling with math anxiety?	Mathematical anxiety reduction strategies	Teaching strategies Attractive educational games Differentiated training School psychologist	Perceived Level of Math Anxiety (PLMA)

Teachers have noted that in the online environment, students benefit from several strategies to reduce anxiety caused by mathematics and a possible explanation would be the attractive digital content and another explanation would be the distance given by the screen of the device they use. The teachers emphasize the benefits of online education: "I use various educational platforms or use phone applications and the children are happy to show me how to use these digital tools; I also give the tests using a standardized testing platform and the students agree to this way of assessment". And yet, the perception of teachers is that students who do not have digital skills face the math anxiety phenomenon because they cannot access these educational platforms properly, they cannot upload assignments on time and they cannot use these platforms when they have to take tests.

*Table 5 Investigating question 7 from the focus group*

Question 7	Topic	Subtopic	Category
What differences and what similarities have you noticed in comparison with the physical teaching?	The competence of using online resources (DC)	Less online math anxiety Intensity Frequency Digital educational platforms Educational games Standardized tests	Perceived Level of Math Anxiety (PLMA)

The answers received to questions 8 and 9 showed that teachers want to know more information about the phenomenon of mathematics anxiety. A professor stated that: "I propose the elaboration of an explanatory guide of this phenomenon, a guide that should include the ways we identify and treat this phenomenon, and also he strategies for the prevention of this impactful phenomenon for students".



Table 6 Investigating question 8 and 9 from the focus group

Question 8 and question 9	Topic	Subtopic	Category
Our intention is to find out more information about students' perceived level of math anxiety. Do you think we have skipped some other important questions? Is there something you would add?	Adjacent conclusions	School homework Profile of the Generation Z student Anxiety about other disciplines	Conclusions
What would you like to know about this phenomenon when we have finished this study?	Expectations on the phenomenon of anxiety caused by mathematics	Math Anxiety Reduction Strategies Explanatory guide Scales for measuring mathematics anxiety	Conclusions

#### 4. Conclusions

Our study aimed to cover a gap in terms of studies on the observation of the phenomenon of math anxiety in the context of online education during the Covid-19 pandemic. Remote education caused by the Covid-19 pandemic led to the emergence of methods for teachers to encourage student independence in learning (Al Ghazali, 2020). However, not all students were prepared to learn math online, which led to the phenomenon of math anxiety.

Our findings showed that the way of how teachers perceived the students math anxiety is mediated by two different processes:

- (1) the students' engagement in online learning (SEO)
- (2) digital competences (DC)

Regarding the student online engagement (SEO), our study shows that the students who are less involved in online learning activities are more likely to develop math anxiety. A possible explanation would be that these students gather math gaps and then they lose their self-efficacy (Bandura & Schrenk, 1981); so, the need to conduct new studies related to this phenomenon becomes quite prominent.

Regarding the digital competences (DC), as other studies have suggested (Attard, 2020; Camacho-Zuñiga, 20 21), it has been confirmed that the use of educational platforms has important advantages due to the animated content, the presence of engaging videos and the creation of a digital environment with which students are familiar.

However, after analyzing the data collected, an interesting phenomenon has been noticed, namely that students feel safe and show less math anxiety when they have essential digital competences.

The conclusions of our study show that the phenomenon of math anxiety is also present in the online environment and can be diminished by the student engagement in properly using different educational platforms. A limitation of our research is the fact that we have based our research only on the opinion of teachers and on specialized studies, and thus we consider it necessary to undertake new studies in which the opinion of parents and students should be more taken into consideration.

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