The mathematical problem-solving ability of junior high school students based on their mathematical resilience

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Abstract. This research aims to describe the mathematical problem-solving ability of grade VIII students at State Junior High School in Sragen Region and found the patterns of mathematical problem-solving abilities that were analysed based on students’ mathematical resilience. The method used in this research was descriptive quantitative research with 153 students as the samples. Data were collected using a questionnaire and a written test. The results of the research give an overview that mathematical problem-solving ability of students has high resilience level of mathematics which can deal with and be able to overcome obstacles and negative situations related to the problem-solving process because they can successfully coach themselves. Students who are given non-routine mathematical problem show differences in their mathematics problem-solving based on levels of mathematical resilience.

1. Introduction
The concept of mathematics education in the 21st-century is oriented on mathematics literacy, that is the ability of individuals to identify and understand the role of mathematics in life, to be able to make informed decisions and utilize mathematics in life as constructive, caring and reflective citizens [1]. Moreover, partnership of 21st-century Skills which is an educational institution based in Tucson, Arizona, United States, identified that students in the 21st-century must be able to develop the competitive skills which focus on high-level thinking skills (higher order thinking skills) development, includes critical thinking, problem-solving, information literacy, information and communication technology literacy. Those abilities can be developed through learning, especially mathematics. Mathematics can be basic knowledge and the formation of a mindset for students to make them ready to face future demands. National Council of Teacher of Mathematics (NCTM) in 2000 formulated mathematical learning power included problem-solving, reasoning and proof, communication, connection, and representations [2]. NCTM places problem-solving as the first order in mathematics learning.

But ironically, Indonesia is still one of the countries that have problems in education, especially in mathematics subject. Based on data from several international research, mathematical thinking skill needs to be improved. Data results of Trends in International Mathematics and Science Study (TIMSS) show that the average score of mathematics achievement in Indonesia is 397, still below the international average value [3]. Besides that, data of Programme for International Student Assessment (PISA), Indonesia is at 63rd out of 69 countries. The mathematics literacy score shows 386, below the international average score which is 500 [4]. The measurement of PISA and TIMSS achievements
obtained by students in Indonesia is similar to the results of the national examination of Junior High School students.

In this research, the problem was found in Sragen Regency, Central Java. The results of mathematics national examination of Junior High School in Sragen Regency for the past three years is shown in Table 1.

**Table 1. The result of mathematics national examination in Sragen Regency in 2016, 2017, 2018.**

| Average Result of Mathematics UNBK in Sragen Regency | 2016 | 2017 | 2018 |
|-----------------------------------------------------|------|------|------|
|                                                     | 44.35 | 49.22 | 46.08 |

Based on Table 1, it is shown the results of the Mathematics National Examination of Junior High Schools in Sragen Regency for the last three years, it can be seen that the results of the national examination score have increased in 2017, then in 2018 the result of national examination scores was decreased. The results of semi-structured interviews from two schools in Sragen Regency, that was interviews with mathematics teachers and some students in grade IX, some information was obtained related to the implementation of mathematics learning. Those things include learning and solving mathematical problems. Students find it difficult to translate the mathematics problem that is usually shown by mistakes in interpreting the question language, especially if non-routine story questions. Most students find it difficult in using the principles including the student’s ambiguity in determining the paths in solving problems. Besides, there are some students who still think that learning is not a need that has to be done because learning mathematics is still lacking in daily life, the students are given examples of questions and practice questions that almost the same, students are less able to solve mathematical problems because they are not used to practice with various questions.

As mentioned by Ms. Handayani, a teacher of mathematics at State Junior High School 2 Sambirejo in this occasion have a statement if the lack of students ability to solve mathematical problems is usually because the students are less understand the problems in the questions and less understand the problem-solving procedures. Similar with these findings Buschman, entitled “Teaching Problem Solving in Mathematics” explained the causes of students difficulties in mathematical problem solving are the lack of students primary skill; lack of mathematical literacy skills [5]. The learning model applied by the teachers is not right, the teachers do not see differences in student skills, the teaching skills in problem-solving is also lack. In fact, problem-solving is considered as the heart of mathematics learning because the skills are not only to learn the subject but also emphasize the development of thinking skills methods.

Problem-solving is the process of applying the knowledge that has been obtained by students into a new situation and is also an important activity in mathematics learning because the learning aims to be achieved in problem-solving is related to everyday life [6]. Problem-solving is not only skill to be taught and used in mathematics but also a skill that will be brought to the students daily problems of or decision-making situations, thus problem-solving skills help a person well.

Factors that can influence the achievement of mathematical problem-solving skills are not only from the learning model and intelligence or intelligence quotient level. There are other factors such as learning motivation, learning activities, the habit of mind, emotional quotient, mathematical disposition, mathematical resilience, and others. Mathematical resilience is one of the factors that have a role in supporting student achievement, students who have perseverance have more chance to succeed than students who are lazy. Students who have perseverance are more able to face difficulties than students who easily give up, so they have more opportunities to maintain their achievements. Therefore, it is important for us to know how are the differences and which give students the ability to solve problems better among students who have high, medium, or low mathematical resilience. In this research, indicators of mathematics problem-solving skills were synthesized from Polya. Mathematics problem-solving skills indicators include a) understanding the problem; stating the problems with their own words, finding the information, c) carrying out the plan; executing the plan that has been made, and d) re-examining the obtained result [7]. In the mathematical concept, mathematical resilience as a quality
attitude in mathematics learning that includes confidence in its success through hard work; show the diligence in facing difficulties; wants to discuss, reflect, and research. Resilience allows students to solve obstacles in learning mathematics [8]. This factor must be noticed by the teacher because it affects student learning achievement. Mathematical resilience can be seen as a science that analyses human perseverance and perseverance especially in facing challenges. Most students not only learn from challenges but they even respond to get something better. Mathematical resilience can also be used to assess how far student ability in facing complex problems. Mathematical resilience contains a persistent attitude in facing difficulties, working or collaborative with peers, having language skills to express mathematical understanding, and mastering mathematical learning theories [9].

Indicators of mathematical resilience as a) showing diligence, confidence, working hard and not easily give up in facing problems, failures, uncertainties; b) showing the desire to socialize, easily give help, discussing with peers, and adapting to their environment; c) bringing new ideas and find creative solutions to challenges; d) using experience of failure to build self-motivation; e) having curiosity, reflecting, researching, and utilizing various sources; f) having self-control ability; aware of their own feelings [10].

2. Method
This research used a descriptive quantitative research design. The population in this research was all students of the eight grade of junior high school in Sragen Region, East Java, Indonesia. The population was divided into three categories of schools, namely high, medium, and low category, which are obtained based on the national examination score in 2018. The sample was obtained using stratified cluster random sampling. The subject consisted of 153 students of grade eight students from three schools in Sragen, conducted in the second semester of academic year 2018/2019.

The instrument used in this research was the questionnaire of mathematical resilience and a written test. The student’s mathematical resilience ability was measured by using mathematical resilience scale that consisted of 40 items of statements. Prepared on the basis of its indicators, where each statement had five scale options using a Likert scale. The written test was used to measure the ability of specialization and generalization of mathematical problem-solving. The instrument in this study was validated by six validators each of which was three validators by for tests and three validators from psychology lecturers for questionnaires. The essay topic for the test was about linear programming. Next, the data were descriptively quantitative analyzed. The data analysis techniques in this study using one-way ANOVA statistical test with unbalanced cell and based on the acquisition of questionnaire scores which then it is categorized by category mathematical resilience of students score.

3. Result and discussion
The research began with observations in several schools that represent the population in Sragen Regency and found several mathematical problems that were equal with the results of the mathematics national examination in Sragen Regency that still showed a score below the average national examination score. The research population was all junior high school students in Sragen Regency, Central Java. Determination of research subjects was taken from sampling to seventh-grade students from three schools in Sragen Regency. Based on the analysis of the 2018 national exam scores, obtained six schools with high categories, twenty-eight schools with medium categories and fifteen schools with low categories. After categorization, one school from each category was chosen randomly to be used as the sample of this research. The result of the school categorization analysis is shown in Table 2.

| School Category | Name of School            | Number of Students |
|-----------------|---------------------------|--------------------|
| High            | SMP Negeri 2 Sragen       | 54                 |
| Medium          | SMP Negeri 1 Sidoharjo    | 56                 |
| Low             | SMP Negeri 2 Sumberlawang | 43                 |
| Total number of students |                           | 153               |

Table 2. The result of school categorization.
Based on Table 2, it is shown that State Junior High School 2 Sragen was selected as a high category school, State Junior High School 1 Sidoharjo as a medium category school, and low category school was State Junior High School 2 Sumberlawang. The total subjects in this research were 153 students. In this research also took a total of 50 students from schools outside the medium category research subjects, that is State Junior High School 1 Masaran as a school for trying out the questionnaire and the test.

The test and questionnaire were first validated by three validators who are experts in their fields. After that, the test totalling 6 items and questionnaire totalling 40 items were tested on students outside the research. The results of the questionnaire tests were obtained by the internal consistency test to each item and ended with the Cronbach Alpha reliability test of 0.818 for the mathematical resilience questionnaire. Based on the questionnaire analysis result, 40 statements items questionnaires and 4 test items that can be used as research instruments. The instrument that fulfils the requirements as a feasible instrument to be used was then given to all samples from the three schools selected as research subjects. The results of the resilience questionnaire test, obtained by students with high category mathematics resilience were 42 students, medium mathematics resilience were 66 students and low mathematics resilience as many as 45 students. Table 3 shows the results of the mathematical problem-solving ability distribution of mathematics resilience questionnaire which is used to find out the number of students who are high, medium, and low in each school.

| Mathematics Resilience | School Category | Total |
|------------------------|----------------|-------|
|                        | High | Medium | Low |
| High                   | 27   | 11     | 4   | 42  |
| Medium                 | 20   | 27     | 19  | 66  |
| Low                    | 7    | 18     | 20  | 45  |
| Total                  | 54   | 56     | 43  | 153 |

Based on Table 3, students with high mathematics resilience category are 42 students, medium category 66 students, and low category 45 students. From the results of this analysis, it is seen that students with a medium category are more than the other two categories. It means that many students with characters who have the ability to adapt to difficult situations in life but are more dominant in safe situations. The results of the data in this study were analyzed by statistical one-way ANOVA test with unbalanced cells. This is because the size of each sample in each school is not the same, in order to find out which one provides better mathematical problem-solving abilities students with high, medium or low resilience. The results of data analysis will be used in one-way ANOVA statistical tests with unbalanced cells shown in Table 4.

| Mathematics Resilience | N    | Mean | Standard Deviation | Minimum Score | Maximum Score |
|------------------------|------|------|--------------------|---------------|---------------|
| High                   | 42   | 54.58 | 27.61              | 18.33         | 91.67         |
| Medium                 | 66   | 32.15 | 26.10              | 6.67          | 93.33         |
| Low                    | 45   | 30.15 | 18.44              | 6.67          | 83.33         |
| Total                  | 153  | 37.79 | 26.59              |               |               |

Based on Table 4, the data obtained were used for statistical tests by classifying the types of achievement scores from the problem-solving ability test based on the three categories of mathematical resilience. The results of grouping data were tested hypothetically using one-way ANOVA with unbalanced cells. The goal is to find out whether the three types of mathematical resilience have the same effect on students' mathematical problem-solving abilities. The statistical test results can be seen in Table 5.
Table 5. Anova summaries.

|                | Sum of Squares | Df | Mean Square | Fobs | Fα   | Sig.  | p   |
|----------------|----------------|----|-------------|------|------|-------|-----|
| Between Groups | 16916.60       | 2  | 8458.301    | 14.016 | 3.02 | 0.000 | < 0.05 |
| Within Groups  | 90518.90       | 150| 603.459     |       |      |       |     |
| Total          | 107435.50      | 152|             |       |      |       |     |

Based on Table 5, the critical region = \{F \mid F > Fα; k - 1; N - k \} with \( F = 0.05; 2; 150 = 3.02 \) and \( Fobs = 14.016 \) is in critical region, then \( H_0 \) is rejected. In conclusion, it is not true that all three types of mathematical resilience namely high, medium, and low resilience have the same effect on students' mathematical problem-solving abilities. Furthermore, in this study, a post hoc test with the Scheffe method was conducted to find out which ones provide better mathematical problem-solving abilities between students who have high, medium or low mathematical resilience.

Table 6. Multiple comparisons with Scheffe method.

| (I) Mathematics resilience | (J) Mathematics resilience | Mean Difference (I-J) | Sig. | P   |
|-----------------------------|-----------------------------|-----------------------|------|-----|
| High                        | Medium                      | 22.69554              | 0.000| < 0.05 |
|                             | Low                         | 24.65635              | 0.000| < 0.05 |
| Medium                      | High                        | -22.69554             | 0.000| < 0.05 |
|                             | Low                         | 1.969081              | 0.918| > 0.05 |
| Low                         | High                        | -24.65635             | 0.000| < 0.05 |
|                             | Medium                      | 1.969081              | 0.918| > 0.05 |

Based on Table 6, the results of the average comparison between students with high and medium mathematical resilience categories has \( p=0.000<0.05 \), then \( H_0 \) is rejected. This means that students with a high category of mathematical resilience have different abilities with students in the category of medium mathematical resilience. Because the average student with a high mathematical resilience category has a higher average of students with a category of medium mathematical resilience in students' mathematical problem-solving abilities, it is concluded that students with a high mathematical resilience category have better mathematical problem-solving abilities than students in the category of medium mathematical resilience. Likewise, between students with high and low mathematical resilience categories has \( p=0.000<0.05 \), then \( H_0 \) is rejected. This means that students with a high category of mathematical resilience have different abilities with students in the category of low mathematical resilience. Because the average students with a high mathematical resilience category have a higher average of students with a category of low mathematical resilience in students' mathematical problem-solving abilities, it is concluded that students with a high mathematical resilience category have better mathematical problem-solving abilities than students in the category of low mathematical resilience. The average comparison between students with medium and low mathematical resilience categories has \( p=0.918>0.05 \), then \( H_0 \) is accepted. This means that students with medium mathematical resilience categories have the same abilities as students in the category of low mathematical resilience.

The above findings were similar to the study that showed a positive and significant relationship between mathematical resilience and student academic ability [11]. Resilience is an ability that allows students to deal with difficult situations, which may affect them negatively. Adverse situations that may arise when students are faced with the problem that made them give up in the learning process [12,13]. That means that mathematical resilience can be used to predict the level of academic ability of students, in this study, therefore, researchers are also interested. Back to the initial problem, problem-solving is one of the common skills students must possess as a need for evaluation at the school level and also in carrying out its role in people's lives [14,15], so that mathematical problem solving becomes one of the
cognitive abilities that occupy important roles and research factors that can influence and grow problem-solving skills are also important.

Problem-solving is a process of individual efforts to respond to and overcome obstacles when an answer or answer method is not yet clear. There are several factors that influence problem-solving skills, one of which is desire and motivation [16]. This opinion is in line with the results of statistical testing in this study, which concluded that students who have a high type of mathematical resilience have better mathematical problem-solving abilities than students who have moderate and low mathematical types of resilience. Strong encouragement from within students will foster strong self-confidence as well, confidence is able to solve challenging questions, able to discuss when finding difficulties, can influence the results of mathematical problem-solving students.

However, if we see in Table 4, each student has a different level of mathematical resilience, the level of mathematical resilience also affects the ability to solve mathematical problems differently. Students with strong mathematical resilience, have adaptive attitudes or can adapt to the environment; can face uncertainty, challenge problems; solve problems logically and flexibly; looking for creative solutions to challenges; curious and learn from experience; have self-control ability; aware of his feelings; have a strong and easy social network [13]. Mathematical resilience as a positive adaptive attitude towards mathematics that gives students the opportunity to continue solving mathematical problems despite difficulties [9]. Whereas students with moderate and low mathematical types of resilience make students become lazy and do not dare to take risks in solving mathematical problems, especially that fear and not being interested in mathematics make students not meet the indicators of ability to be achieved.

4. Conclusion
Based on the result, it can be drawn to the conclusion that there are differences in students' mathematical problem-solving ability based on the categorizing of mathematical resilience. The result of the research gives an overview based on the statistical analysis of the test that students having the high resilience level of mathematics have better mathematical problem-solving ability than students with medium and low-level mathematical resilience. Students with a medium level of mathematical resilience have the same mathematical problem-solving ability with students with low mathematical resilience level. Students having the high resilience level of mathematics can to deal with and be able to overcome obstacles and negative situations that related to the problem-solving process because they can successfully coach themselves when having difficulties in mathematics problem-solving.

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