education sciences

MDPI

Article

Mathematical Anxiety among Primary Education Degree Students in the Post-Pandemic Era: A Case Study

María Teresa Costado Dios * and José Carlos Piñero Charlo

Department of Didactics, Faculty of Educational Sciences, University of Cádiz, 11510 Puerto Real, Spain; josecarlos.pinero@gm.uca.es

* Correspondence: mariateresa.costado@gm.uca.es

Abstract: The study of the affective domain has grown in relevance ever since educators and researchers showed its influence in the process of teaching and learning, playing a fundamental role in the evolution of student learning. Anxiety is one component of the affective domain. The study of mathematical anxiety in pre-service primary teachers at university is the focus of this study. We analyse mathematical anxiety by examining specific data from the sample (age, gender, the subjects they studied in upper-secondary education, and academic performance). One hundred and nineteen students from the Primary Education degree completed the mathematical anxiety questionnaire, obtaining an average anxiety score considered negative (3.08 above the neutral value of 3). The results show a high anxiety toward examinations (3.68) and a negative relation with academic performance. Furthermore, the results show that women, 19-year-old university students, and those from a humanities-based upper-secondary education present greater levels of anxiety than men, older students, or students from other areas of upper-secondary education, respectively. All values of mathematical anxiety are higher than pre-pandemic levels. We can conclude from the studied sample that the students show low–medium global anxiety over mathematics, medium anxiety over problem solving, and high anxiety about exams.

Keywords: COVID-19; pre-service primary teacher; mathematical anxiety; university education

Citation: Costado Dios, M.T.; Piñero Charlo, J.C. Mathematical Anxiety among Primary Education Degree Students in the Post-Pandemic Era: A Case Study. *Educ. Sci.* **2024**, *14*, 171. https://doi.org/10.3390/educsci14020171

Academic Editors: Yosi Yaffe and Gal Harpaz

Received: 23 November 2023
Revised: 1 February 2024
Accepted: 5 February 2024
Published: 7 February 2024

1. Introduction

The affective domain plays a fundamental role in the teaching and learning process. This has begun to gain importance as educators have come to appreciate the influence it has on school learning [1].

The complexity of studying the affective domain is one of the problems we encounter when addressing this area in the teaching and learning of mathematics. This complexity arises in the sense that the research aims are to consolidate a satisfactory theoretical framework for the interpretation of the affective domain and to develop measurement instruments [2,3], i.e., the limitation of basic descriptors, the structuring of theoretical frameworks, and the connection between theory and practice. Authors such as [4] argue for the existence of three descriptors and define the affective domain as a wide range of mood states that are generally considered as somewhat different from pure cognition and include the set of belief systems, attitudes, and emotions as specific components.

Mathematical beliefs are a component of the subjective knowledge of an individual, based on their experience of mathematics and their teaching and learning process [5]. The belief system forms part of the cognitive component of the affective domain, having low intensity but great stability over time. Intensity is defined as the level with which the affective domain is manifested and stability as its duration over time [4].

In contrast, the emotions form part of the affective domain but possess high intensity and little stability, i.e., the emotions change from positive to negative (or vice versa) quickly and are shown at a high level [3]. They arise as an organised response to an internal or external occurrence, with a positive or negative meaning depending on the case or experience for the individual [5]. Emotions are difficult to identify and demonstrate even for the person themselves and are part of a social construction (the situation in which the person finds themselves) [3].

In the medium state of intensity and stability, we find the attitudes toward mathematics [3,5]. This is the predisposition of the student to respond positively or negatively to mathematics, which determines their intention and influences their behaviour when faced with the subject. These attitudes have a cognitive component, as they are influenced by beliefs, and an affective component, since the emotions also affect them. As [6] says, if the student has a positive attitude, they will be able to learn and develop their knowledge and skills much better than if they have a negative attitude, since this negativity would mean that the student did not believe in themselves, with lack of autonomy and presenting difficulties in the learning process.

This study focuses on one of the main affective factors that intervenes in the teaching–learning process of mathematics: anxiety. Anxiety is a mood fed by qualities such as fear and terror, the feeling of insecurity and powerlessness that an individual can experience when they are required to perform in a subject [7]. Anxiety is an unpleasant emotion that is present in students above all when they are being assessed, such as in an exam, and arises when the student is faced with subjects that they find particularly difficult. Mathematics is commonly one such subject, and the affective factor is known as mathematical anxiety. The rejection of mathematics occurs through the undermining or elimination of a person's feeling of well-being when confronted by a situation connected with the topic, whether at school or in daily life. Many studies have focused on the study of mathematical anxiety [7–12], including older and more recent studies, such as those by Sarah Buckley or Richard Daker and collaborators. Mathematical anxiety has been considered an important issue for many decades and continues to be so.

1.1. Mathematical Anxiety

The authors of [13] define mathematical anxiety as a series of feelings of anxiety, dread, nervousness, and associated physical symptoms that appear when doing mathematics. It also manifests through a series of symptoms like tension, nerves, apprehension, worry, irritability, impatience, confusion, fear, and mental block, which interfere in the calculation of numbers and the solving of mathematical problems in a wide variety of situations, both everyday and academic. Ref. [14] states that mathematical anxiety has its roots in the fear of encountering mathematics, which includes classes, homework, and exams. Similarly, ref. [15] found important connections between the manifestations associated with fear and those observed through the perspective of mathematics courses and examinations.

Along the same lines, authors such as ref. [16–18] define mathematical anxiety in the following way. Ref. [16] establish anxiety toward mathematics as the unease students experience when doing mathematical operations, as well as anguish at failing an exam. Ref. [17] describe mathematical anxiety as a feeling of nervousness that hinders the handling of numbers and the ability to solve mathematical operations in daily life and in academic situations. Lastly, ref. [18] describe mathematical anxiety as a state of anxiety caused by doing mathematical tasks, which manifests through feelings of apprehension, aversion, tension, worry, frustration, and fear. They also indicate that environmental (negative experiences in class) and intellectual (degree of thinking) factors and personality (self-esteem, learning style, attitude, and confidence) have an influence in producing this feeling in students.

All these authors relate mathematical anxiety to feelings and emotions, especially fear, tension, and nervousness. According to these authors, these emotions occur in different situations, whether doing mathematics in everyday life or in classes or during mathematical tasks or exams.

A recent study [19] differentiates between state and trait mathematics anxiety. State mathematics anxiety is transient and is defined as the type of anxiety an individual feels while he is participating in mathematics. In contrast, trait mathematics anxiety is a more persistent feeling, connected to the level of fear that an individual associates with mathematics in any situation. The authors of [19] also suggest that trait mathematics anxiety is more stable and enduring and has an impact through its effects on learning-related choices. Students with higher levels of trait mathematics anxiety are less likely to choose to study mathematics or pursue careers that involve mathematics [19,20]. Additionally, ref. [19] suggest that techniques such as relaxation, mindfulness, cognitive reappraisal, and cognitive behavioural approaches may be effective in reducing mathematical anxiety.

Within the field of mathematics education, particular attention has been paid to the effects that mathematical anxiety can have in terms of gender, or regarding low academic performance, or mathematics course dropouts, or on the choice of university degrees that do not require a high level in the subject [8,13,21]. According to ref. [22] in her review study, many students showed worry, nervousness, and unease at dealing with mathematics, causing feelings of anxiety and, therefore, neglect of the subject and even dropping out.

Looking at the causes that bring about the rejection of mathematics, ref. [23] show that the main problem is found in the education system and in that there is no space for reflection in classrooms, where students learn to do mathematics mechanically without knowing why, what for, or how. Students cannot act or think when faced with a high-pressure situation such as a mathematics activity or exam. The teacher is responsible for reducing the stress that leads to rejection of the subject inside the classroom or during the mathematical activities.

Mathematical anxiety is an extremely common phenomenon among university students [9]. Amongst these students, anxiety is usual, along with issues concerning study techniques and emotional problems [24]. Although most individuals develop mathematical anxiety prior to university, 27% of them develop their first stressful mathematical situation in their first year of university. Ref. [9] defines different types of mathematical anxiety among university students: moderate and variable mathematical anxiety; mathematical anxiety that the student has had for a long time, and which began because of the action of a teacher; and that caused by the mechanical nature of the subject, focused on rules and procedures, and lack of comprehension when learning mathematical concepts.

There are significant differences between men and women, with the latter showing greater anxiety toward mathematics, either because they truly experience this to a greater degree or because they are more likely to admit their mood [25]. Ref. [13] analysed a sample of secondary-school students, with the female students being more anxious than their male counterparts. The literature review carried out by [26] reaches the same conclusion. Within the set of studies with university students, the literature reviews also show that female students suffer more mathematical anxiety than the men. One example of this is found in [24], in which an anxiety questionnaire was administered to psychology students at the University of Malaga and the women obtained higher scores than the men.

In the training of primary teachers, it is vital to consider this affective dimension, since they are students who tend not to like mathematics and who have low grades in the subject [27]. Despite the importance and transcendence of mathematics in all ambits of life, it is a discipline that tends to throw up a plethora of learning difficulties. Moreover, it has a negative social stigma, seen as a difficult and complicated subject [28]. This author stresses that good teacher training is essential for improving the quality of education and the academic performance of students, thereby reducing school failure. The sample in these two studies [27,28] are pre-service primary teachers, i.e., university degree students.

Several studies have demonstrated that mathematical anxiety decreases after undertaking mathematics courses during initial teacher education [29]. Learning to teach mathematics seems to reduce the anxiety through facilitating the conceptual understanding of mathematics. By improving skills, teachers in training express greater confidence in their teaching efficacy and more positive attitudes towards mathematics [29].

1.2. Impact of the COVID-19 Pandemic

Ref. [30] carried out a review of studies that analyse how the global pandemic has affected the mental and emotional health of individuals, along with self-care coping strategies in home lockdown. In the study carried out by [31], they concluded that the students surveyed had suffered from anxiety, lack of motivation, or frustration due to work overload, concern about their own training or learning success, as well as the same emotions brought about from the lockdown situation.

One study from before the COVID-19 pandemic [32], obtained a mean anxiety value of 31.52 (the same as 2.63 considering that the minimum is 12 and maximum 60), with 2.45 for men and 2.78 for women. All these values are lower than the neutral value of 3, showing a positive character of anxiety with medium-to-low values for university students. In another study, ref. [25] obtained a mean mathematical anxiety value of 2.66 for pre-service primary teachers. However, almost all of their participants did not feel calm during mathematics exams and showed insecurity in their ability to solve problems. On the other hand, ref. [33] concluded from a sample of pre-service primary teachers that anxiety levels were maintained between two consecutive academic years, showing medium-to-high levels, and that women had greater anxiety than men. The same conclusion was drawn by [34], with medium-to-low anxiety being higher among girls than boys from upper-secondary students.

During the home lockdown, the implementation of distance learning revealed a lack of digital devices among teachers and students, unreliable internet connections, and inadequate digital skills, which could have hampered the learning process and limited understanding of the mathematical content being taught online [35]. Furthermore, the lack of social interaction was a significant problem that affected student learning. Some students felt that they could not learn mathematics effectively without face-to-face teaching interactions [35]. These factors could have limited students' learning processes in mathematics and their understanding of mathematical concepts, which in turn might have led to greater mathematical anxiety. Studies such as [36,37] found that most participants showed moderate or high mathematical anxiety during the pandemic in online learning. Specifically, ref. [36] found that 55% of participants showed moderate (between 2.35 and 3.70) and 34% high mathematical anxiety (values between 3.70 and 5.00), with a mean value of 3.359 in the study.

1.3. Academic Performance

In the literature, one can find different definitions of academic performance, some more comprehensive than others. However, assessing the academic record and grades of a student is the most common method for evaluating the results of teaching and as a definition of academic performance [38]. The average of the grades obtained in objective tests through the teaching of a subject is a good indicator of academic performance [39].

In this regard, ref. [7,8,20,40] show that there is a strong correlation between mathematical anxiety and academic performance. They conclude that anxiety hinders a student's ability to carry out mathematical tasks and that a reduction in anxiety translates to better performance. Refs. [41,42] conclude that anxiety and performance are negatively correlated (the greater the anxiety, the worse the performance). In other words, high levels of mathematical anxiety are negative and are significantly related to low scores in performance tests. Likewise, ref. [34] obtain the same negative connection. However, ref. [43] concludes that students with superior performance are characterised by a high affective domain and high self-efficacy (confidence in themselves to achieve a goal).

1.4. The Present Study

Taking into account a preceding study on the change from in-person to online classes and the feelings or emotions related to it [31], and even though there has been extensive research on the impact of distance learning on the mathematical anxiety of university students during the COVID-19 pandemic in the recent literature, this study aims to study the mathematical anxiety of university students with the return to normality—that is, to in-person classes. First, bearing in mind the aforementioned findings, we aim to analyse whether university students (pre-service primary teachers) have been emotionally affected and whether there has been a change—increase or decrease—in their levels of mathematical anxiety with regard to studies prior to or during the pandemic (the average anxiety of the individual participants in the study). Second, more specifically, we set out to analyse item by item the responses to the mathematical anxiety questionnaire of pre-service primary teachers. Third, we seek to analyse whether there are differences according to gender, age, and the subjects (science- or humanities-based) studied in upper-secondary education. Lastly, we aim to see whether there is a relation between the anxiety of university students and their academic performance.

We pose the following questions: 1. Is the mathematical anxiety of pre-service primary teachers higher (or lower) in the post-pandemic era than pre-pandemic studies? 2. Do women have higher levels of mathematical anxiety than men? 3. Do younger students and those coming from non-scientific upper-secondary subjects have a higher level of anxiety? 4. What is the relationship between anxiety and performance? All these questions will be answered regarding the studied sample.

2. Method

In the study of mathematical anxiety, as part of the affective domain of an individual, we have used a case study quantitative methodology for a specific group, conducting a survey through a multiple-choice questionnaire. Mathematical anxiety is usually identified through self-reporting surveys or questionnaires in which individuals are asked how they feel about specific situations involving mathematical tasks. Mathematical anxiety exists on a continuous spectrum ranging from no mathematical anxiety to paralysing fear when anticipating mathematical tasks [40].

2.1. Sample

The participants are 119 students from the 2021/2022 academic year, studying the Primary Education Degree at the University of Cádiz. This sample is divided into two groups, according to their year and subject. Specifically, 61 students belonged to the second year of the degree, studying the subject "Conocimiento Matemático 2" ("Mathematical Knowledge 2") (CM2), while the remaining 58 were in the third year, studying "Didáctica de la Matemática 2" ("Teaching Mathematics 2") (DM2). These two subjects are focused on: primary mathematics topics (CM2—geometry, measurements, and statistics) and how to teach these topics and knowing the state law and curriculum in order to teach and create a specific learning situation for a specific school as a real case, i.e., examples of activities or classes to teach by the future professional (DM2). These subjects correspond to the first four-month period of the second and third degree years, respectively.

2.2. Instrument

The instrument used in this study is the questionnaire from the Mathematical Anxiety Scale of [13]. The scale was validated when created and has continued to be so throughout the thirty years it has been applied and has also been confirmed with the data from this study, obtaining a Cronbach's alpha reliability index of 0.93, which is considered highly acceptable. This Cronbach's coefficient is recommended for instruments with more than two values in the item responses, representing the internal consistency of the scale as a whole.

The questionnaire uses a Likert-type scale and comprises a total of 12 items, each with 5 possible responses: from "completely disagree" to "completely agree", including a central or neutral response corresponding to "neither agree nor disagree". The coding of these possible responses takes values from 1 to 5, respectively. The items in Table 1 are part of the original questionnaire, are not adapted, and are in the original order. The negatively worded items have been assigned a reverse value so that a higher score on the scale really means a higher level of anxiety. For example, item 1 in Table 1 is the original item of the questionnaire, and a high response (4 or 5) indicates low anxiety. For consistency of results, whereby a higher response corresponds to higher anxiety, we reversed the coding of negative items for the analysis where the value of 5 changes to 1.

Table 1. Items that comprise the anxiety questionnaire from the anxiety scale of [13]. The mean (M) and standard deviation (SD) are shown for each item. It also describes the average anxiety and the three categories defined by [44].

Items	M	SD
1. I do not feel any fear of mathematics. (CAT1)	3.05	1.07
2. I would not mind doing more mathematics courses. (CAT1)	2.94	1.21
3. I do not normally worry about whether I am capable of solving mathematical problems. (CAT2)	3.42	1.10
4. I almost never get nervous during a mathematics exam. (CAT3)	4.09	1.03
5. I am normally relaxed during mathematics exams. (CAT3)	3.87	1.07
6. I am normally relaxed in mathematics classes. (CAT1)	2.46	1.01
7. Mathematics normally makes me uncomfortable and nervous. (CAT1)	2.88	1.14
8. Mathematics makes me uncomfortable, uneasy, irritable and impatient. (CAT1)	2.82	1.15
9. I feel unwell when I think about trying to do mathematical problems. (CAT2)	2.74	1.16
10. When I do mathematical problems, my mind goes blank and I cannot think clearly. (CAT2)	2.71	1.03
11. I get frightened by the idea of doing a mathematics test. (CAT3)	3.08	1.20
12. Mathematics makes me feel worried, confused and nervous. (CAT1)	2.86	1.17
Average anxiety	3.08	0.84
CAT1	2.84	0.93
CAT2	2.96	0.86
CAT3	3.68	0.95

One danger with applying Likert-type questionnaires with a central value, as in our case, where the items can be valued from 1 to 5, is that the middle value of 3 can be taken as the “non-committal response” value. In order to examine this possibility, we undertook a recount of the response frequencies in each of the items and discovered that the middle response was not selected by the students more frequently than the other options.

Having rejected the possibility that the students opted for the neutral response discriminately and without criteria, this response has been taken as the one that denotes neutrality. It has therefore been taken as a neutral value of 3, which is utilised as a reference to compare the results obtained for the purpose of determining the tendency (positive or negative) of anxiety.

2.3. Procedure

The questionnaire was applied in university classrooms at the start of the 2021/2022 academic year, under the supervision of the researchers. We explained the purpose of the study, why it was important to collaborate, and the instructions for completing the online questionnaire, which had been created for this purpose. This online questionnaire included a first section where the students gave their consent to the use of their data. The anonymity of their answers was guaranteed, and no names, surnames, or email addresses were requested. The students were given sufficient time to answer all the items on the questionnaire. The researchers were present at all times to deal with any doubts that arose.

For each participant, we collected data corresponding to gender, age, type of subjects studied in upper-secondary education, and the anxiety questionnaire. We created a data matrix which was analysed using the Statistical Package for the Social Sciences (SPSS) version 24. Average anxiety was defined as the arithmetic mean of the anxiety of everyone, which took values between 1 and 5, with 3 being the neutral value. This variable identifies the level of anxiety of the participants toward mathematics, according to the value recorded, being positive if below the neutral value of 3, negative if above.

2.4. Data of the Sample

The data of the sample in our study are gender, age, subjects studied by the students in upper-secondary education, and academic performance. All these data were requested as the first questions on the online form, except the last. We collected this information in order to characterise the sample and analyse the level of anxiety with respect to all data of the sample. The variable of gender has two values—man and woman—which are coded with the value 1 for men and 2 for women (other options for ethical considerations were not offered). Age takes values between 19 and 25 years. The subject type studied in upper-secondary education takes six values that correspond to the different branches of knowledge as organised in the Spanish education system: humanities, health sciences, experimental sciences, social sciences, and technical studies. As well as these five upper-secondary educational categories, a small percentage of students originate from a different undergraduate degree or other higher-education studies. Lastly, we defined the academic performance through the final grade that the participants obtained in their subjects, considering the coursework and the final exam.

3. Results

The group under study comprises 119 students (30.3% men (36) and 69.7% women (83)) from the Primary Education Degree at the University of Cádiz during the academic year 2021/2022. Most of the students had recently graduated from upper-secondary education (the "bachillerato" in Spain) focused on social sciences (46.2%) and humanities (24.4%), followed by health sciences (11.8%). The rest had taken other upper-secondary courses or higher-education diplomas to enter into university (17.6%). The participants were aged between 19 and 25 years old, the mean being 20.65, whose distribution in percentages was: 30.3% (19 years old), 29.4% (20 years old), 13.4% (21 years old), 12.6% (22 years old), and 14.2% (23, 24, and 25 years old).

Table 1 shows the mean (M) and standard deviation (SD) for each of the 12 items that make up the questionnaire, and the average anxiety (arithmetic mean—values between 1 and 5). For the average anxiety, ref. [44] defined the level of the subjects' anxiety from those who present no anxiety (value 1) up to a very high level (value 5) with intermediate scales of low (2), medium (3), and high (4). The 12 questionnaire items can be grouped into three categories according to [44]: global anxiety toward mathematics (CAT1), anxiety toward problem solving (CAT2), and anxiety toward exams (CAT3), which have been included in Table 1 with their mean values and standard deviation.

In Table 1, we can observe that the average anxiety variable takes the value 3.08, with a valid sample of 119 students. The value attained is slightly greater than the neutral value (3), which means it is negative. We checked this using the *t*-test with a confidence level of 95% for the sample, confirming that the difference between the mean value of the sample and the neutral value is significant ($p = 0.00$).

Regarding the categories of anxiety, the results have been calculated as the average value of the corresponding mean for each item belonging to the category. The results show that the pre-service primary teachers show greater anxiety toward exams (CAT3), with a value of 3.68, above the mean anxiety (3.08). The global anxiety toward mathematics (CAT1) shows a level between low and medium, while anxiety toward problem solving (CAT2) is at a level that is almost the same as that of mean anxiety (2.96), and anxiety toward exams (CAT3) is at a level close to high (value 4). We therefore deduce that the students react affectively, from lesser to greater anxiety, when facing: a mathematics class, a problem, and an exam.

3.1. Item-by-Item Study of the Questionnaire

In order to check whether the items have a mean score significantly higher than the neutral value (3), and which differs significantly from it in obtaining a lower score, we carried out a *t*-test with a confidence level of 95%. The results indicate that items 3, 4, and 5 have a mean response score higher than the neutral value ($p = 0.00$). However, the rest of the items differ in their mean, being below the neutral value, while only items 1 and 11 are close to the neutral value (3).

Items 4 and 5 ("I almost never get nervous during a mathematics exam" and "I am normally relaxed during mathematics exams") have a higher mean score than all other items, which indicates that there is coherence in the students' answers, since in both cases they are asked about the same thing, their nervousness in exams. The fact that the scores are significantly higher than the neutral value indicates that the students do indeed get nervous in mathematics exams. If we compare these results with those obtained in items 7 ("Mathematics normally make me uncomfortable and nervous"), 8 ("Mathematics make me uncomfortable, uneasy, irritable and impatient"), and 12 ("Mathematics make me feel worried, confused and nervous"), which are significant for being below the mean value and all with approximately the same value of 2.85, they are coherent since all are from category CAT1 and enquire about the same thing. It should be noted that item 6 ("I am normally relaxed in mathematics classes"), also in the same category because it asks specifically about classes and not about mathematics in general, is the item that has the lowest value of all (2.46).

Analysing each statement according to these results, we can see that in both item 2 ("I would not mind doing more mathematics courses") and item 3 ("I do not normally worry about whether I am capable of solving mathematical problems"), the higher mean score of these items indicates a certain unwillingness to take mathematics in years to come and worry over their own ability to solve mathematical problems, with item 3 being one of those that attains a level significantly higher than the neutral value (3.42). However, doing mathematical problems does not create unease amongst the students, as the mean score for item 9 ("I feel unwell when I think about trying to do mathematical problems") indicates, and neither does it cause a mental block, as can be seen in the mean of item 10 ("When I do mathematical problems, my mind goes blank and I cannot think clearly"), since both values are significantly lower than the neutral value.

3.2. Study by Gender

We analysed the mathematical anxiety of the students according to their gender, attempting to see whether there was any variation between them and if it could be concluded that, in this sample, men and women differ in their anxiety level when faced with mathematical tasks. To do this, we carried out a hypothesis contrast using the Mann–Whitney test, with a significance level of 0.05. The results of this test show that there are indeed significant differences according to gender ($p = 0.00$). In order to examine how these differences present themselves, we analysed the descriptive statistics of the average anxiety variable, classifying the participants according to their gender (Table 2).

Table 2. Descriptive statistics of average anxiety according to gender, where N is the number of students in each category, M the mean value, and SD the standard deviation.

Gender	N	M	SD
Men	36	2.81	0.77
Women	83	3.19	0.84
Total	119	3.08	0.84

Table 2 shows that the men report less average anxiety than the women, with a score difference of 0.38 points, and with a value for the women above that obtained for the sample as a whole, whereas for the men the value is below. This indicates that the women suffer from more mathematical anxiety than the men or that they are more willing to recognise that they suffer from it than the men.

3.3. Study by Age

We analysed the descriptive statistics of the average mathematical anxiety of the students according to their age (Table 3), attempting to see whether it varies or not between ages and if one can conclude that there are differences according to age in the anxiety level when faced with mathematical tasks. We studied the ages that were most represented in the sample by percentage: 19, 20, 21, and 22 years old.

Table 3. Descriptive statistics of the average anxiety according to age, where N is the number of students in each category, M the mean value, and SD the standard deviation.

Age	N	M	SD
19	36	3.28	0.85
20	35	3.08	0.69
21	16	2.92	1.06
22	15	2.84	0.66

We also carried out a hypothesis contrast using the Kruskal–Wallis test, with a significance level of 0.05, in order to check whether the ages differed significantly in anxiety. The results indicate that there are indeed significant differences ($p = 0.00$).

From these results, we learn that the youngest students (19 and 20 years old) present the highest level of average anxiety, higher than the mid-value of 3, showing a negative character. In contrast, the 21- and 22-year-old students have a positive average anxiety, suggesting that the level of anxiety lessens as the person ages and/or advances in their degree studies. This result is also obtained in the data analysis according to the second or third year of the degree (Section 3.5).

3.4. Study by Subject Type in Upper-Secondary Education

For the study of the average anxiety of the students toward mathematics by subject type studied in upper-secondary education, they were grouped into three blocks according to the branches of knowledge that were most represented. We carried out a hypothesis contrast using the Kruskal–Wallis test with a significance level of 0.05, in order to prove whether the branches of knowledge studied differed significantly in terms of anxiety. The results indicate that there are significant differences ($p = 0.00$).

The descriptive statistics of the average anxiety (Table 4) show that the values of the students from the humanities have anxiety values above the sample value and the highest of all branches of knowledge. In contrast, the lowest values of anxiety came from students from health sciences, followed by social sciences.

Table 4. Descriptive statistics of average anxiety according to subject type studied in upper-secondary education, where N is the number of students in each category, M the mean value, and SD the standard deviation.

Upper-Secondary Education	N	M	SD
Social Science	55	3.02	0.82
Humanities	29	3.52	0.67
Health Science	14	2.68	0.67

3.5. Study by Year of Degree and Academic Performance

To study the students' average anxiety toward mathematics according to the degree year they belong to, we grouped the data into two blocks, pertaining to the second and third years, respectively. The descriptive statistics of the average anxiety (Table 5) show that the students in the second year have anxiety values above the sample value and the neutral value, showing a negative character. However, the lowest values of anxiety are reported by the third-year students, lower even than the neutral value, showing a positive character. These results thus show that the students lessen their average anxiety toward mathematics as their studies advance.

Table 5. Descriptive statistics of average anxiety according to the year of degree studied, where N is the number of students in each category, M the mean value, and SD the standard deviation.

Degree Year	N	M	SD
Second	61	3.20	0.89
Third	58	2.95	0.77

Seeing these values of average anxiety differing between second- and third-year students, we calculated all the variables as a function of these two groups. The results are shown in Tables 6 and 7, with descriptive statistics and frequencies, respectively.

Table 6. Descriptive statistics of gender (%), age, CAT1, CAT2, CAT3, and academic performance (AP) according to the year of degree studied, where N is the number of students in each degree year, M the mean value, and SD the standard deviation.

Degree Year	N	Gender	%	Age	CAT1	CAT2	CAT3	AP
Second	61	Men	31.1	M 20.43	M 3.00	M 3.05	M 3.73	M 4.2
		Women	68.9	SD 1.92	SD 0.99	SD 0.92	SD 0.99	SD 2.1
Third	58	Men	29.3	M 20.88	M 2.66	M 2.86	M 3.64	M 6.3
		Women	70.7	SD 1.39	SD 0.83	SD 0.80	SD 0.93	SD 1.7

Table 7. Descriptive statistics of subject type studied in upper-secondary education (%) according to the year of degree studied, where N is the number of students in each degree year, M the mean value, and SD the standard deviation.

Degree Year	N	Humanities	Social Science	Health Science	Other
Second	61	27.9	47.5	6.6	18.0
Third	58	20.7	44.8	17.2	17.3

Table 6 shows that the previously defined categories also present different mean values, which are significant. These values indicate that the mathematical anxiety in all categories is lower for the third year compared to the second-year students. Specifically, all the values for the second year are equal or higher than the mean value, representing a negative character. In contrast, for the third year, only the category of anxiety toward exams (3.64) is negative, while the rest have a value lower than the neutral value and so are positive.

Lastly, if we examine academic performance according to the degree year, we also find differences. For academic performance, we have taken into account the final grade given in the January 2022 exam, because the two subjects taken by the students (CM2 and DM2) correspond to the first term of the academic year (from September to January). The final grade corresponds to the summation of the average grade of the exam and the coursework handed in by the students throughout that term. The exam asked questions related to the content of each subject and coursework was practice worksheets done in groups or individually for studying the topics of each subject (CM2 or DM2). We can see that the second-year students have on average a grade that is below a pass (5), whereas the third-year students obtained a pass grade, nearing the equivalent of a B grade (7).

Even if we do a statistical study by grade intervals, we also obtain differences, shown in Table 8. Of the second-year students, 31.1% obtain a grade lower than 3 in the CM2 subject, whereas only 6.9% do so in the third year. Moreover, 37.9% obtain a B grade or higher in the third year, compared to 11.5% in the second. The grade intervals 4–5, 5–6, and 6–7 are achieved by 13.5%, 16.3%, and 11.5% of the second year, respectively, compared to 1.7%, 20.7%, and 31.1%, respectively, of the third year. Overall, 89.7% of the third-year students achieve a pass grade (higher than 5), compared to only 39% of the second year. There is thus a proportionally inverse relationship between academic performance and average anxiety, since when one increases, the other decreases.

Table 8. Grade intervals for academic performance and their percentage (%), according to the degree year.

Grades	0–3	3–4	4–5	5–6	6–7	7–10
Second Year	31.1	16.4	13.5	16.3	11.4	11.3
Third Year	6.9	1.7	1.7	20.7	31.1	37.9

It should be mentioned that, in the Primary Education degree at the University of Cádiz, there are four subjects related to mathematics: Mathematical Knowledge I (first year); Mathematical Knowledge II and Teaching Mathematics I (second year); and Teaching Mathematics II (third year). This means that the second-year students surveyed are in the middle of the training process regarding mathematics, while the third years are at the end of the process. Therefore, it is reasonable for the third-year students to feel less anxiety and have better academic performance than the second-year students, bearing in mind the low level in mathematics that the university students have when they begin their studies.

4. Discussion and Conclusions

We can deduce from the results that the higher levels of anxiety are related to the nervousness that exams produce in the students and their capacity to solve mathematical problems. Taking into account the average anxiety, the level of these pre-service primary teachers is medium (3.08), in agreement with [44], but in our case negative while it was positive in the case of [44]. Likewise, ref. [25], who obtained the anxiety levels for 76 students in the first year of the primary-education teaching degree, concluded that the participants present a low-to-medium anxiety level (2.66). This result could imply that the level of the average mathematical anxiety of university students has increased, looking at studies from before or during the pandemic [32,33,36,37].

From the study of the results by item, we can conclude that there was a certain reluctance to study mathematics in previous years by the members of the sample, as well as some worry about their ability to solve mathematical problems (3.42). Nevertheless, the act of doing problems does not cause uneasiness or mental block in students. However, assessment situations do condition their mental state, because, although they declare that they do not get nervous in mathematics classes, they do get nervous when given an exam in the subject (4.09). The students do not come to feel fear when faced with mathematics, nor with exams, and neither do they feel uncomfortable, impatient, confused, worried, or irritable when doing the subject.

If we compare our mean values for each category with those obtained by [25], one sees that similar results are obtained, but with higher values, thus demonstrating that anxiety has increased after the pandemic, taking into account the studied sample. Global anxiety toward mathematics (CAT1) shows a level between low and medium (2.84), anxiety about problem solving (CAT2) is at a medium level (2.96), and anxiety about exams (CAT3) is at an almost high level (3.68). From the study of the categories of the sample participants, it is noteworthy that they go from a lower value, below the neutral value, to a higher value above the mean anxiety. This corresponds to the fact that the students feel less anxiety in a general way about mathematics, but their anxiety increases when talking about problem solving and reaches a truly anxious state when the topic of mathematics tests or exams is mentioned.

Regarding the study by gender, the data show that there are significant differences between men and women in their mathematical anxiety, with men suffering less anxiety when faced with mathematical tasks (2.81 for men compared to 3.19 for women). These conclusions are in line with those by authors such as [13,24–26,32–34,45], according to whom the anxiety level is higher for women than for men in every knowledge branch and greater in health sciences and humanities. However, detecting gender differences in the collected data may have been brought about because women are more likely than men to admit to suffering from anxiety.

Looking at the branches of knowledge, we can conclude that there are significant differences between the branches in terms of students' mathematical anxiety, above all in the humanities and health sciences, which attained the highest (3.52) and lowest (2.68) values of average anxiety, respectively. If we order the branches from the highest to the lowest value for the variable of mathematical anxiety, it goes as follows: humanities, social sciences, and health sciences (which is the only branch with a level below the mean for the variable), the same as [32,46]. Thus, the students with a lower level in mathematics are those who have a higher level of anxiety over the subject. We can affirm that the students with greater anxiety over mathematical tasks have opted to study a degree in which a lower level of mathematics is required than in other disciplines, a fact that is in agreement with the assertions made by [7,20] referring to the tendency of anxious students to avoid taking courses with a high level of mathematics, thus constraining their options to access other degrees where there is greater involvement of mathematical knowledge at higher levels.

Regarding the study of anxiety according to the age of the participants, the analysis reveals that there are differences between younger and older ages. The 19-year-old students had higher average anxiety (3.28) than the 22-year-olds (2.84). One could therefore conclude that the anxiety level decreases with age (the same conclusion as [45]) or because the young students have recently emerged from upper-secondary education, beginning their university studies where the new level of social or family pressure to achieve a qualification is higher than when finishing a degree and when one has already taken the subjects corresponding to mathematics in the degree, thus having already overcome the "fear" or anxiety that they cause.

This can also be seen in the results of the study according to the degree year being studied. For the second-year students, we obtained anxiety values higher than the neutral value, indicating the negative character of this anxiety. For the third-year students, the opposite is the case: their mathematical anxiety is below the neutral value in almost all their categories, showing that the higher the cognition level, the lower the anxiety.

The same thing can be deduced from the results obtained according to academic performance. There is a negative correlation between this and mathematical anxiety, which concurs with the results from other previous studies [7,8,34,41–43,45,46]. Mathematical anxiety is related to academic performance via its influence on mathematical ability [20]. Reducing mathematical anxiety in students will have the potential of increasing confidence in their abilities, their interest and hence also their engagement with the subject. Poor or low self-concept of one's own mathematical ability has a stronger effect on increasing mathematical anxiety than mathematical anxiety has on self-concept [40]. Therefore, better performance implies less anxiety [45,46], as obtained from our study. The students that enjoy doing mathematics gain a positive effect on their confidence in their ability, and confidence and enjoyment are closely linked to student engagement with the subject which, combined with increased effort, will result in improved performance and further increases in confidence in their own ability [8].

By way of conclusion, these results about the studied sample subsequent to the pandemic show that university students (in our case pre-service primary teachers) have a medium–high level of mathematical anxiety, but this gradually diminishes during their time at university and studying different mathematics courses that form part of the teaching degree. The results also highlight greater average levels of anxiety, being higher in women than in men and greater in students coming from humanities-based upper-secondary education. Lastly, the negative relation between anxiety and academic performance reveals the connection between them as stated by [20].

The present study has certain limitations. The results from the present study cannot provide evidence about the directionality of the relationship among variables. More complex designs, of an experimental or longitudinal nature, will be necessary to examine this aspect properly. Another limitation would be that, in order to improve knowledge of the determinants of mathematics achievement, other components such as prior achievement, subject, and environmental features must be considered in further studies. It would also be interesting to examine the extent to which the affective–motivational variables and approaches to learning analysed in the present study relate to academic achievement using another—and deeper—criterion and not just marks as a measure of academic achievement. Additionally, our findings are limited to the number of participants, the selected research methodology, and other potential factors specific to this study, such as the time period of collecting the data after the pandemic and the specific group studied.

Therefore, our conclusions and results are relative to the group studied, according to the particular characteristics analysed, and cannot be extrapolated to all university students, nor to all pre-service primary teachers. Further research would have to be done in this regard to know whether these high levels of anxiety correspond to the time studied after the pandemic and whether they decrease with the passage of time and return to those of the normal era.

Author Contributions: Conceptualization, M.T.C.D. and J.C.P.C.; methodology, M.T.C.D.; formal analysis, M.T.C.D.; investigation, M.T.C.D. and J.C.P.C.; resources, M.T.C.D.; data curation, M.T.C.D.; writing—original draft preparation, M.T.C.D.; writing—review and editing, M.T.C.D. and J.C.P.C.; visualization, M.T.C.D.; supervision, M.T.C.D. and J.C.P.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: As the study is non-interventional, all the participants were informed that the questionnaire was anonymous and they provided only gender, age, and upper-secondary courses. Also, the first step in the questionnaire was for the participants to give their consent to use the compiled data for research.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Hernández, J. Sobre Habilidades en la Resolución de Problemas Aritméticos Verbales, Mediante el uso de dos Sistemas de Representación Yuxtapuestos. Ph.D. Thesis, Universidad de La Laguna, San Cristóbal de La Laguna, Spain, 1996.
2. Gómez-Chacón, I.M. *Matemática Emocional. Los Afectos en el Aprendizaje Matemático*; Narcea Ediciones: Madrid, Spain, 2000.
3. Gómez-Chacón, I.M. Tendencias actuales en investigación en matemáticas y afecto. In *Investigación en Educación Matemática XIV*; Moreno, M., Estrada, A., Carrillo, J., Sierra, T., Eds.; SEIEM: Lleida, Spain, 2010; pp. 121–140. Available online: https://core.ac.uk/download/pdf/12342062.pdf (accessed on 24 October 2023).
4. McLeod, D.B. Affective issues in mathematical problem solving: Some theoretical considerations. *J. Res. Math. Educ.* **1998**, *19*, 134–141. [CrossRef]
5. Gil, N.; Blanco, L.J.; Guerrero, E. El dominio afectivo en el aprendizaje de las matemáticas. Una revisión de sus descriptores básicos. *UNION Rev. Iberoam. Educ. Matemática* **2005**, *2*, 15–32.
6. Orjuela, C.P.; Hernández Barbosa, R.; Cabrera González, L.M. Actitudes hacia la matemática: Algunas consideraciones en su relación con la enseñanza y el aprendizaje de la misma. *Rev. Educ. Matemática* **2019**, *34*, 23–38. [CrossRef]
7. Hembree, R. The nature, effects, and relief of mathematics anxiety. *J. Res. Math. Educ.* **1990**, *21*, 33–46. [CrossRef]
8. Ma, X. A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *J. Res. Math. Educ.* **1999**, *30*, 520–540. [CrossRef]
9. Perry, A.B. Decreasing math anxiety in college students. *Coll. Stud. J.* **2004**, *38*, 321–324.

10. Greshman, G. A study of mathematics anxiety in preservice teachers. *Early Child. Educ. J.* **2007**, *35*, 181–188. [CrossRef]
11. Sherman, B.; Wither, D. Mathematics anxiety and mathematics achievement. *Math. Educ. Res. J.* **2003**, *15*, 138–150. [CrossRef]
12. Miller, H.; Bichsel, J. Anxiety, working memory, gender, and math performance. *Pers. Individ. Differ.* **2004**, *37*, 591–606. [CrossRef]
13. Fennema, E.; Sherman, J. Fennema-Sherman Mathematics Attitudes Scales. Instruments designed to measure attitudes toward the learning of mathematics by males and females. *JSAS Cat. Sel. Doc. Psychol.* **1976**, *6*, 31.
14. Manapa, I. Mathematics Anxiety Level of Pre-Service Elementary School Teachers during Online Learning in the Covid-19 Pandemic. *J. Medives J. Math. Educ. IKIP Veteran Semarang* **2021**, *5*, 339–352. [CrossRef]
15. Escalera-Chávez, M.; Moreno-García, E.; García-Santillán, A.; Córdova-Rangel, A. Factors that promote the level of anxiety towards mathematics in upper middle-level students in the Rioverde San Luis Potosí region. *Eur. J. Educ. Stud.* **2016**, *2*, 8–22. [CrossRef]
16. BaoGuo, A.; KahHeng, C. Emotional Status of Malaysian Teacherson Online Teaching during the COVID-19 Pandemic. *Turk. J. Comput. Math. Educ.* **2021**, *12*, 4727–4737.
17. Huyen, L.; Ngo, T.; Nguyen, T.; Thanh, T.; Bao, T.; Vinh; Long, T. An Investigation of Mathematics Anxiety and Academic Coping Strategies Among High School Students in Vietnam: A Cross-Sectional Study. *Front. Educ.* **2021**, *6*, 742130. [CrossRef]
18. Lailiyah, S.; Hayat, S.; Urifah, S.; Setyawati, M. Levels of students' mathematics anxieties and the impacts on online mathematics learning. *Cakrawala Pendidik.* **2021**, *40*, 107–119. [CrossRef]
19. Buckley, S.; Reid, K.; Goos, M.; Lipp, O.V.; Thomson, S. Understanding and addressing mathematics anxiety using perspectives from education, psychology and neuroscience. *Aust. J. Educ.* **2016**, *60*, 157–170. [CrossRef]
20. Daker, R.J.; Gattas, S.U.; Sokolowski, H.M.; Green, A.E.; Lyons, I.M. First-year students' math anxiety predicts STEM avoidance and underperformance throughout university, independently of math ability. *Sci. Learn.* **2021**, *6*, 1–13. [CrossRef]
21. Ho, H.; Senturk, D.; Lam, A.G.; Zimmer, J.M.; Hong, S.; Okamoto, Y.; Chiu, S.; Nakazawa, Y.; Wang, C. The affective and cognitive dimensions of math anxiety: A cross-national study. *J. Res. Math. Educ.* **2000**, *31*, 362–379. [CrossRef]
22. Sagasti Escalona, M. La ansiedad matemática. *Matemáticas Educ. Soc.* **2019**, *2*, 1–18.
23. Vaca, B.; Armas, V. Amor u odio a la matemática: Reflexión desde la práctica pedagógica. *Rev. Educ.* **2020**, *24*, 338–352. [CrossRef]
24. Valero, L. Evaluación de ansiedad ante exámenes: Datos de aplicación y fiabilidad de un cuestionario CAEX. *An. Psicol.* **1999**, *15*, 223–231.
25. Segarra, Y.R.; Pérez-Tyteca, P. Nivel de ansiedad hacia las matemáticas de futuros maestros de educación primaria. In *Investigación en Docencia Universitaria. Diseñando el Futuro a Partir de la Innovación Educativa*; Roig-Vila, R., Ed.; Octaedro: Barcelona, Spain, 2017; Available online: http://hdl.handle.net/10045/71148 (accessed on 7 November 2023).
26. Fennema, E. Women and girls in mathematics-equity in mathematics education. *Educ. Stud. Math.* **1979**, *10*, 389–401. [CrossRef]
27. Piñero Charlo, J.C.; Costado Dios, M.T. Codiseño de problemas geométricos apoyados en TICs: Estudio de un caso con estudiantes de maestros bajo un modelo de aprendizaje mixto. *Edutec. Rev. Electrónica Tecnol. Educ.* **2020**, *74*, 94–113. [CrossRef]
28. Sánchez-Mendías, J. Actitudes Hacia las Matemáticas de los Futuros Maestros de Educación Primaria. Ph.D. Thesis, Universidad de Granada, Granada, Spain, 2013. Available online: https://digibug.ugr.es/handle/10481/29827 (accessed on 31 October 2023).
29. Sloan, T.R. A quantitative and qualitative study of math anxiety among preservice teachers. *Educ. Forum* **2010**, *74*, 242–256. [CrossRef]
30. Valero, N.; Vélez, M.; Durán, A.; Portillo, M. Afrontamiento del CO-VID-19: Estrés, miedo, ansiedad y depresión? *Enfermería Investig. Investig. Vinculación Docencia Gestión* **2020**, *5*, 63–70. [CrossRef]
31. Costado Dios, M.T.; Piñero Charlo, J.C. Face-to-Face vs. E-Learning Models in the COVID-19 Era: Survey Research in a Spanish University. *Educ. Sci.* **2021**, *11*, 293. [CrossRef]
32. Pérez-Tyteca, P.; Castro Martinez, E.; Rico Romero, L.; Castro Martinez, E. Ansiedad matemática, genero y ramas de conocimiento en alumnos universitarios. *Enseñanza Las Cienc.* **2011**, *29*, 237–250. [CrossRef]
33. Nortes, R.; Nortes, A. Ansiedad hacia las matemáticas, agrado y utilidad en futuros maestros. In *Investigación en Educación Matemática XVIII*; González, M.T., Codes, M., Arnau, D., Ortega, T., Eds.; SEIEM: Salamanca, Spain, 2014; pp. 485–492. Available online: https://www.seiem.es/docs/actas/18/ACTAS2014.pdf (accessed on 18 September 2023).
34. Villamizar Acevedo, G.; Araujo Arenas, T.Y.; Trujillo Calderón, W.J. Relación entre ansiedad matemática y rendimiento académico en matemáticas en estudiantes de secundaria. *Cienc. Psicológicas* **2020**, *14*, e-2174. [CrossRef]
35. Mukuka, A.; Shumba, O.; Mulenga, H.M. Students' experiences with remote learning during the COVID-19 school closure: Implications for mathematics education. *Heliyon* **2021**, *7*, e07523. [CrossRef] [PubMed]
36. Delima, N.; Cahyawati, D. Students' Mathematics Self-Concept, Mathematics Anxiety and Mathematics Self-Regulated Learning during the COVID-19 Pandemic. *J. Pendidik. Mat.* **2021**, *15*, 103–114. [CrossRef]
37. Ludwig, J. Poor Performance in Undergraduate Math: Can We Blame it on COVID-19 Despair? *Int. J. Innov. Sci. Math.* **2021**, *9*, 31–40.
38. Rodríguez Garcés, C.; Jarpa Arriagada, C.G. Capacidad predictiva de las notas en enseñanza media sobre el rendimiento en pruebas de selección universitaria: El caso chileno. *Aula Abierta* **2015**, *43*, 61–68. [CrossRef]
39. Caldera-Montes, J.F.; Reynoso-González, O.U.; Gómez-Covarrubia, N.J.; Mora-García, O.; Anaya-González, B.B. Modelo explicativo y predictivo de respuestas de estrés académico en bachilleres. *Ansiedad Estrés* **2017**, *23*, 20–26. [CrossRef]
40. Ramirez, G.; Shaw, S.T.; Maloney, E.A. Math anxiety: Past research, promising interventions, and a new interpretation framework. *Educ. Psychol.* **2018**, *53*, 1–20. [CrossRef]

41. Tárraga, R. Relación entre rendimiento en solución de problemas y factores afectivo-motivacionales en alumnos con y sin dificultades de aprendizaje. *Apunt. Psicol.* **2008**, *26*, 143–148.
42. De la Torre, E.; Mato, M.D.; Rodriguez, E. Ansiedade e rendemento en matemáticas. *Rev. Galega Ensino* **2009**, *53*, 73–77.
43. Schneider, M.; Preckel, F. Variables associated with achievement in higher education: A systematic review of meta-analyses. *Psychol. Bull.* **2017**, *143*, 565–600. [CrossRef] [PubMed]
44. Pérez-Tyteca, P. La Ansiedad Matemática Como Centro de un Modelo Causal Predictivo de la Elección de Carrera. Ph.D. Thesis, Universidad de Granada, Granada, Spain, 2012. Available online: https://digibug.ugr.es/handle/10481/23293 (accessed on 4 January 2024).
45. Delgado Monge, I.; Espinoza González, J. Ansiedad matemática en docentes de primaria en formación y en ejercicio: Un estudio comparativo. *Repert. Científico* **2023**, *26*, 15–28. [CrossRef]
46. Sánchez Mendías, J.; Segovia Alex, I.; Miñán Espigares, A. Ansiedad matemática, rendimiento y formación de acceso en futuros maestros. *Rev. Investig. Didáctica Matemática* **2022**, *16*, 115–140. [CrossRef]