The mathematics anxiety: Do prospective math teachers also experience it?

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Abstract. Many events illustrate how students who have high mathematical abilities but become unable to solve a mathematical problem due to high mathematics anxiety. So, what about prospective math teachers who work and study mathematics every day, whether they also experience mathematics anxiety? We described the mathematics anxiety of prospective math teachers, examined the effect on mathematics performance, and investigated the differences between mathematics anxiety levels based on gender, year of study, and reasons for choosing a college in mathematics education. The subjects were 148 prospective math teachers. We used the correlation test and alpha Cronbach to test the instrument’s reliability and validity, the regression test to see the effect of mathematics anxiety on mathematics performance, and the t-test and MANOVA to analyze the differences level of mathematics anxiety type for each group. We obtained that the mathematics anxiety level of prospective math teachers was relatively high and had a significant adverse effect on mathematics performance. The mathematics anxiety level of male and female students was the same. The level of mathematics anxiety of first-year, second-year, and third-year students was also the same. The reasons of students chose the study programs did not provide different levels of mathematics anxiety.

1. Introduction
There is no doubt that mathematics plays a crucial role in life; many types of work require mathematics. Many fields of study require mathematics, such as engineering, physics, biology, and even social science. But in reality, mathematics is considered a scary thing for many people. Many students choose social science majors just to avoid mathematics. Mathematical anxiety is a feeling of discomfort, anxiety, or fear that is felt by someone related to mathematics, either while taking math classes or when studying and solving math problems or when facing math tests. Richardson and Suinn described mathematics anxiety as involving "…feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of the mathematical problems in a wide variety of ordinary life and academic situations" [1]. Vukovic showed that mathematics anxiety could arise in a person from an early age or after he/she was an adult due to one thing and another he experienced. For young students, mathematics anxiety could be caused by many factors; it could be external factors in the form of parental influence, teacher influence, or the influence of the social environment [2]. Lay in [3] said that the nature of abstract mathematics that made young students had difficulty in learning it because of the cognitive level that may not be appropriate. He showed that math problems in the form of word problems also caused anxiety for elementary students. Harari [4] found that mathematics anxiety in early childhood was based on
many aspects; it could be an adverse reaction to a basic mathematical concept, related to students’ numeracy skills.

Research conducted by Mutawah [5] showed that there was a relationship between the level of mathematics anxiety of middle and high school students in Bahrain with the achievement of mathematics, it was seen that the groups of students with high levels of anxiety had lower average mathematical abilities compared to the groups of students with low mathematics anxiety levels. Many studies investigated mathematics anxiety, most of the subjects studied were elementary to high school students, only a few studied with subjects of college students, especially prospective math teachers. The studies about mathematics anxiety of prospective math teachers were qualitative research involving two or three subjects. Such as, Pantaleon described the mathematical proof process of prospective math teachers with high mathematics anxiety [6]. According to the results of a literature review conducted by Fernández-Cézar, R., in [1] research on mathematics anxiety, there were not many researchers from the field of mathematics education who explored about mathematics anxiety, which so far had been much concerned with mathematics anxiety, especially psychologists, psychiatrist and medical doctors. Juniati and Budayasa [7] found in their studies that mathematics anxiety was significantly negatively correlated with mathematics achievement for mathematics students. There is not much research about the anxiety of prospective math teachers; some research on prospective teacher students usually examined other aspects. Yazgan-Sag [8] explored the creativity of prospective mathematics teachers and compared them to mathematicians. Lestari [9] investigated the gender differences in prospective teachers’ mathematical literacy, Muhtarom [10] examined the prospective teachers’ belief and pedagogical content knowledge. Budayasa [11] in his research showed that the cognitive style of math prospective teachers affects mathematics communication in solving problems and they developed the learning material involving technology and culture that is appropriate for prospective math teachers to study group theory [12].

The enthusiasm of high school graduate students to become a prospective teacher is quite high, this is due to students who do have a desire to become a teacher because they are motivated by their mathematics teacher, but not a few also because of the encouragement and support of parents who play a role. Many parents consider teachers to be promising jobs, and they have the important assumptions that teachers are expected to become government employees later. If seen from the reasons students choose study programs in mathematics education can be divided into two groups, the groups of students who choose study programs because of their own volition (like mathematics or want to be a math teacher) and the groups of students who choose study programs because of encouragement from others, from their parents who want their children to become teachers or their high school teachers.

Prospective math teachers meet and learn mathematics every day. Therefore, an interesting question to know whether they also experience mathematics anxiety, how do mathematic anxiety they face, and what the effect on mathematics performance. Investigations to see whether gender, year of study, and the reasons students choose study programs provide different levels of mathematics anxiety need to be done for a more detailed description that will be useful in determining strategies to reduce anxiety levels. The results of this study will have a substantial impact, which can be one of the references in determining some effective and appropriate strategies in reducing mathematics anxiety levels of prospective math teachers. This will have a positive impact because later, they will become mathematics teachers who will face many students who experience mathematics anxiety.

2. Methods
The type of this research was quantitative research. This research aimed to describe the mathematics anxiety of prospective math teacher students and investigated whether differences in sex, the years of study, and the reasons for choosing the mathematics education study program, gave different levels of mathematics anxiety. The effect of mathematics anxiety on mathematics performance was also investigated.

The sample of this study was selected by using cluster random sampling method. The three clusters obtained were the third-year students (junior), the second-year students (sophomore) and the first-year students (freshman). A total of 148 prospective math teachers of Universitas Negeri Surabaya
participated in this study, 121 were female and 27 were male. Of the participants, 34 were juniors, 57 were sophomores, and 57 were freshmen. In this study, the math test used to determine mathematics performance consisted of questions constructed such that the first-year to third-year students can answer it. The test consists of questions about integrals and derivatives, problems of inequality of exponential shapes, questions related to geometric sequences, and a problem of maximum determination. The range of the score was 0-100. The validity test was done by the experts.

The mathematics anxiety instruments used were developed and arranged by referring to several existing instruments and adapted to the conditions of the research subjects. Measurements of mathematics anxiety that have been produced until now only for elementary students through high school students that can be seen at [13], those were: The Mathematics Anxiety Rating Scale (MARS) with 98 items introduced by Richardson in 1972, The Abbreviated Math Anxiety Scale (AMAS) contains 9 items, composed of two components, anxiety related to learning math and the anxiety related to being tested in math, developed by Hopko et al. The Revised Mathematics Anxiety Rating Scale (RMARS) has 25 items, the Mathematics Anxiety Scale (MAS) has 12 items. The mathematics anxiety instrument in this study was developed by referring to three components, namely, anxiety related to mathematics learning (4 items: item number 1 to item number 4), anxiety related to taking mathematics courses (5 items: item number 5 to item number 9) and anxiety related to being tested in mathematics (6 items: item number 10 to item number 15). One example of a statement regarding a math test is "I lost focus on the math exam time, and I can't remember the material that I understood before the exam". For the detailed items used, see [7]. Subjects answered each statement by selecting an option that indicated how often they felt the condition as in the statement. Responses were rated on a 4-point Likert scale from "never" with a score of 1, "rarely" with a score of 2, "often" with a score of 3 and "always" with a score of 4.

The mathematics anxiety instrument was tested on 122 students to get a reliable instrument. The Cronbach alpha value obtained from the Reliability Statistics table using SPSS was 0.849 and this score was greater than 0.7, so it concluded that this instrument was reliable. The correlation Pearson of each item between test dan retest score was significant; these indicated that the instrument was stable and consistent across time. From the product-moment validity test obtained that the correlation between the score of each item with the score total of mathematics anxiety was significantly positive, so the instrument was valid. For more detailed results, see [7].

Instruments that were valid, reliable and consistent were given to 148 research subjects. In addition to being given a mathematics anxiety questionnaire to be filled according to their circumstances, subjects were asked to fill out forms by explaining their reasons for choosing a mathematics education study program. The reason the subjects chose the mathematics education study program was grouped into 2 groups, namely their desires or the encouragement of others. The reason came from themself, for example choosing a mathematics education study program because they liked mathematics, because they wanted to be a teacher, liked exact science rather than social science. The other group was the students that chose mathematics education study programs because of encouragement from others, such as the encouragement of parents who want them to be teachers or the encouragement of their high school teachers.

The data were classified for three groups, the anxiety related to mathematics learning (Learning Anxiety), the anxiety related to taking mathematics courses (Course Anxiety), and the anxiety related to being tested in mathematics (Test Anxiety) to more detail investigation. To see whether the different sex and the reasons students chose study programs provide different levels of three types of math anxiety, the mathematics anxiety data of prospective mathematics teachers were grouped based on the same sex and the same reason and tested for differences by the t-test. Meanwhile, the MANOVA test was used to see the differences in mathematics anxiety of learning, mathematics anxiety, of course and mathematics anxiety on tests based on the year of the student.
3. Results and discussion
Mathematics anxiety instruments were given to 148 prospective mathematics teachers, and the average score of each item obtained was shown in the following table 1 and figure 1.

Table 1. The average score of each mathematics anxiety item.

| The items | Average (Total=148) | Average (First-year) | Average (Second-year) | Average (Third-year) |
|-----------|---------------------|----------------------|-----------------------|----------------------|
| 1         | 3.03                | 3.12                 | 2.98                  | 2.94                 |
| 2         | 2.77                | 2.88                 | 2.75                  | 2.62                 |
| 3         | 2.64                | 2.56                 | 2.81                  | 2.47                 |
| 4         | 2.12                | 2.14                 | 2.18                  | 2.00                 |
| 5         | 2.62                | 2.70                 | 2.49                  | 2.68                 |
| 6         | 2.81                | 2.84                 | 2.79                  | 2.79                 |
| 7         | 2.54                | 2.74                 | 2.40                  | 2.44                 |
| 8         | 2.03                | 1.98                 | 2.05                  | 2.09                 |
| 9         | 2.53                | 2.66                 | 2.40                  | 2.50                 |
| 10        | 3.23                | 3.32                 | 3.28                  | 3.00                 |
| 11        | 2.63                | 2.77                 | 2.51                  | 2.59                 |
| 12        | 2.38                | 2.39                 | 2.32                  | 2.47                 |
| 13        | 2.78                | 2.79                 | 2.74                  | 2.85                 |
| 14        | 2.35                | 2.49                 | 2.26                  | 2.27                 |
| 15        | 2.53                | 2.65                 | 2.42                  | 2.53                 |
| Total     | 2.60                | 2.67                 | 2.56                  | 2.55                 |

The data of mathematics anxiety level of 148 prospective math teachers showed that the average total was 2.60, and there were 104 students, or 70%, with the level of mathematics anxiety greater than 2.5. This result illustrated that 70% of subjects answered more than half the items that were asked with answers “often” or “always.” This situation indicated that the level of mathematics anxiety of prospective mathematics teachers was relatively high, and they tend to feel anxious often. From the Table 1, it was known that the 3 items with the highest average consecutively were the item “I panicked when there is
a math quiz without prior notice” (item No. 10) with average equal to 3.23, the item "I feel uneasy if there is mathematical material that I did not understand when studying (item No.1) with average equal 3.03 and the item "I panicked when I got a lot of assignments and it wasn't easy for me" (item No.6) with average equal 2.81. Meanwhile, subjects were not worried when they had to study with computers or other technology, and they were not too worried even though their friends knew when they didn't understand the material or couldn't answer questions. Impressive results obtained were the items with the highest average and second order for first-year students, second-year students and third-year students were the same. The two items with the lowest mean scores for all three groups were also the same. From the average of each item, it was known that the first-year students had a slightly higher level of mathematics anxiety than those of second-year students, and the second-year students’ anxiety levels were marginally higher than those of the first-year students. This showed that the longer students take the lectures in college, their mathematics anxiety was slightly reduced even though it was still high.

The influence of the level of mathematics anxiety on mathematical performance was investigated using a statistical regression test with the average total mathematics anxiety as an independent variable and the value of the mathematics test as the dependent variable. Table 2 showed the regression test result obtained using the SPSS program.

| Model | SS   | df | MS   | F    | p-value |
|-------|------|----|------|------|---------|
| Regression | 2372 | 1  | 2372 | 5.735 | 0.018   |
| Residual | 60393 | 146 | 414  |       |         |
| Total  | 62765 | 147 |      |      |         |

| Coefficients | Std. Error | Beta | t     | p-value |
|--------------|------------|------|-------|---------|
| Constant     | 74.598     | 11.442 | 6.520 | 0.000   |
| Math. Anxiety | -10.445   | 4.362  | -0.194 | -2.395  | 0.018   |

Dependent variable: math test score.

Table 2 showed the p-value of the regression model was 0.018 that less than 0.05 (alpha value used); this indicated that the regression model statistically significantly predicts the outcome variable, it was mean that the model was a good fit for the data. The regression model obtained was: math test score = -10.445 math anxiety level+ 74.598. The p-value of math anxiety level variable was 0.018 that less than 0.05; this indicated that math anxiety level effect math test score significantly and the coefficient value was negative so it gave a negative effect. The higher the level of mathematics anxiety the lower the math test score.

To determine an effective strategy in reducing the level of mathematical anxiety, surely a more detailed investigation is needed. The following investigations on mathematics anxiety levels were divided into 3 categories for more detail, the anxiety related to mathematics learning (Learning Anxiety), the anxiety related to taking mathematics courses (Course Anxiety) and the anxiety related to being tested in mathematics (Test Anxiety). The investigation to know whether the anxiety levels of first-year, second-year and third-year students differed significantly, Multivariate ANOVA (MANOVA) test was used with three variables dependent (Learning anxiety, Course Anxiety, Test anxiety). Table 3 showed the descriptive statistics based on different years of students and table 4 MANOVA that was obtained using the SPSS program.
Table 3. Descriptive statistics based on different year.

| year | Learning Anxiety | Course Anxiety | Test Anxiety |
|------|------------------|---------------|-------------|
|      | Mean  | Std dev. | Mean  | Std dev. | Mean  | Std dev. | Mean  | Std dev. |
| 1    | 2.68  | 0.46    | 2.59  | 0.45    | 2.73  | 0.53    | 2.60  | 0.60    |
| 2    | 2.69  | 0.47    | 2.43  | 0.44    | 2.59  | 0.51    |        |         |
| 3    | 2.51  | 0.53    | 2.50  | 0.51    | 2.60  | 0.36    |        |         |

Table 3 above described the descriptive statistic of learning anxiety, course anxiety and test anxiety of prospective math teachers of first-year students, second-year and third-year students. For the first-year students and the third-year students, the highest level was the test anxiety with the score 2.73 and 2.60, respectively. Meanwhile, for the second-year students, the highest level was learning anxiety. To see the difference between the three types of anxiety in the three groups can be seen from the following MANOVA table.

Table 4. Multivariate table based on difference year.

| The test  | F     | Sig  |
|-----------|-------|------|
| Eq. of covar. matrices | Box's test | 2.695 | 0.001 |
| Eq. of error variances | Levene's test: | | |
|         | Learning Anx | 0.134 | 0.874 |
|         | Course Anx. | 0.168 | 0.846 |
|         | Test Anx | 4.011 | 0.020 |
| Multivariate test | Pillai's Trace | 1.533 | 0.167 |

Table 4 showed the F score of Box's Test was 2.695 with the Significant score (p-value) =0.001 was less than 0.05, so the null hypothesis was rejected, so the observed covariance matrices of the dependent variables were not equal across groups. The Significant scores of Levene's test for Learning Anxiety and Course Anxiety were 0.874 and 0.846 respectively. Both of them were greater than 0.05, these indicated that the error variance of the dependent variable was equal across groups. But this was not the case for test anxiety with the Significant score was 0.020 (less than 0.05). Because the Box's Test was significant and there was one variable dependent that was not homogeneous, so the Pillai's Trace was used.

The F score of Multivariate-test by Pillai's Trace was 1.533 with the Significant value equal 0.167 (greater than alpha used), this showed that there was no difference means between the groups viewed from the different years of the students. This result indicated that the level of learning anxiety, course anxiety and test anxiety of first-year students, second-year students and the third-year students was the same.

Next, the t-statistical test was used to see the differences in learning anxiety, course anxiety and test anxiety of female and male students. The results of the statistical t-test used were given in the following table. Table 5 illustrates the descriptive statistic and Table 6 illustrates ANOVA table of mathematics Anxiety of female and male students.

Table 5. Descriptive statistic and ANOVA table based on gender.

| Gender | Learning Anxiety | Course Anxiety | Test Anxiety |
|--------|------------------|---------------|-------------|
|        | F    | M    | F    | M    | F    | M    |
| Mean   | 2.62 | 2.71 | 2.49 | 2.60 | 2.66 | 2.60 |
| Std dev.| 0.44 | 0.62 | 0.44 | 0.55 | 0.47 | 0.58 |
Table 6. ANOVA table of math anxiety based on gender.

|                          | Levene's Test of Eq.Var | Test of equality means |
|--------------------------|-------------------------|------------------------|
|                          | F-score | Sig | t-value | Sig |
| Learning Anxiety         | 6.061   | 0.015 | -0.716 | 0.479 |
| Course Anxiety           | 2.685   | 0.103 | -1.124 | 0.263 |
| Test Anxiety             | 2.566   | 0.111 | 0.486   | 0.628 |

Table 5 showed that the level of Learning Anxiety and Course Anxiety for male students was slightly higher than for female students, and the opposite occurs for test anxiety levels. Based on the ANOVA table and using an alpha value of 0.05, it was found that the significant value of the test for equality means (t-test) was greater than alpha for three of them. So, it can be concluded that the level of learning anxiety, course anxiety and test anxiety between male and female students was equal.

The following will be given the results of the t-test statistical test to see whether the different reasons for choosing a mathematics education study program provide a different level of mathematics anxiety. The group is divided into two groups, S-group, which is a group of students who choose study programs because of their desires and O-group, namely groups of students who choose study programs because of encouragement from others. After being grouped, out of 148 students who chose the study program because of the encouragement of their parents or high school teachers there were 34 students or around 23 percent. Table 7 illustrates the descriptive statistic and table 8 illustrates ANOVA of mathematics anxiety of those groups.

Table 7. Descriptive statistic and ANOVA Table based on the reason for choosing the study program.

| Groups | Learning Anxiety | Course Anxiety | Test Anxiety |
|--------|------------------|----------------|--------------|
|        | S                | O              | S            | O            | S            | O            |
| Mean   | 2.65             | 2.62           | 2.49         | 2.55         | 2.64         | 2.66         |
| Std dev.| 0.49             | 0.46           | 0.45         | 0.50         | 0.52         | 0.38         |

Table 8. ANOVA table of math anxiety based on the reason for choosing the study program.

|                          | Levene's Test of Eq.Var | Test of equality means |
|--------------------------|-------------------------|------------------------|
|                          | F-score | Sig | t-value | Sig |
| Learning Anxiety         | 0.206   | 0.651 | 0.321   | 0.749 |
| Course Anxiety           | 0.880   | 0.350 | -0.588  | 0.557 |
| Test Anxiety             | 4.583   | 0.034 | -0.247  | 0.806 |

From the descriptive statistic table, it was known that the level of Course Anxiety and Test Anxiety for O-students was slightly higher than for S-students and the opposite occurs for learning anxiety levels. Based on the ANOVA table and using an alpha value of 0.05, it was found that the significant value of the test for equality means (t-test) was greater than alpha for three of them. So, it can be concluded that the level of the learning anxiety, course anxiety and test anxiety between the two groups was equal. This showed that various reasons for choosing mathematics education study programs did not affect the different level of mathematics anxiety.

Based on the results of this study, it can be concluded that the level of mathematics anxiety of prospective math teachers was quite high, with an average rate equal to 2.60. This showed that almost all students often or always felt anxious in most of the situations that were asked on the questionnaire. Statistic test results showed that the level of mathematics anxiety of prospective math teachers had a significant negative effect on their math performance. The higher the level of mathematics anxiety, the lower the mathematical performance. These results are in line with several studies of mathematics anxiety for elementary to high school students [1][2][5][14] and the same results obtained with the subject of mathematics undergraduate students [7]. As a prospective teacher, feelings of mathematics anxiety will affect their students if they teach mathematics later. Therefore, a high level of mathematics...
anxiety in prospective teacher students must be given sufficient attention, and effective learning strategies must be determined to reduce their level of mathematics anxiety. Effective strategies will help prospective math teachers deal with their math anxiety so that mathematical performance increases and later when they become teachers they will be able to utilize their experiences to help their students reduce their mathematical anxiety.

4. Conclusion
Based on the MANOVA test, it was known that the level of Learning Anxiety, Course Anxiety and Test Anxiety between first-year students, second-year students, and third-year students were the same. The level of three types of mathematics anxiety was not influenced by the sex of students and the reasons of for students choosing a mathematics education study program. Therefore, the strategy that will be determined to reduce the level of student anxiety does not distinguish student years, gender or the reason students choose study programs. By paying attention to the highest average score of items, it is necessary to find a solution to overcome students’ anxiety when they do not understand the material they learned, when facing a quiz, and when they have many and complicated assignments and create a conducive learning atmosphere so as not to be tense need to be done. What needs to get more attention and need further investigation to find effective strategies is to find the factors that cause students to feel anxious. Because by finding the causative factors, the suitable and effective solution to reduce anxiety can be determined so that the mathematical achievement will be increase.

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