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Exploring mathematics anxiety among senior high school students

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Abstract. One of the psychological factors that determines student's mathematics achievement is mathematics anxiety. This survey research aimed to find out the different student's mathematics anxiety related to gender, school grade, and programs among senior high school students. This research can be used as a source of information for various parties in ordered plan in education. The data were obtained from mathematics anxiety questionnaires for 215 students from Bengkulu, Pasaman, Bogor, and Yogyakarta in Indonesia. The data analyzed descriptively and inferentially. The results indicated that high school students had moderate mathematics anxiety. The male students had lower mathematics anxiety than female students, but no significant mean difference. The 12th grade students had higher in mathematics anxiety, followed by the 10th and 11th respectively. There is a significant difference in the mean scores of mathematics anxiety based on grade students between the 10th and 11th grade students. It can be concluded that the 11th grade students were more positive in dealing with things related to mathematics. Students at Social Program had higher mathematics anxiety, but no significant than Science Program and Chemical Industry Program.

1. Introduction

Mathematics is one of the lessons that must be mastered by students in Indonesia. However, the mathematics achievement of the students in Indonesia has not been satisfactory. This is indicated by the average value of the national examination of high school students in 2018 which did not reach 55 according to the Ministry of Education and Culture target. Based on the results of the National Examination, the mathematics achievement of high school students in Indonesia in various programs has been declined. There are differences in the average value of the mathematics national examinations of high school students based on their programs.

Table 1. The Average score of National Mathematics Examinations for High School Students

Year	Science	Social	Vocational
2018	36.46	32.72	33.73
2017	41.39	38.09	36.81
2016	53.03	48.29	40.04
2015	59.17	55.76	48.24

[1-4]

From table 1, the students in the science programs always have higher scores than the students in social and vocational programs. The difference in value among programs on high school students indicates that there are differences on the factors that influence the students' mathematical achievements. Mathematics anxiety includes factors that influence the students' mathematics achievement [5].

Many studies have been carried out showing the fact that the students with high anxiety will have low mathematical achievements [6]. Some researchers have examined several sources of mathematics anxiety that affect the level of the students' mathematics anxiety. Sources of mathematics anxiety can be read on different greater familiarity, social class, culture ecosystem, age level, high activity, and gender [7]. However, there is still not enough research in mathematics anxiety among senior high school students more specifically.

In this article, the author presents a survey to explore the mathematics anxiety among senior high school students based on the dimensions of mathematical anxiety (cognitive, psychological, and physiological). The students who participated in this research consisted of high school students in science, social, and vocational programs. The purpose of this research is to find and describe differences in mathematics anxiety of high school students based on programs, gender, and grade.

2. Literature review

Psychological and physical reactions of someone that feels the tension is anxiety [8]. Anxiety includes the psychophysiology trouble [9]. Dreger and Aiken [10] have been interpreted an emotional symptom when responding mathematics and arithmetic as mathematics anxiety. Sense of tensely and anxiety when students manipulate numbers and solve the mathematics problems in academic settings and various ordinary life is mathematics anxiety [11]. A condition of discomfort due to working mathematical tasks is mathematics anxiety [12]. So, we can conclude that mathematical anxiety is a condition of someone's discomfort when dealing with everything related to mathematics.

Students with mathematics anxiety will show negative responses. Ma and Xu [6] said that the characteristics of mathematics anxiety are distaste, worry, afraid and showing the behavior of tension, distress, frustrating, mental disorganization, and helpless. Uusimaki and Kidman [13] stated that students who have mathematics anxiety are afraid, panic, helpless, inability to cope, tension, breathing difficulties, and physiological symptoms like missing concentration. Students with anxiety have cognitive deficit such as misunderstanding of information or memory and blocked recall [14]. Based on various opinions above, anxiety will be showed by someone physically (physiological), emotionally (psychological), or way of thinking (cognitive).

Several research have been conducted to determine the differences in levels of mathematical anxiety in various sources of anxiety, such as, age, gender, and programs. When it is viewed by age, some research showed that older students and adults have mathematics anxiety levels which were higher than younger students [15, 16]. Mathematics anxiety can increasingly be developed with age [15, 17]. This shows that students at a higher level will have higher levels of anxiety. Furthermore, there is also difference in the relationship between mathematics performance and mathematics anxiety for the university students based on programs and gender [18].

There are many studies that concern about the connection between mathematical anxiety and gender. Some studies suggest that mathematics anxiety of the male students is lower than that of the female students [19-26]. There are also some research that indicated no gender differences in mathematics anxiety [12, 27-29]. However, there are indeed a few researches that have found mathematics anxiety in males that was higher than females [30]. Based on various studies on mathematical anxiety based on gender, there are several different findings. This may be because mathematics anxiety is not measured or defined consistently [29]. The research question was whether there were differences in the level of mathematics anxiety of high school students by programs (science, social, vocational), grade, and gender.

3. Method

The respondents were 215 students from senior high schools in Bengkulu, Pasaman, Bogor, and Yogyakarta. They consisted of 83 males and 132 females; 107 students from the 10th, 70 students from the 11th grade, and 38 students from the 12th grade based on grade level and also consisted of 133 students from science, 69 students from social science, and 13 students from chemical industry based on programs.

Information about students' mathematics anxiety based on anxiety questionnaire was developed by Prasetyawan [31] that has fulfilled valid and reliable criteria. The questionnaire which contained 32 items and had five scales was given to the students through a paper-based and online survey. The students were required to provide answers based on thinking, feeling, and experiences about mathematics anxiety. An anxiety questionnaire consists of three aspects, namely, cognitive, psychological, and physiological. The questionnaire also asked the students about grade, programs, and gender.

The data were analyzed descriptively to provide information about the students' anxiety levels based on gender, school grade and the programs on each dimension or aspect of anxiety. The anxiety data obtained from non-test instruments were converted into qualitative data according to the following assessment criteria:

Table 2. Assessment Criteria

Interval Score	Qualitative Value
$134.4 < k \leq 160$	Very high
$108.8 < k \leq 134.4$	High
$83.2 < k \leq 108.8$	Moderate
$57.6 < k \leq 83.2$	Low
$32 \leq k \leq 57.6$	Very low

Then, the data were analyzed with independent t-test to discover a significance of mathematics anxiety in each dimension based on gender. One-way ANOVA and post hoc test (Tukey HSD) were to investigate the mean scores of mathematics anxiety based on grade and programs among senior high school students. The level of significance was $p < 0.05$.

4. Results and discussion

The data were analyzed with descriptive and inferential. The result of the survey showedm the difference in mathematics anxiety between the students based on gender, school grade, and programs.

4.1. Descriptive

Based on the research data, it was found that the average anxiety of high school students was 86.37 with std. deviation 17.06. This means that the students' anxiety levels were moderate. The maximum score of the students' anxiety is 133. This indicates that no student is at a very high level of anxiety. The minimum score of the students' anxiety is 46. This shows that there are students with very low level of mathematics anxiety.

4.1.1. Gender Difference. The results indicated that mathematics anxiety level of high school students is classified as moderate, both for female and male students. The mean score of female students on mathematics anxiety is higher than male students. From the data, it can also be known that there are no male or female students in high schools who have very high levels of mathematics anxiety. It is shown with maximum score of male and female students sequentially ie 130 and 133. The minimum score of male and female students sequentially ie 46 and 50. This shows that there are male and female students who are at the very low level of mathematics anxiety.

Table 3. Descriptives Based Gender

Gender	Mean	SD	Min	Max
Male	85.133	17.042	46	130
Female	87.144	17.097	50	133

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4.1.2. *School Grade Difference.* The results exhibit that the mathematics anxiety level of students in grade 10, 11 and 12 is moderate. The mean of mathematics anxiety score in the 12th is higher than 10th and the 11th sequentially. The researcher assumes that the 10th students still adapt to placing themselves in the high school learning. On the other hand, the 12th students are in the period of preparing for high school graduation exams. The students in grades of the 10th, 11th, and 12th are at the level of anxiety between very low and high.

Table 4. Descriptives Based Grade

Grade	Mean	SD	Min	Max
10 th	88.589	16.488	46	133
11 th	81.786	17.262	50	130
12 th	88.816	16.570	55	121

4.1.3. *Programs Difference.* The results show that the students in Social, Industrial Chemistry, and Science had moderate anxiety levels. The students in Social had mean scores of mathematics anxiety which were higher than Science and Industrial Chemistry sequentially. It is also known that the students' mathematics anxiety in Social and Science are at the level of anxiety between very low and high. Meanwhile Students in Industrial Chemistry are at the level of anxiety between very low and moderate.

Table 5. Descriptives Based on Programs

Programs	Mean	SD	Min	Max
Social	88.420	16.692	55	131
Industrial Chemistry	82.154	17.262	57	107
Science	85.714	17.252	46	133

4.2. Inferential

After the data were analyzed descriptively, the following will be presented the results analysis inferential by using independent samples t-test for gender difference, Anova and Tukey HSD test for school grade and programs difference.

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4.2.1 *Gender Difference.* The results show that $t(213) = -0.741$ with $p = 0.401 > 0.05$. It means that there is no significant difference in mean of mathematics anxiety scores between female and male students. Mean difference of mathematics anxiety scores between female and male students is 2.01141. This shows that the mean of both not far different.

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4.2.2 *School Grade Difference.* The results show that $F(214) = 3.846$ with $p = 0.023 < 0.05$. This shows that there is a significant difference in the mean scores of mathematics anxiety between the students in grades of the 10th, 11th, and 12th. Therefore, to do the Tukey HSD test to determine the group which showed a significant difference.

2
Based on the results of the Tukey HSD test, it can be seen that there is a significant difference in the mean score of mathematics anxiety. The value of $p = 0.027 < 0.05$ for mean score of mathematics anxiety

between the 10th grade and 11th grade students. This shows that the 10th grade students have the mean score of mathematics anxiety which is higher than that of the 12th grade students, with the mean difference of 6.710. As for the value of $p = 0.994 > 0.05$ for mean score of mathematics anxiety between the 12th grade and 10th grade students. This is evidence that no significant difference between the two. It is also applies between 12th and 11th grade students, but the results almost significant with $p = 0.098 > 0.05$.

Table 6. Multiple comparisons with Tukey HSD test based on programs difference

(I)	(J)	Mean Difference (I-J)	Std. Error	Sig.
10 th	11 th	6.710*	2.589	.027
12 th	10 th	.320	3.180	.994
	11 th	7.030	3.394	.098

2.2.3 Programs Difference. The results show that $F(214(= 0.993))$ with $p = 0.372 > 0.05$. This exhibits that there is no significant mean difference of mathematics anxiety between Social, Industrial Chemistry (IC), and Science. Next, Tukey HSD test done to see the mean difference of programs in more detail. Based on Tukey HSD test, show that there is no significant difference between the groups. The value of $p = 0.446 > 0.05$ between Social and Industrial Chemistry. The value of $p = 0.534 > 0.05$ between Social and Science. The value of $p = 0.753 > 0.05$ between Science and Industrial Chemistry.

Table 7. Multiple Comparisons with Tukey HSD test based on programs difference

(I)	(J)	Mean Difference (I-J)	Std. Error	Sig.
Social	IC	6.26644	5.15954	.446
	Science	2.70600	2.53178	.534
Science	IC	3.56044	4.95883	.753

After the data were analyzed with descriptive and inferential, we can know the difference mean score of mathematics anxiety students based on gender, school grade and programs. Mean score of mathematics anxiety at student high school is moderate, and located in the range of very low to high level. Level of mathematics anxiety of student high school on each group (male and female; 10th, 11th, and 12th; social, industrial chemistry, and science) is moderate.

Based on gender, the mean score of mathematics anxiety at female students is higher than male, but there is no significant mean difference. Based on grade, the mean score of mathematics anxiety of 12th grade students is higher than the 10th and 11th grade students, and there is a significant mean difference. The 10th students have the mean score of mathematics anxiety that is significantly different and higher than the 11th. Based on the programs, the mean score of mathematics anxiety at Social is higher than Industrial Chemistry and Science, but there is no significant mean difference.

5. Conclusion

The mathematics anxiety level of high school students is moderate. Mean score of mathematics anxiety is significant between the 10th and 11th grade students. However, based on gender and programs, mean score of mathematics anxiety is not significant. The researchers suggest for further research on the dimensions of anxiety mathematics most shown by the students, and looking for a cause of anxiety mathematics, as well as the right way to deal with so as not to prevent the learning process of students.

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