STEM Based Learning to Overcome Math Anxiety

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Abstract. Quality learning can be interpreted as learning that achieves learning goals through an effective, efficient, interesting and fun learning process. Low-quality learning is unpleasant learning so that the learning objectives are not optimally achieved. Math anxiety impacts students as early as the first grade by affecting their working memory. Working memory is like a ‘mental scratchpad’. This study is qualitative research that aims to determine the level of decreasing of mathematics anxiety (MA) in students' perspective at Elementary School level in Bukittinggi after they have learned with STEM-Based Learning. The subject of this study is 58 elementary school students. This research uses a qualitative descriptive method. The data collected by observation and using a MA Scale. The results showed that after applying STEM-Based Learning, the most decreased in students mathematical anxiety were anxiety about mathematical tests and anxiety about numerical calculations.

1. Introduction

Education is a social institution that serves the needs of the community to survive and develop. Good education is not only comprehensive, sustainable, and extraordinary, but also has to develop constantly to address the challenges of a rapidly changing and unpredictable global world. Therefore, school teachers, university professors, administrators, researchers and policy makers are those who are expected to be able to innovate in teaching and learning theories and practices, as well as all other aspects of this complex organization to ensure good quality of all students to live and work [1]. In Indonesia, student formal education starts at the elementary school level.

Primary school is the first formal education institution for students to learn basic concepts that support the development of cognitive aspects of students as a provision for the development of other aspects. The 2013 curriculum states that the approach used in schools is an integrative thematic approach [2]; [3]. Subjects taught, at the lower level (grades 1, 2, and 3) consist of mathematics, citizenship, language, and art. Mathematics is a subject given since elementary level. Mathematics aims to familiarize students with systematic, critical, logical, and rational thinking [3]; [4]. However, the paradigm that develops in society is that mathematics is a difficult, tedious lesson, many tasks and problems that complicate, and only certain people who can work on mathematical problems. The developing paradigms are not directly affected the students. A very real impact is the emergence of anxiety in learning mathematics or called Mathematics Anxiety (MA). Mathematics Anxiety (MA) is the condition of someone who feels tense, worried, and afraid of things related to mathematics [5]; [6]; [7]; [8]. Math Anxiety is a feeling of intense frustration or helplessness about one's ability to do math [9]; [10]; [11]. In this opinion it can be understood that the math anxiety is characterized by the emergence of frustration or despair in solving problems that require skills in mathematics. Tailor Manifest Anxiety Scale (TMAS) states that anxiety is a person's subjective feelings concerning mental
tension in the form of anxious feelings as a general reaction to the absence of security or inability to overcome a problem [12]; [13]; [14].

Students at school, during math lessons often do things that show symptoms of MA. These things, among others, are when working on the questions given, always asking the teacher or friend to make sure the answers they get are correct or not. When given a question, students tend not to dare to express their opinions and choose to be quiet, many students forget about the mathematical concepts that have been obtained during school. If the MA definition is reviewed, it is clear that students have an MA during the learning process.

This resulted in learning being ineffective and running monotonously. In addition, it also resulted in the learning objectives of mathematics being not achieved. The decline in mathematical performance and limited cognitive thinking ability is one of the negative effects caused by mathematical anxiety [4]; [15]; [16]. In addition, negative influences also have an impact on understanding certain materials in mathematics, such as arithmetic and geometry [17]; [18]. The mathematical anxiety criteria that are the reference in developing test instruments in this study are three, namely anxiety about mathematics learning, anxiety about math tests [19] and anxiety towards assignments and numerical math calculations [20]; [21]. These criteria refer to the Revised Mathematics Anxiety Rating Scale (RMARS) developed by Alexander & Martray (1989) on the scale of anxiety [22]. To assist teachers in overcoming the mathematical anxiety that arises during the learning process, knowledge is needed on how the level of mathematics anxiety (MA) students [23].

One of the efforts made to assist teachers in overcoming students' mathematical anxiety during the learning process is learning based on Science, Technology, Engineering, and Mathematic (STEM). STEM is a combination of four concepts of knowledge [24]; [25]; [26]. This approach has been used in America and has received great attention from experts in recent years. Americans strongly believe in the big role in STEM-based learning [27]; [28]. STEM has been developed in several countries for 3 decades and is increasingly significant in recent years. STEM education means to strengthen education practices in STEM fields separately, while at the same time developing an educational approach that integrates science, non-engineering, engineering, and mathematics, focusing on the educational process in solving real problems in daily life or professional life [29]; [30]. In the context of primary and secondary education, STEM education aims to develop students who are STEM literate. By applying the STEM approach in learning it is expected that it can lead to meaningful learning for students so that students' math anxiety can be overcome.

2. Method
The research method used is a qualitative descriptive method. This descriptive study aims to describe or describe the observed object as it is by not drawing conclusions or generalizations. The purpose of this study was to determine the effect of the STEM approach to the level of mathematics anxiety of the students of SDN 09 Manggis Ganting Kota Bukittinggi and classify it in the categories of high, medium, and low. The subjects of this study were students in grades 4, 5, and 6, total of them are 58 students. The MA Observations Scale List was prepared by referring to a standard MA Scale, such as the Math Anxiety Scale Revision (MAS-R), the Attitudes Toward Mathematics Inventory (ATMI), the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEQ), and the Cooke mathematics anxiety questionnaire [14]; [13]; [18] and consider various domains, symptoms, and causes of MA [21]. The MA questionnaire in this study was compiled based on three criteria, namely anxiety in facing mathematics learning, anxiety about mathematics tests and anxiety towards mathematical assignments and numerical calculations characterized by various domains, including cognitive, attitude, somatic, and mathematical representations [31]; [32]. Then each domain is broken down into several indicators which are then stated in statement items. The MA Questionnaire that has been compiled is validated by the expert using a validation sheet. Validation conducted is the validation of the format and language used in the MA questionnaire for students. We conducted MA tests performed on students in grades 4, 5, and 6 twice, before and after STEM based learning applied. The data analysis process was
carried out using Microsoft Excel and the results of the study were simplified in the form of high, low, or medium MA groups. The purpose of this grouping is to place individuals in tiered positions according to a series based on measured attributes [8]. Grouping is done by looking at the scores obtained by students.

Table 1. Student mathematics anxiety level group.

| Interval Score | MA Group |
|----------------|----------|
| MA Score < 70  | High     |
| 71 ≤ MA Score < 110 | Medium  |
| MA Score ≥ 110 | Low      |

3. Result and Discussion
To find out the MA level students are given an MA questionnaire that has been prepared previously. The MA questionnaire given to 58 students contained 40 statements (20 positive statements and 20 negative statements). Before getting STEM-based learning, the results obtained can be seen in Table 2.

Table 2. Analysis of the mathematics anxiety level questionnaire data before studying with STEM.

| Interval Score | MA Group | Frequency | Percentage |
|----------------|----------|-----------|------------|
| MA Score < 70  | High     | 15        | 25,9       |
| 71 ≤ MA Score < 110 | Medium  | 35        | 60,3       |
| MA Score ≥ 110 | Low      | 8         | 13,8       |

After the results are obtained, students are given STEM-based learning. Then the MA test was held again. The questionnaire data that has been obtained is then processed using the help of Microsoft Excel 2016 program. Based on the results of the MA questionnaire, the scores obtained are then grouped according to 3 categories. Interpretation of MA level scores can be carried out directly by changing the response of the research subject with a score of numbers. The results of the student MA level questionnaire after learning with STEM can be seen in Table 3.

Table 3. Analysis of the mathematics anxiety level questionnaire data after studying with STEM.

| Interval Score | MA Group | Frequency | Percentage |
|----------------|----------|-----------|------------|
| MA Score < 70  | High     | 6         | 10,3       |
| 71 ≤ MA Score < 110 | Medium  | 32        | 55,2       |
| MA Score ≥ 110 | Low      | 20        | 34,5       |

High and low levels of MA students are influenced by several factors, one of which is negative attitudes toward mathematics. This negative attitude can be formed due to the teaching techniques used by the teacher in teaching mathematics, including the selection of the approach used. Therefore, the teacher plays an important role in creating, preventing, or reducing MA. In addition to the MA test, the student was also interviewed. Interviews are conducted with the aim of finding more in-depth information about MA factors that occur in students. Questions given to students relate to things that make students feel uncomfortable when studying, examining, and when working on assignments that involve numerical calculations. Students at the high MA level often feel insecure when asked by the teacher due to lack of understanding the material, when asked to present the class often feel nervous and stammer when explaining. They are afraid that what is explained is not in accordance with what the teacher wants and is afraid of other friends laughing. When the teacher gives questions that require
numerical calculations, they cannot answer because they forget what mathematical procedures and which concepts should be used. During the exam, they work the questions very carefully and try hard to be able to answer all the questions correctly, they are afraid to make mistakes. This is due to a strong desire to get perfect grades. In addition, they feel nervous if given an impromptu test because they feel they will not be able to answer the questions given.

After getting STEM-based learning, research and interviews were conducted in line with observations for three months. We found that symptoms of MA were reduced both during the learning process and when given the exam. When the teacher gives a question, the class becomes noisy because students scramble to answer questions, some of them were flip notes, and answer with enthusiasm. Some students have started to dare to express their opinions, although they are still nervous. This in line with Fantuzzo’s research that found almost 32% of students got their self-confidence after experiencing STEM based learning [29]. When asked to present answers in front of the class, students begin to believe in what must be said and sometimes glance at friends as if they want to find support that what is explained is correct. The frequency of students who want to answer questions has increased. The more obvious thing when given a math test, there was no sound of breath and complaints after seeing the exam question sheet. The symptoms of the MA that still appear are the hand movements that play the pen and there are still students who rub their heads while remembering the concept of the lesson learned.

Based on the explanation, it can be concluded that with the STEM approach, the MA level of students when given a test is decreased and the ability to do tasks that require numerical calculations increases. This results in the value of learning outcomes that they obtained. Based on the average value of learning outcomes, it is known that students who are classified as high and low MA have low average learning outcomes, whereas students who are classified as MA have a good average learning outcomes. MA becomes one of the key factors that can affect the academic results of student participants. Furthermore, it is also known that students with a low MA learn without burden because there is no pressure both from within themselves and family. When working on tasks that involve numerical calculations or during tests, they only answer as best they can. They don't think about the value that will be obtained either or not. Students with medium MA, sometimes feel nervous when asked or asked to explain in front of the class. However, they can handle it well. When given numerical calculation tasks, they prefer to do it themselves or ask for help from others only if necessary. In stable conditions the MA can be profitable. This means that when the MA level is at a moderate level, MA can actually be a factor that can encourage learning motivation. Conversely, if the MA is in an unstable condition, namely the MA level is too high or too low, then the MA will be an inhibiting factor in achieving learning outcomes as expected [30]; [33].

4. Conclusion

Based on the results of the research and discussion that have been described it can be concluded that after learning with STEM-based learning, there were 34.5% of the 58 students of SDN 09 Manggis Ganting Bukittinggi at the MA level in the low category, 55.2% of students were in the MA medium category, and 10.3% of students are at the high level of math anxiety. The most decrease of mathematical anxiety criterion are anxiety about math tests and anxiety about mathematical assignments and numerical calculations. By knowing the reduction in MA level of students of SDN 09 Manggis Ganting Bukittinggi after learning with STEM, teachers as organizers can choose STEM based learning as one of the learning techniques to encourage students to learn better, especially in mathematics. The goal is that students no longer consider mathematics to be a difficult and frightening subject.

5. Reference

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