Comparison of Mathematical Resilience among Students with Problem Based Learning and Guided Discovery Learning Model

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Abstract. Mathematical resilience is very important thing in learning mathematics. It is a positive attitude in order to make student not easily give up in the face of adversity when solving mathematics problems through discussion and research about mathematics. The purpose of this study was to examine comparison of mathematical resilience among students receiving problem based learning model and the students who received guided discovery learning model. This research was conducted at one junior high school in Jakarta. The method was used in this study is quasi-experimental with 66 students as the samples. The instrument which was used in this research is mathematical resilience scale with 24 items of statements. The result of this research is mathematical resilience between the students who received problem based learning model is better than the students who received guided discovery learning model. According to this study result the authors presented some suggestions that: 1) problem based learning and guided discovery learning model can both develop mathematical resilience, but problem based learning is more recommended to use, 2) in order to achieve mathematical resilience better than this findings, it needs to do the next research that combine problem based learning with other treatment.

1. Introduction
The mathematical skills that will be reached in the learning of mathematics include understanding mathematical concepts, reasoning patterns, solving problems, communicating mathematical ideas, and making mathematical connections in the form of daily problem solving using mathematical concepts. Learning mathematics should develop students into: (1) knowledge builders; (2) complex, creative, and flexible thinkers; (3) creative and innovative problem solvers; (4) effective communicators and collaborators; and (5) Optimistic learners who do the learning process [1]. Mathematics learning is also expected to produce learners who have an attitude of appreciating the usefulness of mathematics in everyday life, tenacious and confident in solving problems. Mathematics learning becomes very important because in the learning process, teachers are required to implement quality teaching process so that the mathematical skills of hard skill or soft skill are expected to be realized.

One of the soft skills to be achieved in mathematics learning is mathematical resilience. Mathematical resilience is one’s diligent and persistent attitude in the face of adversity in mathematics. Mathematical resilience is a quality attitude in learning math to: be confident of its success through hard work, showing diligence in the face of adversity, the desire to discuss to everyone in learning process, and research something related to mathematics [2]. A person who has good mathematical resilience will stand it when faced with difficulty in solving mathematical problems because he
mastered the theory of mathematics learning. The mastery of mathematics learning theory along with strong resilience then the problem will be immediately solve. A person with high mathematical resilience is also able to interact and work with math in groups. This indicates that a person with high mathematical resilience is able to build social relationships with others, be able to learn in groups, and discuss about something in order to construct their knowledge independently while studying in the classroom. That’s why mathematical resilience is an important thing in learning mathematics.

There are several indicators to construct mathematical resilience scale, including: 1) be diligent, confident, and not easily give up facing problems and failure, 2) desiring to socialize and discuss with the environment, 3) using the experience of failure to build self-motivation, and 4) show desire to find their own learning resources through ICT, internet, and books before asking friends or teachers, and 5) not afraid to try new ideas to solve mathematics problems [3]. These indicators refer to 3 aspect, they are value, struggle, and growth. There are several resilient indicators that can be used to develop the mathematical resilience scale, they are: 1) recognize the value of mathematics in everyday life both within and outside the academic context, 2) understand that effort is needed to develop a mathematical concept, 3) understand that perseverance (endurance) is necessary to develop a mathematical concept, 4) understand that curiosity is needed to develop a mathematical concept, and 5) believing that the ability to learn and master mathematical concepts is not static and limited to only a handful of people [4].

There are 4 factors that influence mathematical resilience, they are: 1) convinced that the ability of the brain to grow, 2) understand the ability of mathematics yourself, 3) understand about how to work with mathematics, and 4) awareness of support available from colleagues-mates, other more mature people, ICT, and the internet [5]. Therefore, the development of mathematical resilience through the learning of mathematics in the class should take into account the factors that have been stated previously. The intended mathematics learning is learning by interaction with others through discussion and utilization of learning resources.

Learning that is considered able to accommodate the development of students’ mathematical resilience is problem based learning model. This learning provides an opportunity for students to independently discover mathematical concepts through group discussion activities. In the group discussion activities are presented contextual problems that require students to interact with peers in the group in the discussion. The previous study revealed that one of the advantages of PBL is to generate motivation in students because students feel the problem and try hard to find a solution [6]. This indicates that the student has persistence or perseverance that generates high motivation to solve math problems. In other words, PBL is supposed to improve students’ mathematical resilience. In line with another finding that PBL is an effective method for improving K–8 students’ science academic achievement, including knowledge retention, conceptual development, and attitudes [7].

PBL is learning with problem solving approach. Students have to solve some problem given by teacher. This activity can improve students’ confidence and reduce math anxiety because their work together to solve the problem. This is in line with another finding. The strategies that teachers use when teaching problem solving develops self-confidence, regulates emotions of mathematical anxiety and struggles to succeed, remains persistent by struggling in solving problems, uses resources around the classroom, and clears misconceptions and incorrect solutions [8].

There are 5 stages of problem-based learning. This learning stage involves the process of interaction between students, teachers, and learning environment. Stages of problem-based learning are 1) student’s orientation on the problem. In this stage the teacher explains the competencies and indicators to be achieved, explains the logistics required, proposes phenomena or demonstrations or stories to raise issues, and motivates students to engage in problem solving 2) organize students to learn. In this stage the teacher helps students define and organize learning tasks related to problem, 3) guide individual and group investigations. In this stage the teacher motivates students to collect information, to discuss it to others in order to solve the problem, 4) develop and present the work. In this stage the teacher helps students to plan and prepare the results of discussion or problem solving results, and 5) analyse and evaluate the process of problem solving. In this stage the teacher helps students to do some reflections or evaluations about their investigation and some processes that they used during the lesson [9].
Guided discovery learning is a learning activity designed so that students can find independently concepts or principles through the mental process. The mental process can be observe, classify, make allegations, explain, measure, makes conclusions and so on. There are stages on guided discovery learning model are: 1) motivation, 2) exploration activity, 3) presentation, 4) practice, and 5) evaluation [10]. Guided discovery learning model can be implemented in 6 stages, they are: 1) learning objectives explanation, 2) problem orientation, 3) hypotheses formulation, 4) discovery activity, 5) presentation of findings, and 6) evaluation [11]. Based on the explanation that have been described below, the stages are stimulation, exploration, verification, and generalization.

One of study about guided discovery reported that student’s ability of observation, discussion, and acquisition are improved with guided discovery learning [12]. The improvement of discussion indicates the improvement of mathematical resilience. Another study by Achera,et.al. showed that the performance in geometry of those students taught using guided discovery was significantly higher than those student taught using traditional lecture approach.

Mathematical resilience is important attitude to enhance students’ motivation in order to improve their performance in mathematics. Therefore, the urgency of this study is to see whether there is a difference in mathematical resilience of students between students studying with problem-based learning model and guided based learning model.

2. Experimental Method

This research is a quasi-experimental research with pretest-posttest two treatment design. The design of the research show as follows [13].

| Kelas Eksperimen 1 | O | X₁ | O |
|-------------------|---|----|---|
| Kelas Eksperimen 2 | O | X₂ | O |

Descriptions:
X₁ = Treatment (learning with problem based learning model)
X₂ = Treatment (learning with guided discovery learning model)
O₁ = Measurement of mathematical resilience (in groups with problem based learning model)
O₂ = Measurement of mathematical resilience (in groups with guided discovery learning model)
----: The subject is not grouped randomly

The population in this research is all students of the eight grade of elementary school in Jakarta. The number of sample in this research is 66 peoples. The sample was taken through purposive sampling technique. One class by the number of student as many as 33 students selected as the first experimental groups who had taught with problem based learning model and also selected one class by the number of students 33 students as the second experimental groups who had taught with guided discovery learning model.

The data were collected by using mathematical resilience scale that consist of 24 items of statements. The scale was developed by Kooker, et. al. it is obtained from research development result. It measures 3 aspects: 1) value; it is addresses that math is essential for future success, 2) struggle; it is belief that experiencing challenges and difficulties is a normal part of working on math, and 3) growth; it refers to the belief that math can be learned by anyone and it is not limited to those with a predisposition or “math gene”[14]. The mathematics resilience scales consist of 8 statements of value aspect, 9 statements of struggle aspect, and 7 statements of growth aspect. There are 18 positive statements and 6 negative statements.

Polyhedron chapter is used in this research. The content of polyhedron in this research are consist of: 1) the surface area of cuboid, 2) the surface area of cube, 3) the surface area of prism, 4) the surface area of pyramid, 5) the volume of cuboid, 6) the volume of cube, 7) the volume of prism, and 8) the volume of pyramid.
There are 8 meetings of learning process in every experimental group. The first experimental group is given problem based learning model and the second experimental group is given guided discovery learning model. After that, both groups are given post response in form of mathematical resilience scale. The collected data was then viewed by each presentation of the frequency of the two classes based on the mathematical resilience indicators in order to see the description of mathematical resilience in each group. Because of the data obtained is ordinal data then Mann Whitney U test is used to test the difference in the sum of rank scores. After that, the researcher analyse the data to make conclusions.

3. Result and Discussion

The following table depicts the recapitulation of average percentage of students in achieving mathematical resilience both experimental groups.

| Indicators                                      | Group    |
|------------------------------------------------|----------|
| recognize the value of mathematics in everyday life both within and outside the academic context | PBL 84,38% | GDL 78,13% |
| understand that effort is needed to develop a mathematical concept | PBL 93% | GDL 89% |
| understand that perseverance (endurance) is necessary to develop a mathematical concept | PBL 60,33% | GDL 64,67% |
| understand that curiosity is needed to develop a mathematical concept | PBL 90,50% | GDL 89,5% |
| believing that the ability to learn and master mathematical concepts is not static and limited to only a handful of people | PBL 44,86% | GDL 47,43% |

From the above table it is known that the average percentage of students in the achievement of mathematical resilience who obtained the model of problem based learning model is superior in 3 indicators compared to guided discovery learning model. The indicators that problem based learning group is superior are: 1) recognize the value of mathematics in everyday life both within and outside the academic context, 2) understand that effort is needed to develop a mathematical concept, 3) understand that curiosity is needed to develop a mathematical concept. This means that problem based learning train students to strive and have a high curiosity in finding new knowledge or solving math problems and also makes students realize that mathematics is one of tool for solving everyday problem.

To analyze is there any difference between mathematical resilience in both groups or not, especially which one better, the researcher used Mann Whitney U Test using 1-tailed test. The hypotheses proposed are:

$H_0$: the sum of rank score of mathematical resilience between students who had taught with problem based learning is not better than guided discovery learning model
H₁: the sum of rank score of mathematical resilience between students who had taught with problem based learning is better than guided discovery learning model.

The decision making criteria in level of significance α = 0.05 are: 1) Asym.Sig (2-tailed) > 0.05 then H₀ accepted, and 2) Asym.Sig (2-tailed) < 0.05 then H₀ rejected.

The following table presents the hypothesis test.

Table 2. The Result Test of Mann Whitney U

| Groups          | n  | Mann Whitney U | Z    | Asym.Sig (2 tailed) | Conclusion |
|-----------------|----|----------------|------|---------------------|------------|
| First Experimental | 33 | 281021,000     | -3.871 | 0.000               | Reject H₀  |
| Second Experimental | 33 |                |      |                     |            |

Table 2 shows that Asym. Sig (1-tailed) = 0.000 and it is less than 0.05, so H₀ is rejected. It means that H₁ accepted, in other word the achievement of students’ mathematical resilience who received problem based learning model is better than who received guided discovery learning model. This is because of: 1) In the phase of organizing students on problems in the problem based learning model, students are required to recognize the value of mathematics in everyday life. This is reflected in the students’ activities in formulating the problem into the mathematical model. This activity can make students realize that mathematics is a very valuable tool to solve problems in everyday life. In addition, the dish of relatively difficult problems in problem based learning challenges students to have a high curiosity in every solving problem activity. This is in line with Rusman’s opinion which states that the problems given in the problem based learning challenge students’ knowledge, attitudes, and competencies that then require the identification of learning needs and new areas of learning [15].

2) Learning mathematics with problem based learning model makes students more empower all their ability to construct new concepts and solve problems so that students in problem based learning group realize that effort is needed to develop mathematical concept. Unlike problem based learning group, guided discovery learning group the students are directed or guided by the teacher in finding concepts and solving problems. This makes students more dependent on teachers, lacks in effort to construct the concept independently and low curiosity so that the achievement of low mathematical resilience on indicators related to cause.

4. Conclusion
Based on the results, it can be drawn conclusion that there is difference between first experimental group and second experimental group. The achievement of mathematical resilience between students who had taught with problem based learning is better than guided discovery learning model. Its means that problem based learning model is better than guided based leaning in order to enhance mathematical resilience. So the use of problem based learning model has a significant effect on students' mathematical resilience on polyhedron material for junior high school students.

According to this study result the authors presented some suggestions that: 1) problem based learning and guided discovery learning model can both develop mathematical resilience. But in order to reach better mathematical resilience, problem based learning more recommended to use, 2) in order to achieve mathematical resilience better than achievement in this research, it needs to do the next research that combine problem based learning with other treatment.

Acknowledgments
We thank all students and teacher for supporting us to collect the data in this paper. We really appreciate your support.

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