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# INVESTIGATING SOME ASPECTS OF PRE-SERVICE PRIMARY SCHOOL TEACHERS' MATHEMATICS ANXIETY

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**Abstract.** One of the challenges that mathematics teacher educators face is the fact that teachers' own schooling experiences shape their beliefs about teaching and how they interact with pupils. Research suggest that pre-service primary school teachers experience higher level of mathematics anxiety than other university students. On the other hand many studies point out that higher levels of mathematics anxiety in teachers might affect their instructional practices, the willingness to embrace innovations and are related to mathematics anxiety and lower achievement of their pupils. This paper aims to investigate if there are any indications of mathematics anxiety in first and second year teacher students enrolled in the study year of 2019/2020 in two teacher education programs at the Faculty of Education in Jagodina, University of Kragujevac, Serbia. The sample consisted of 95 teacher students and a quantitative research method was applied. Results have implications for possible improvements of teacher education programs, and can be used as support to encourage further investigations on mathematics anxiety of future primary school and preschool teachers and ways of reducing it.

## 1. INTRODUCTION

In spite of its role, importance and broad application in the development of world and modern society, mathematics is still considered as a difficult school subject. Research point out that many students encounter learning difficulties and have poor performance in mathematics [1]. As Peker indicates, there are various factors that might affect students learning abilities such as instruction, teacher beliefs, lack of self-confidence, mathematics anxiety, etc [14]. It is therefore important to equip future teachers of mathematics with adequate teaching competences and skills which will enable them to respond to the fast changing needs of learners in mathematics classrooms. One of the challenges that mathematics teacher educators face is the fact that teachers' own schooling experiences shape their beliefs about teaching and how they interact with pupils. As a result of their classroom experiences, the majority of pre-service primary teachers come to teacher education courses with deeply rooted anxieties and attitudes about mathematics [6]. One of the ongoing concerns for pre-service teacher education programs is the mathematics anxiety [12].

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*Key words and phrases.* Mathematics anxiety, pre-service primary school teachers, teaching mathematics, teacher education programs.

Richardson and Suinn define mathematics anxiety as the “feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations” ([17], p. 551). Trujillo & Hadfield defines it as a state of discomfort which occurs as a response to situations that involve mathematical tasks and that are perceived as a threat [21]. Mathematics anxiety has important implications for teacher students’ learning and might inhibit performance in mathematics courses and affect future opportunities for engagement in mathematics [16]. Research indicate that pre-service primary school teachers experience higher level of mathematics anxiety than other university students ([4], [18], [21]). The mathematics anxiety of pre-service primary teachers might be attributed to their prior mathematics experiences at school level ([3], [22]) and lack of mathematical knowledge ([8], [10]). A significant body of literature exists suggesting that higher levels of mathematics anxiety in teachers might affect their instructional practices, less-skilled teaching, the willingness to embrace innovations and are related to mathematics anxiety and lower achievement of their pupils ([5], [7], [11], [12], [19], [20], [21], [23], [24]). Mathematics anxiety affects teachers’ behaviour since it impacts their confidence in abilities to do and understand mathematics [8]. Teachers with higher level of mathematics anxiety tend to use more traditional methods, direct instruction and less student-centered approaches ([3], [7]), and they spent less time in mathematics lesson preparation, and do not effectively use instructional time [5]. Ramirez et al. point out that mathematically anxious teachers tend to “harm student mathematics learning by responding angrily when students request help with mathematics” and spend less time to respond to students’ question when compared to less anxious teachers [15]. The same authors also emphasize that these teachers primarily promote algorithmic thinking and problems with a single solution/problem solving method. Olson and Stoehr indicate that “teachers who felt uncomfortable with mathematics may model their anxiety to students” ([12], pp. 73). Consequently, it leads to the transmission of anxiety and continuity of the mathematics anxiety phenomenon. Mathematics anxiety may inhibit pre-service teachers from learning mathematical contents and developing instructional skills. Pre-service teachers with high level of mathematics anxiety are more likely to express negative attitudes towards mathematics and necessary mathematics university courses, and to have lower performance in mathematics teaching methodology courses ([3], [16]). In order to be able to make sense of students’ mathematical thinking, pre-service teachers must develop strong mathematics content knowledge and rich conceptual understanding of mathematical pedagogy ([12], [25]). There is one more issue that must not be neglected. Researchers determined that female pre-service teachers demonstrated higher levels of mathematics anxiety than male [26]. Some of this differences might be related with the impact that female teachers’ mathematics beliefs have on their female students’ perceptions of their mathematical abilities [27]. These and the fact that majority of pre-service

primary teachers at teacher education faculties in Serbia are female, indicate that it is of extreme importance to pay attention to these aspect of educating future primary teachers. Since pre-service primary teachers represent the first face of mathematics to young children, it is of extreme importance to educate the future generations of teachers to be as effective as it is possible in teaching mathematics ([9], [13]).

Given that numerous studies show that teachers' mathematics anxiety has significant influence not just on their teaching practice, but on students' mathematics learning, achievement, attitudes and anxiety, we have decided to examine the pre-service primary teachers' level of mathematics anxiety at Faculty of Education in Jagodina, University of Kragujevac. The value of this study can be recognized in the fact that this is the first time that a research on pre-service primary teachers' mathematics anxiety had been conducted in Serbia. Pavlin-Bernardić, Vlahović-Štetić and Mišurac Zorica examined mathematics anxiety in pre-service primary teachers and pre-service mathematics teachers in Croatia [13]. The authors determined that although none of the groups of pre-service teachers indicated extremely high levels of mathematics anxiety, future primary teachers expressed higher level of mathematics anxiety than future mathematics teachers.

## **2. RESEARCH METHODOLOGY**

This study aims to investigate if there were any indications of mathematics anxiety in first and second year teacher students enrolled in the study year of 2019/2020 in teacher education program at the Faculty of Education in Jagodina, University of Kragujevac, Serbia. The aim was realized through the following *research questions*:

- 1) to examine the mathematics anxiety level of pre-service primary and preschool teachers in general;
- 2) To examine the level of certain aspects of mathematics anxiety (oral and written examination, some situations in mathematics classes, use of mathematics in everyday life) of pre-service primary and preschool teachers;
- 3) to investigate if there are statistically significant differences in level of mathematics anxiety between pre-service primary and pre-service preschool teachers;
- 4) to determine if there are statistically significant differences in level of mathematics anxiety in regard to the year of study and average high school mathematics grades.

The study was conducted at the Faculty of Education in Jagodina, University of Kragujevac, Serbia. Since survey instruments were administered and numerical data collected, a quantitative method was used in analyzing the data. Data were collected through questionnaires. The participants were pre-service teachers (PST) enrolled in Preschool and Primary Teachers Education Programs (Year 1 and Year 2). All students were enrolled in Mathematics courses at Year

1/Year 2. Participants had not yet attended methodology of teaching Mathematics courses since these courses are taught at Year 3 and Year 4.

*Sample.* The research sample involved 95 teacher students. The study was conducted at the end of the summer semester of academic year 2019/2020. All PST participated in the study on voluntary basis. The sample distribution in regard to the year of study is presented in Table 1, in regard to the teacher education program in Table 2 and in regard to the average mathematics grade in high school in Table 3.

**Table 1.** Sample distribution in regard to the year of study

<i>Year 1</i>	<i>Year 2</i>
64	31

**Table 2.** Sample distribution in regard to the teacher education program

<i>Preschool Education Program</i>	<i>Primary Teachers Education Program</i>
44	51

**Table 3.** Sample distribution in regard to the average mathematics grade in high school

<i>Average mathematics grade</i>	<i>Year 1</i>	<i>Year 2</i>
2	10	1
3	27	7
4	12	10
5	15	13

*Instrument.* The used instrument was a questionnaire that consisted of two parts. In the first part, background information about PST was collected (mathematics grades, teacher education program and a year of study). The second part of the instrument contained Mathematics Anxiety Scale (MA) developed by Arambašić, Vlahović-Štetić and Severinac [2]. The MA scale consisted of 20 items. Each of the items was rated on a Likert scale (1 = not upset at all, 2 = slightly upset, 3 = very upset, 4 = extremely upset). The participants were asked to respond how upset they were in some situation that was related to mathematics or required them to use mathematics. In order to investigate the mathematics anxiety of PST, we used the MA scale for the reason that it was developed and used in a country (Croatia) with historically common educational background as that to Serbia. Therefore, no translation was needed, and we obtained authors' permission to use the scale in our research. The Cronbach's alpha reliability coefficient indicated acceptable reliability ( $\alpha=0.948$ ). We present some examples of research items in Table 4.

**Table 4.** Examples of some items of Mathematics Anxiety scale [2]

<i>Example of items</i>
When the next class is mathematics.
When I am having important mathematics test.
When I am having an oral examination in mathematics.
When we learn new mathematics contents.

The items were determined so that four subscales could be structured. The subscales examine the mathematics anxiety level of pre-service primary and preschool teachers in: oral examination (AS1); written examination (AS2), some situations in mathematics classes (AS3); use of mathematics in everyday life (AS4).

The statistical analyses were conducted using SPSS for Windows, version 20.0. For the purpose of statistical analysis, p values lower than 0.05 were considered statistically significant. The normality of data was evaluated with the use of the Shapiro-Wilk test of normality. For the quantitative analyses of data methods of descriptive statistics were used (frequency, percentage, mean, standard deviation, mean ranks), Welch ANOVA with Games-Howel post hoc for parametric variables and Kruskal-Wallis H test with Dunn post hoc for non-parametric variables. The effect size was estimated by using Cohen's d. The independent variables in the data analysis was the year of study.

### 3. RESULTS AND DISCUSSION

In general, pre-service and preschool teachers express small degree of anxiety towards mathematics ( $M = 2.31$ ,  $SD = 0.71$ ). Results showed that there were no statistically significant differences in level of anxiety towards mathematics in regard to the education program or year of study, for any item or group of items. According to that, the first part of discussion will be based on a global observation of all students' mathematics anxiety level.

The highest level of anxiety occurs in oral examination and in giving answers on mathematics classes ( $M = 2.94$ ,  $SD = 0.98$ ). The similar level of anxiety occurs whether an oral examination is announced ( $M = 2.95$ ,  $SD = 0.99$ ) or not ( $M = 2.93$ ,  $SD = 1.12$ ). This result is in favour with students' lower exam achievements, not just on those related to mathematics, where knowledge is tested by an oral examination.

Although students showed a slightly lower degree of anxiety according to written tests ( $M = 2.79$ ,  $SD = 0.80$ ), it is still very high and may be one of the reasons for lower student achievement. The lowest anxiety in students is when they know that they have to start learning for a written test ( $M = 2.40$ ,  $SD = 0.95$ ). As the term of written examinations approaches, it increases, so the day before the written examination it becomes high ( $M = 2.69$ ,  $SD = 1.01$ ), and it becomes even higher during the written examination itself ( $M = 2.86$ ,  $SD = 1.01$ ). However, although we expected that the anxiety would be lower after the control exercise, it is actually the highest in the period while waiting for the results of the written test ( $M = 2.99$ ,  $SD = 0.98$ ). It was noticed that the degree of anxiety in students with unannounced written tests ( $M = 2.99$ ,  $SD = 1.11$ ) is equal to the degree of anxiety they have while waiting for the results of these tests.

Unlike written and oral tests, a small degree of anxiety in students occurs in math classes ( $M = 2.12$ ,  $SD = 0.80$ ). Similar to written tests, the lowest level of

anxiety occurs just before the start of math class ( $M = 1.83$ ,  $SD = 1.06$ ) and remains at a similar level in class during the process of working on a math problem on the board, either by another student ( $M = 1.87$ ,  $SD = 0.95$ ) either by teachers ( $M = 1.92$ ,  $SD = 0.96$ ). However, anxiety becomes greater with the knowledge that the processing of new material begins in class ( $M = 2.23$ ,  $SD = 1.05$ ) and remains unchanged even while the teacher interprets the material ( $M = 2.24$ ,  $SD = 1.06$ ). The anxiety that students feel is no less even in the moments when they encounter mathematical formulas in class ( $M = 2.34$ ,  $SD = 0.99$ ) or when solving mathematical problems that are not the direct application of learned patterns ( $M = 2.43$ ,  $SD = 0.97$ ), when is the anxiety on the verge of becoming very great.

We registered that the lowest level of mathematics anxiety is in students' use of mathematics in everyday life ( $M = 1.91$ ,  $SD = 0.70$ ). It is interesting that level of mathematics anxiety increases when student solving harder mathematical problems. Mathematical anxiety is almost absent while students are solving simple mathematical problems ( $M = 1.57$ ,  $SD = 0.83$ ), but it becomes almost high when they face with complex problems ( $M = 2.46$ ,  $SD = 1.02$ ). Students' attitude toward mathematical literature is also interesting. In first touch with mathematical literature, students have a slight anxiety ( $M = 1.61$ ,  $SD = 0.89$ ) and it increases during literature review ( $M = 2.09$ ,  $SD = 1.10$ ). The good thing is that it crashes again during long-term using of literature ( $M = 1.85$ ,  $SD = 0.98$ ).

As we have already said, the observed global characteristics are the same for all of students, no matter to the education program or a year of studying. However, a level of a students' high school knowledge was a key parameter to investigate mathematics anxiety. Level of high school knowledge was measured as a average high school mathematics grade. Although we wanted to take mathematics grade at the end of a fourth year of high school as a key parameter it was not possible because there were students who only had mathematics in first two years of high school.

Namely, it was determined that in the first year of study there is a statistically significant difference in the degree of anxiety in the three subscales (Table 5), where it is characteristic that the degree of anxiety is inversely proportional to the grade in mathematics in high school (Table 6). This result is in accordance with some foreign research that we had the opportunity to get acquainted with.

**Table 5.** Statistical significance of the degree of anxiety for each of the subscales in relation to the average grade from high school

	<i>F</i>	<i>p</i>
<i>AS1</i>	8.845	<b>.000</b>
<i>AS2</i>	3.335	<b>.025</b>
<i>AS3</i>	1.702	.176
<i>AS4</i>	2.925	<b>.041</b>

**Table 6.** Degrees of anxiety on each of the subscales in relation to the average grade from high school

<i>Average highschool mathematics grades</i>	<i>AS1 (M)</i>	<i>AS2 (M)</i>	<i>AS3 (M)</i>	<i>AS4 (M)</i>
2	3.65	3.16	2.46	2.30
3	3.35	3.01	2.32	2.12
4	2.46	2.65	2.10	1.96
5	2.20	2.32	1.79	1.53

In each group, we note that there is a higher level of anxiety in students with average grade two in mathematics in highschool, while the level of anxiety in students who had average grade five is reduced by an average of 31.76%. Also, it can be noticed that students with a lower grade in mathematics from highschool have a higher level of mathematics anxiety during oral examination, while those with a higher grade are more anxious during written exams. In all groups, the lowest level of anxiety and the smallest difference in groups occur when it comes to solving classic textual tasks in which two quantities are known, and based on them third quantity should be determined by applying one of the four arithmetic operations. The highest level of anxiety and the greatest difference occur in frontal oral examination in mathematics class. In 80% of cases students with a average grade two from highschool stated they have the highest, fourth, level of anxiety on this item while the remaining 20% defined for the third level of anxiety (they were very upset).

It is interesting to look at the answers of Year 2 students of the Primary Teachers Education Program. Due to the sample size, we cannot talk about the statistically significance of the results but based on the mean values of the answers we can notice that the level of anxiety of students with lower highschool grades is a little bit lower than that Year 1 students (Table 7). The level of anxiety in oral examination is still the highest among Year 2 students, but in relation to Year 1 students, the anxiety that occurs when waiting for the results of a written exam is more evident.

**Table 7.** Level of anxiety according to each of the subscales regard to the average highschool grade of the Year 2 students

<i>Average highschool mathematics grades</i>	<i>AS1 (M)</i>	<i>AS2 (M)</i>	<i>AS3 (M)</i>	<i>AS4 (M)</i>
3	3.14	2.97	2.31	2.26
4	2.85	2.86	2.09	1.75
5	2.85	2.63	1.88	1.57

At this point, we surely cannot draw any long-term conclusions in terms of whether and how a level of students' anxiety changes over a long period at the Faculty because long-term observation and scaling is required.

#### 4. CONCLUSION

Pre-service primary and preschool teachers in general expressed small degree of anxiety towards mathematics. The impression is that if we want students to successfully master mathematical content and thus successfully work on their future vocation, we would have to pay attention to the different spectrum of factors that can enable us to do so.

For example, a higher level of anxiety during oral exams of students with lower mathematics grades indicates that students in addition to giving an incorrect answer, fear of public appearance creates additional discomfort. Thus, we should work on strengthening the self-confidence of this group of students for public presentations. Especially, if we have in mind their future vocation and the demands they will face with. In contrast, students with higher mathematics grades have shown that oral examination makes them less anxious and closer to them than giving answers on paper. The common denominator for all students is the uncertainty they express while waiting for the results of written exam, which indicates uncertainty in the results of their work.

Furthermore, keeping in mind that the level of anxiety is influenced by previous experiences of students, it is necessary to pay more attention to overcoming the resulting conditions when they come to the faculty. It is also necessary to prevent possible side effects of their faculty education, especially considering the fact that, in their future occupation, they will directly teach mathematics or develop children's initial mathematical concepts. Also, they will indirectly use the mathematics contents in almost a third of the contents that children will be learning.

It is of extreme importance that teacher education programs give pre-service primary teachers adequate training on mathematics content knowledge and pedagogical knowledge. Furthermore, teacher educators must be aware of the fact that teachers' negative attitudes and beliefs towards mathematics, and high levels of mathematics anxiety might affect their teaching behaviour, teaching process, choice of teaching methods and strategies, readiness to embrace innovation, but also pupils' mathematics achievement, attitudes, beliefs and mathematics anxiety. The studies show that "the teachers who are not specialist mathematics teachers at the start of their training follow the 'heritage' path" ([9], pp. 19), i.e. they teach as they have been taught. This means that teacher education programs must provide opportunities for future teachers to experience mathematics in the way they should teach. Since mathematics anxiety of future primary teachers might be attributed to their previous mathematics experiences and lack of mathematical knowledge, teacher education faculties should consider increasing a number of classes in general Mathematics and teaching methodology courses. Another solution might be in introducing some elective mathematics appreciation courses. We believe that the results of this research can be used as support to encourage some further investigations of the mathematics anxiety in pre-service primary teachers, but also investigating

mathematics anxiety of students of different faculties, and finding ways of decreasing anxiety towards mathematics.

### CONFLICT OF INTEREST

We authors declared that no competing interests exist.

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$$1) \int \frac{\sqrt{x} dx}{(a \pm bx)^{m-1}}$$

$$\int \frac{x\sqrt{x} dx}{a - bx} = \frac{6a\sqrt{x} - 2bx}{3b^2}$$

$$\frac{a + x + x\sqrt{x}}{(a \pm bx)^{m-1}} + \frac{3}{2(m-1)}$$

$$\frac{2a\sqrt{x} + \frac{a\sqrt{a}}{b^2\sqrt{b}} \ln \left| \frac{\sqrt{a} + \sqrt{b}}{\sqrt{a} - \sqrt{b}} \right|}{2(m-1)}$$