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MATHEMATICAL ANXIETY AMONG ENGINEERING STUDENTS

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ABSTRACT

Mathematical anxiety has a negative relationship with mathematics performance and achievement. Further explained, mathematics anxiety has an indirect effect on mathematics performance. This research explores sources or factors related to mathematics anxiety among engineering students at a private university in Indonesia. A total of 47 engineering students participated in this survey that randomly chosen based on gender, major, and age. Two main factors are affecting the mathematics anxiety of engineering students, namely internal and external factors. The results show that mathematics anxiety among engineering students is manifested into three aspects. Firstly, the home aspects are talking about the influence of parents and sibling. Secondly, society's issues are discussing self-efficacy, social reinforcement to hate mathematics, and social stereotypes. Lastly, the classroom aspects are talking about the traditional mathematics learning process and classroom culture, namely the experience of learning mathematics in classrooms and relationships between friends during learning. The details of the statements under the aspects also highlight unique problems and are not covered by previous research in mathematical anxiety. Next, differences in mathematics anxiety by gender and faculty were examined.

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1. INTRODUCTION

Nowadays, mathematics and its ability is an essential and frequent phenomenon in education (Hannula, 2012; Sundayana, Herman, Dahlan, & Prahmana, 2017). Mathematical anxiety determines more than mathematics that overcomes the manipulation of numbers and the ability to solve mathematical problems both in everyday life and in the academic world (Gresham, 2010). Mathematical anxiety is the adequacy of intelligence for intelligent people to overcome quantification, faced with mathematical problems. In his research, Blazer (2011) challenged mathematics universally as a non-intellectual factor that

inhibited mathematical achievement. Mathematical anxiety raises negative attitudes towards subjects, and results in poor and reasonable academic performance, increasing student performance in the mathematics learning process (Gresham, 2010). Therefore, it is necessary to have a discussion that discusses mathematics.

Mathematics underlies the universal development of technology (Stoet & Geary, 2018). Mathematical knowledge is directly related to the ability to do logic, analytic, systematic, critical, and creative thinking (Hoover, Mosvold, Ball, & Lai, 2016; Widodo, Istiqomah, Leonard, Nayazik, & Prahmana, 2019). Engineers have to study math during lectures to support their work on technology innovation.

In fact, prospective engineers still have difficulty in learning mathematics (Vitasari, Herawan, Wahab, Othman, & Sinnadurai, 2010). Engineering students have low comprehension and negative attitudes toward mathematics (Kargar, Tarmizi, & Bayat, 2010; Vitasari et al., 2010). They tend to avoid mathematics since their beliefs cannot solve math problems (Bates, Latham, & Kim, 2011; Charalambous & Philippou, 2010). Students with mathematical difficulties will look confusing, helpless, shy, nervous, and feel weak in concentration (Charalambous & Philippou, 2010; Cranfield, 2013; Hersh & John-Steiner, 2010). Engineering students still have a problem in learning mathematics because of their beliefs that affect their physical and emotional condition.

Engineering students have an affiliation with mathematics, where mathematics is essential for engineering as a language for describing physical, chemical, and other formulations in terms of mathematical inquiry (Vitasari et al., 2010). Furthermore, Erden & Akgül (2010) stated that high mathematical anxiety correlated with poor mathematical performance proposed at the university. Students need a high level of concentration compared to other subjects so that it is possible to create anxiety about mathematics among engineering students (Vitasari et al., 2010). Mathematics anxiety feelings arise from the consideration of having symptoms such as fear, loss of interest, lack of concentration, impatience, confusion, and tension (Gresham, 2010). On the other hands, female students more anxious than male in learning mathematics (Goetz, Bieg, Lüdtke, Pekrun, & Hall, 2013; Taylor & Fraser, 2013). Therefore, engineering students need a high level of concentration and low mathematics anxiety to learn mathematics, and female students don't have both of them yet.

In this paper, we present a survey to explore mathematical anxiety among engineering students. This survey aims to explore sources or factors related to mathematics anxiety among engineering students at a private university in Yogyakarta, Indonesia. Furthermore, the differences in mathematics anxiety base on gender and majors were examined. This survey involves extracting quantitative data from voluntary engineering student questionnaire groups, grouping variables under the theme, gender, and describe several aspects of the engineering students' mathematics anxiety based on their majors.

2. METHOD

The respondents were 47 students, consisting of 29 males and 18 females. They were informed to fill in the questionnaires based on what they experienced and learned during the lecture. These undergraduate students are from four engineering department: Informatics Engineering Department (IFD), Industrial Engineering Department (IED), Electrical Engineering Department (EED), and Chemical Engineering Department (CED).

The previous research on mathematics anxiety used to develop the mathematics anxiety questionnaire. This survey contains ninety-two items with four scales: strongly disagree (1), disagree (2), agree (3), and strongly agree (4). Students have to answer questions based on their experiences, feelings, and thoughts about mathematical anxiety

felt while studying on campus. Reliability and validity tests have been carried out. The result of the reliability test is 0.940, more than 0.70 as recommended by Raykov & Marcoulides (2011), accessing construct validity was interpreted by inter-correlation items (Drost, 2011). The instrument used to measure the mathematics anxiety of engineering students consisted of 92 items, developed from Shields (2005), Whyte & Anthony (2012), and also Zakariya (2018) instruments, as shown in Table 1.

Table 1. The rubric of mathematics anxiety questionnaires

Aspect	Indicator	Item number	Total items
Home	1. Parents and siblings give a low status to the students' mathematical ability and judgment that mathematics is complicated 2. Parents let the child stop trying when the child has a mathematical fracture 3. Parents demand excessive math success in children.	42, 65, 67, 68, 69, 70, 71, 72, 73, 74, and 75.	11
Society	1. Self-efficacy (men are better than women in mathematics). 2. Social reinforcement to hate mathematics. 3. Social stereotype (language skills are more critical and socially acceptable than mathematical abilities).	11, 15, 24, 25, 26, 27, 28, 34, 36, 37, 39, 43, 48, 49, 51, 52, 53, 54, 59, 60, 63, 64, 66, 77, 78, 79, 81, and 82.	28
Classroom	1. The classroom aspects whose talk about the traditional mathematics learning process and classroom culture 2. The experience of learning mathematics in classrooms 3. Relationships between friends during learning	5, 8, 9, 14, 16, 17, 18, 19, 22, 31, 32, 33, 38, 44, 45, 46, 47, 55, 56, 62, 76, 80, 83, 84, 85, 86, 87, 88, 89, 90, 91, and 92.	32
Personal	1. Physical and behavioral symptoms 2. Perception of difficulty 3. Low motivation	1, 2, 3, 4, 6, 7, 10, 12, 13, 20, 21, 23, 29, 30, 35, 40, 41, 50, 57, 58, and 61.	21

The survey was conducted during the holiday period after students finished the final examination. The inspector consulted several lecturers in each department to select some students to fill the questionnaire. Next, the inspector gives a questionnaire link to be filled by voluntary respondents, who assumed had no awareness in learning mathematics anxiety. The time required for respondents to complete the survey was less than 60 minutes. Students must read and answer questions as guided by the inspector. Afterward, they have to answer the poll based on their learning experience.

3. RESULTS AND DISCUSSION

Table 2 presents the demographic data of respondents. The results showed differences found in mathematics anxiety between engineering students on aspects, gender expectations, and variations based on majors. Data analysis uses statistics descriptive data analysis.

Table 2. The demographic data of respondents

Demographic Information	Frequency	Percentage
Gender		
Male	29	61.7%
Female	18	38.3%
Department		
EED	12	25.5%
IED	17	36.2%
IFD	11	23.4%
CED	7	14.9%
Age		
18-20	2	4.3%
21-23	29	65.9%
24 above	12	29.8%
Total	47	100%

3.1. The home aspects: The influence of parents and sibling in engineering students' mathematics anxiety

The home aspects were explained such as improving math scores when students increase their study time at home, parents' attention to mathematics learning outcomes, parents and siblings assessment of mathematics learning outcomes, and parents and siblings judgment about mathematics. Figure 1 shows that informatics engineering students get the highest while industrial engineering students get the lowest home aspects score in mathematics anxiety. It means that the home aspect has the weakest contribution to the factors affecting mathematics anxiety for informatics engineering students.

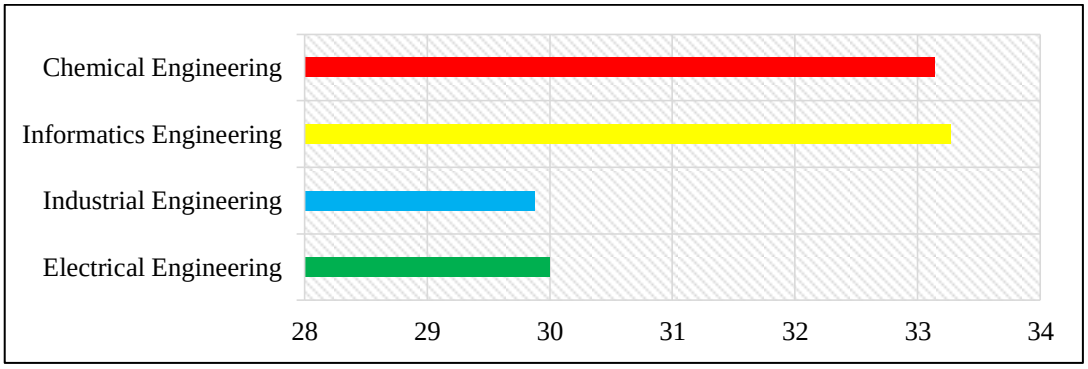

Figure 1. The influence of parents and sibling in engineering students' mathematics anxiety

The result was supported by Shields (2005) that parents who suffer from math anxiety can accidentally transfer it to their children. Parents, especially mother, are a consistent example for their children because their children pay close attention to the attitude of the mother. The position of mathematics attitude that shown to children in the way mothers sees mathematics as a valuable and understandable lesson (Makur, Prahmana, & Gunur, 2019). However, parents can inadvertently increase mathematical anxiety in their children by giving them reasons to stop trying when they are frustrated or upset because of

difficulties with math assignments (Stolpa, Sloan, Daane, & Giesen, 2004). Therefore, parents who suffer from math anxiety can inadvertently transfer this anxiety to their children.

3.2. The society issues: Self-efficacy, social reinforcement to hate mathematics, and social stereotypes

The society issues consist of several aspects affecting the engineering students' math anxiety. The first aspect is self-efficacy, which stated that boys are better than girls in mathematics. The next aspect is social reinforcement to hate mathematics. The last aspect is the social stereotype that language skills are more critical and socially acceptable than mathematical abilities. Figure 2 showed that electrical engineering students get the highest and informatics engineering students to get the lowest society issues to score in mathematics anxiety questionnaire. It means that social problems contribute the weakest to the factors affecting mathematics anxiety for electrical engineering students.

Social factors such as mathematical myths can also induce or strengthen mathematics anxiety for some students, i.e., the myth that boys are better than girls in mathematics and that only a few people have a 'mathematical mind' can damage positive self-confidence (Whyte & Anthony, 2012). A study confirmed that failure in mathematics was socially acceptable - participants were less embarrassed about the lack of mathematical skills compared to language skills (Latterell, 2005).

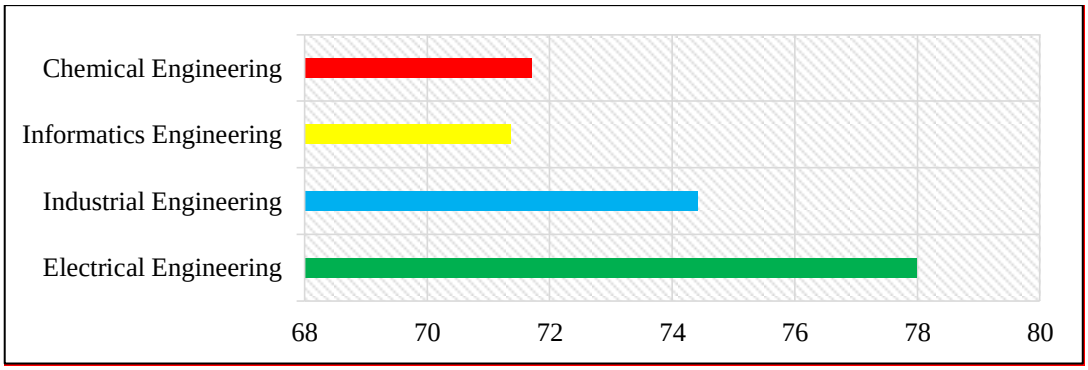

Figure 2. The society issues score

3.3. The classroom aspects: The traditional mathematics learning process and relationships between friends during learning

The classroom aspects discuss the traditional mathematics learning process and classroom culture, the experience of learning mathematics in classrooms, and the relationships between friends during learning. Here, most engineering students agree that mathematics is boring. However, although they also have difficulty in learning mathematics, they still want to learn mathematics successfully. Simple observation found that some the students feel boring because of lack of calculation activities, the students more interest in reading than count (Vitasari et al., 2010). Mathematics requires higher levels of concentration compared than other subjects (Rattan, Good, & Dweck, 2012). Figure 3 describes that electrical engineering students reach the top of the lowest classroom aspects to score in mathematics anxiety, which means that this factor does not give significant influence to them.

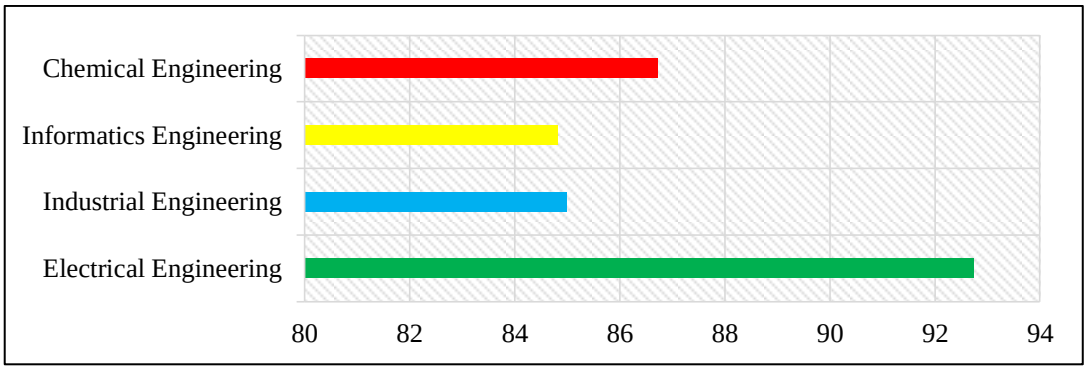

Figure 3. The classroom aspects score

Personal characteristics and academic variables have a rare influence on mathematics anxiety (Karimi & Venkatesan, 2009). Traditional teaching can contribute to mathematics anxiety and also class culture defined as the behaviors and norms that guide class interaction (Whyte & Anthony, 2012). Traditional teaching means teacher center learning with direct instruction without discussion. The experience of learning mathematics in a structured and rigid classroom includes several opportunities to debate or discuss, focus on finding the right answers, offer limited encouragement to reflect on thinking, expect quick responses, and emphasize the test of time (Shields, 2005). In such classrooms, the possibility of teacher's behavior implicitly grows students' mathematical anxiety (Mensah, Okyere, & Kuranchie, 2013).

3.4. The personal aspects: Physical and behavioral symptoms, perception of difficulty, and low motivation

The personal aspects consist of three issues, namely physical and behavioral symptoms, perception of difficulty, and low motivation. This aspect represented in 21 of 92 questions in the mathematics anxiety questionnaire. The problem started about the student condition during math class, such as my limbs trembled, sweated a lot, had difficulty breathing, my heartbeat fast, felt weak, and cold and hot contribute the significant score for engineering students mathematics anxiety. Students who are nervous, bored, afraid, or believe that mathematics is not essential; tend to avoid learning mathematics (Furner & Berman, 2003), yet want to get a satisfactory grade in mathematics. Overcoming this anxiety of the students for Mathematics is the real challenge of every lecturer and also made a good mathematics instruction to solve them (Mensah et al., 2013; Tanujaya, Prahmana, & Mumu, 2017). Figure 4 describes that electrical engineering students get the highest while informatics engineering students get the lowest of personal aspects to score in mathematics anxiety questionnaire. It means that the personal aspects contribute the weakest to the factors affecting mathematics anxiety for electrical engineering students.

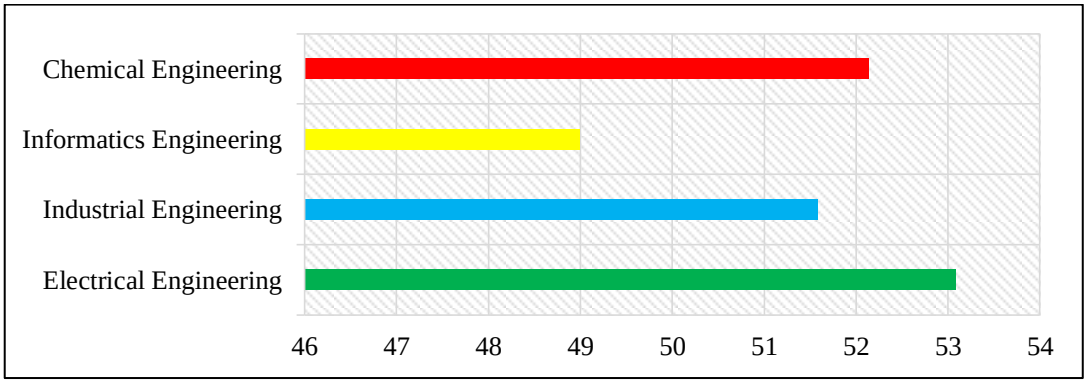

Figure 4. The personal aspects score

3.5. The differences effects of gender and engineering major towards mathematic anxiety

The differences in gender towards engineering students' mathematic anxiety were investigated. The results show that female engineering students more anxious than male engineering students as stated by Karimi & Venkatesan (2009). Female students may perform the same level as the male students when they are given the right educational tools and have visible excelling in mathematics (Else-Quest, Hyde, & Linn, 2010). Figure 5 shows that the male electrical engineering students get the highest and male informatics engineering students to get the lowest mathematics anxiety score in mathematics anxiety.

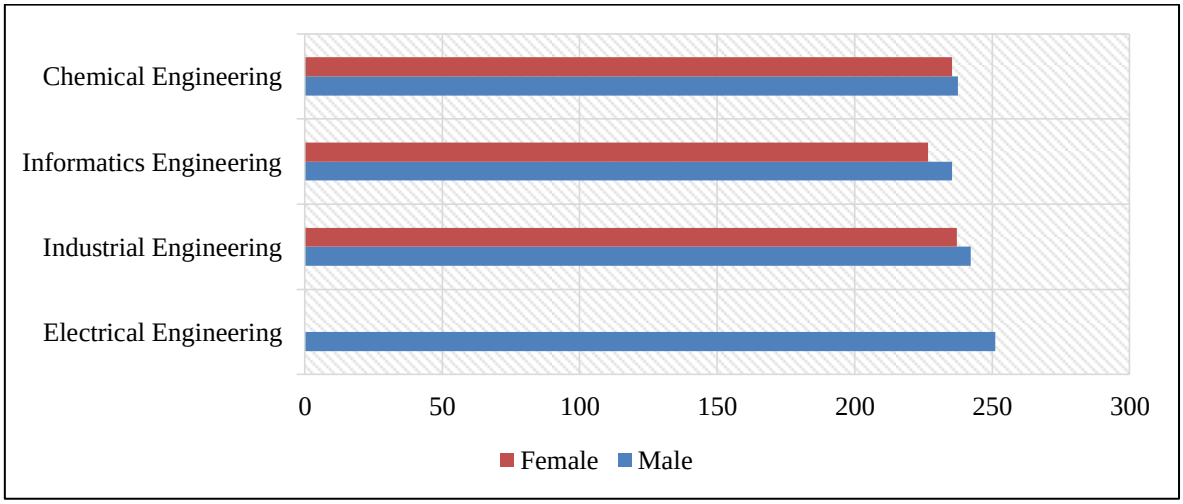

Figure 5. The differences effects of gender towards mathematic anxiety

The differences effects of engineering major towards mathematics anxiety were examined. Electrical engineering students get the highest score in 3 of 4 aspects that affecting engineering students' mathematics anxiety. It means that these aspects contribute the lowest to the factors affecting mathematics anxiety for electrical engineering students as showed in Figure 6.

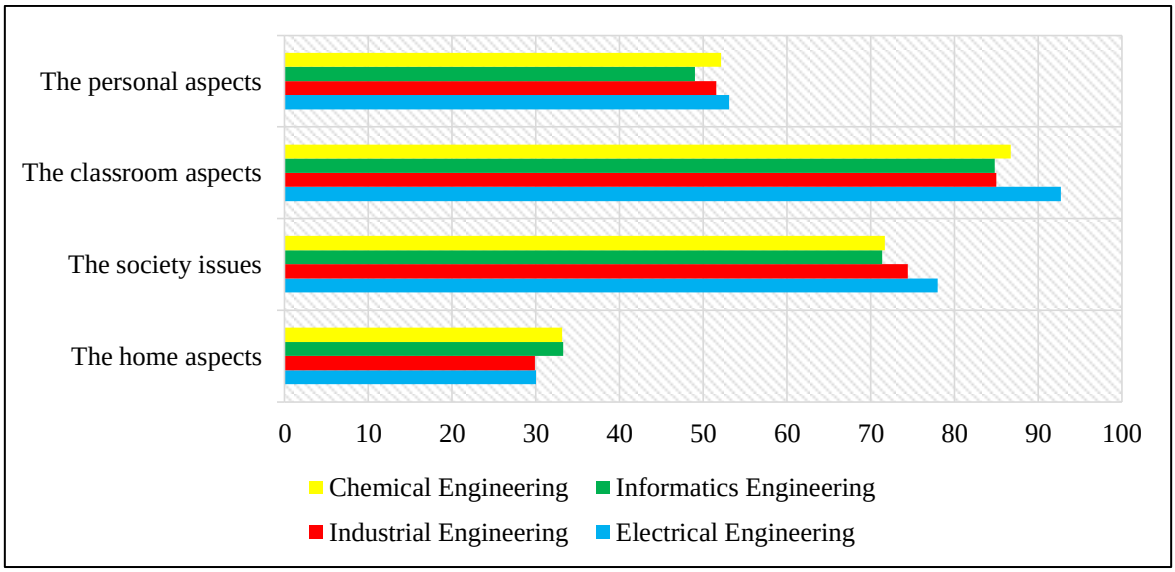

Figure 6. The differences effects of engineering major towards mathematic anxiety

4. CONCLUSION

Mathematics may cause learning anxiety among engineering students. Mathematical anxiety among engineering students is manifested in four aspects: personal, classroom, community, and home aspects. The difference in scores on mathematics anxiety found that females were more anxious than male students. Furthermore, informatics engineering has the highest level of mathematics anxiety compared to other department. Therefore, investigations to reduce mathematics anxiety must be sought to improve student academic performance. It can help engineering students overcome their fear and improve of the quality of learning mathematics. For better and more comprehensive research, further discussion of a mathematics anxiety should be focused on other majors, educational levels, and diversity of sources.

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