Student mathematical anxiety: investigation on problem based learning

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Abstract. Problem-based learning is an alternative for students to exercise problem-solving ability. During the mathematics learning process, students also experience mathematics anxiety which prevents them to perform well. This study aims to explore the students' mathematics anxiety in the problem-based learning process. Based on previous studies, problem-based learning was designed to reduce mathematics anxiety. This research is qualitative research with a phenomenology approach. The phenomenological research was examined based on the experience of the participants attending the mathematics classes with problem-based learning. In this study, we chose the subjects by considering the results of mathematics anxiety tests and students' physical characteristics that indicate the occurrence of mathematical anxiety. The results found that students with high and moderate mathematics anxiety showed physical characteristics of mathematical anxiety observed during the problem-based learning process. After conducting in-depth interviews with the subjects, it was found that they had difficulty with the mathematics problems given. Finally, we concluded that the selection of mathematical problems given with the hope that it will reduce mathematical anxiety turns out to cause mathematical anxiety. It then affected their work that has not succeeded in solving the mathematics problems.

1. Introduction

There are several factors preventing students to perform well in mathematics learning. One of them is math anxiety. Math anxiety occurs when students face to numerical problems. These numerical problems are not the main factors in learning mathematics. It is influenced by emotional attitudes, in this case, mathematical anxiety [1]. Mathematical anxiety is influenced by emotional aspects, such as feelings of apprehension, dislike, tension, worry, frustration, and fear, and it is experienced when performing mathematical tasks [2]. Children’s capability for improving their math skills is contingent on children feeling comfortable with mathematics in general as well as using the novel and cognitive demanding strategies they are taught [3]. The emotional condition of students who have negative perceptions of mathematics causes failure to learn mathematics. Mathemaphobia is one of many concerns during these years causing so many failures in mathematics classes [4].

School counsellors have often been approached by students and teachers who desire new avenues of increasing mathematical problem-solving performance [5]. Anxiety can affect student performance in the classroom [6]. There is also some lack about the possible causes of math anxiety in children,
suggested causes include teacher anxiety, societal, educational or environmental factors, innate characteristics of mathematics, failure and the influence of early-school experiences of mathematics [7]. Math anxiety can be defined as a feeling of tension, apprehension, or even dread that interferes with the ordinary manipulation of numbers and the solving of mathematical problems [8]. Problems in mathematics are interpreted as a situation where a person cannot answer questions/test in a way or habit that applies [9]. There is a relationship between mathematical anxiety and mathematical problem solving [10]. Mathematics problem solving and mathematical anxiety can be defined as feelings of nervousness associated with situations both in and out of school that require students to solve math problems and use the solutions in some way [11]. Higher achievement consistently accompanies reduction in mathematics anxiety [12]. So it becomes important to improve the skills and processes of mathematic abilities.

Mathematics consists of skills and processes [13]. The characteristic of mathematic can be facilitated with problem-based learning (PBL). Students should be able to formulate a temporary answer to a problem requiring logical intelligence, courage and active solution within real situations [14]. PBL is an inquiry teaching strategy related to project-based instruction in which students are given real-world situations or students authentic and meaningful problem situation and asked to offer insights regarding or solutions [15, 16]. The student takes the initiative to construct knowledge and effectively develop the solution to a problem by providing the necessary resources, guidance, and opportunities for exploration and they could obtain meaningful connections between the content and the problem which is hidden in scenario [17, 18]. The problem on PBL is non-routine problem, that is not directly determined the methods in solving the problem. It takes a reasonably mature thinking process, thereby students will grasp the purpose of the problem given [19]. Through solving of problems, learners get the opportunity to discover mathematics creatively and to think independently [20].

Mathematics educators need to recognize the causes of math anxiety [21]. Problem-based learning is designed based on the reasons why math anxiety affects students. Problem-solving becomes an approach to mathematics learning. Japanese problem-solving approach in mathematics classes is comprised of both individual solving of an unknown problem using students’ previous knowledge (known or learned), as well as a whole classroom work (communication or dialectic discussion) that utilizes individual ideas used in their problem solving [22]. It is also necessary for effective teachers to inquire into new teaching strategies to improve pupils’ attitudes, and performances in mathematics to enhance their success, it is important to get their views on how they design their lessons and what they do to reduce mathematics anxiety in the pupils in their classes. The teaching of problem-solving by asking stimulating questions could stimulate learners’ curiosity to solve mathematics questions, and eventually reduce mathematics anxiety [23]. Based on the description above, in this study, we want to find out the students’ mathematical anxiety during their participation in mathematics problem-based learning.

2. Method

This research used qualitative research methods with phenomenology approach. Are used to examine the natural conditions of objects [24] and the phenomenology is known as an educational qualitative research design [25]. To accurately describe the scaffolding or staging of phenomenology we used the transcendental phenomenology, it analyzes the essences perceived by consciousness concerning individual experiences [26]. The subjects in this study were high school students with a total of three participants. The selection of participants is based on the results of mathematics anxiety tests then based on the physical characteristics of students when the problem-based learning process takes place. The instruments used were questionnaires and tests. The questionnaire is given to students before the problem-based learning process is carried out. This research begins with preparing all the prerequisites for the research, conducting research and the process of collecting data in the form of observation, interviews, and documentation. Indicators of mathematical anxiety in this study are students’ mood, motoric, cognitive, and somatic condition [27]. Meanwhile, the categories of math anxiety are mild anxiety, medium anxiety, high anxiety, and panic [28].
3. Result and Discussion
The purpose of this phenomenology research was to determine and identify math anxiety on problem-based. Before the problem-based learning process was carried out 33 students were given a math anxiety questionnaire to find out the extent of their math anxiety. From the results of the questionnaire given 60% of students experienced medium anxiety, 40% experienced high levels of anxiety. To explore the students’ learning experience, we determined three subject students to look at mathematics anxiety in the problem-based learning process, we determined it based on the results of the mathematics anxiety test.

Table 1. Math anxiety score

| Subject | Score | Category             |
|---------|-------|----------------------|
| S1      | 129   | High math anxiety    |
| S2      | 108   | Medium math anxiety  |
| S3      | 104   | Medium math anxiety  |

Other reasons learners experience mathematics as challenging could include poor teaching methods and the abstract nature of mathematics, which could eventually lead to mathematics anxiety. An alternative to reduce math anxiety is meaningful mathematics, preparedness, practice and intervention, teachers, group work, basic principles of mathematics, self-directed learning, motivation, reduced workload and psychological preparation [23, 29]. The problem-based learning process is prepared by researchers as a way to reduce students’ math anxiety. Problem-based learning with the theme of linear programming is carried out in four meetings. Table 2 presents the results of observations during the learning process.

Table 2. Observation of math anxiety

| Math Anxiety Indicator | Meeting I | Meeting II | Meeting III | Meeting IV |
|------------------------|-----------|------------|-------------|------------|
|                        | S1  | S2  | S3  | S1  | S2  | S3  | S1  | S2  | S3  |
| Mood                   |    |     |     |    |     |     |    |     |     |
| 1. Students look nervous | ✓  | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| 2. Students look scared |    |     |     |    |     |     |    |     |     |
| 3. Students look tense  | ✓  | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| Motoric                |    |     |     |    |     |     |    |     |     |
| 1. Students’ voice stammers | ✓  |     |     | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| 2. Students’ body trembles | ✓  | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| 3. Students are in a hurry | ✓  | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| Cognitive              |    |     |     |    |     |     |    |     |     |
| 1. Difficult to concentrate | ✓  | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| 2. Look confused        | ✓  | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| 3. Forget many things   | ✓  | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| Somatic                |    |     |     |    |     |     |    |     |     |
| 1. Students get tired quickly | ✓  | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| 2. Students sweat excessively | ✓  | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| 3. Students look dizzy  | ✓  | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |

Based on Table 2, the results of direct observation towards each student shows math anxiety at each learning meeting. S1 experiences more signs of anxiety when compared with S2 and S3. But this is different from the results obtained by the questionnaire score that is the category of anxiety is the same as S2. This can occur in the problem-based learning process. Other researchers have described these factors as non-cognitive skills; we broaden the term to non-cognitive factors to go beyond a narrow
reference to skills and include strategies, attitudes, and behaviours [30]. Studies of mathematical problem solving and achievement should continue to emphasize non-cognitive, as well as a cognitive factor [31]. When combined with an awareness of analogous relations among problems, schemas can influence behaviour in a broad set of situations of roughly comparable complexity and, thereby, affect the breadth of learning [32]. Anxiety factor becomes non-cognitive which is predicted to influence student mathematics learning outcomes.

The results of student work are linear program material based on math anxiety, as presented in Figure 1.

![Figure 1. The work of the student with high math anxiety (S1)](image)

Based on Figure 1, it can be seen that the work of the S1 with high math anxiety. The purpose of the test is to find out the mastery of the concept of maximum and minimum values. The results of the answers indicate that S1 does not understand the problem. So that the impact on how to complete the answer, immediately carry out the calculation process and solve the problem very briefly and is presented without a review process to see the answers made right or wrong. Prior math achievement was also the strongest predictor of math anxiety [33]. This can happen because of the situation in the learning process. Math anxiety usually comes from negative experiences in working with teachers, tutors, classmates, parents or siblings when learning math in the classroom or at home [34, 35]. Environmental factors produce the highest level of Math anxiety level among students. It shows that it is in the home and the classroom of the respondents displays very high math anxiety [36].

The subject does not write down the important things about the problem. But, subjects were not able to explain when in the interviews. The interview result with S1 is presented below with R refers to us as the interviewer.

R : Do you have any information about the problem?
S1 : I answer according to what I know. I am thinking of finding the value of each variable
R : how to solve the problem?
S1 : Looks for values of variables x and y
R : Do you need to graph it to get the maximum value or the minimum value?
S1 : No.

From the interview, it can be seen that the subjects stated that they did not understand enough information about the problem. S1 can't solve the problem correctly. At the time of the S1 interview, anxiety was very much following what was observed during the problem-based learning process.

The answer to students with medium math anxiety (S2) is presented in Figure 2.
According to Figure 2, S2 looked for points to find the minimum value. But not all steps to complete are passed by S2, the example is a graph. While determining the minimum point, there must be a graph so that the minimum point accuracy can be seen. The interview result is presented below.

**R**: Do you have any information about the problem?
**S2**: Yes, I understand the steps to solve the problem. I finished according to the example problem yesterday.

**R**: How to solve the problem?
**S2**: I determine all the intersecting lines with the X and Y axes (0,6), (6,0), (0,5), and (7.5,0).

**R**: Do you need to graph it to get the maximum value or the minimum value?
**S2**: No.

The next is the answer of the student with medium math anxiety (S3). Based on the sequence of S3 solutions according to the class explanation, begins by defining the X and Y axes and then drawing a graph to find the solution. The points specified by S3 are incorrect but the minimum answer is correct. The details are illustrated in Figure 3.
Figure 3. The work of the student with medium math anxiety (S3)

R : Do you have any information about the problem?
S2 : I know all the information needed to solve the problem.
Look for all dividing lines when cutting the Y-axis, and
Look for all dividing lines when cutting the X-axis.
R : How to solve the problem?
S2 : The most important thing to solve the problem is to draw a graph to
determine the maximum and minimum values first.
R : Do you need to graph it to get the maximum value or the minimum value?
S2 : Yes.

4. Conclusion
Math anxiety is how students’ lack of confidence in academic performance and is a serious obstacle for
many children. Mathematical anxiety plays an important role in problem-based learning. In essence, the
problem-based learning process is prepared to reduce math anxiety, but in reality, the problem-based
learning that is carried outputs a mental burden on students. Problem-based learning by providing non-
routine problems causes students to become more anxious. So it needs more planned preparation so that
students can be emotionally awake even though students are given non-routine problems.

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