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ANALYSIS OF STUDENTS' MATHEMATICAL PROBLEM-SOLVING ABILITY BASED ON CATEGORY LEVELS THROUGH POLYA STEPS

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ABSTRACT

This study aims to describe students' mathematical problem-solving abilities based on the category level through the Polya steps. the stages of solving the problem pattern consist of the stage of understanding the problem, planning solutions, and checking again. The subject of this study chose six people from thirty-one students from class VIII SMP Negeri 1 Soe. Data collection by conducting tests and interviews. the results showed that the upper category students did not experience difficulties at the stage of understanding the problem and making plans, while at the stage of implementing the plan there were still parts that were not done because they felt that they were not needed, while at the stage of re-examining students in the upper category they did not do it. students in the medium category can already understand the plan well, while at the planning stage it has not been fully carried out, so at the stage of implementing the plan not all of them can do well either, for the medium category no one checks again. students with low categories have not been able to fully understand the problem and make plans, so they cannot carry out the plan and also cannot check back on what has been done. Subjects with high score categories have been able to solve problems even though they are still not perfect, subjects with moderate value categories have sufficient problem-solving abilities, and subjects with low-value categories have very poor problem-solving abilities.

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INTRODUCTION

Based on UU Sisdiknas Number 20 chapter 3 2003, the purpose of national education is to develop students' potential so that they can become human beings who believe and fear God Almighty, have a noble character, are knowledgeable, healthy, creative, capable, creative, independent, become democratic and responsible citizens. The achievement of educational goals and the intellectual life of the nation can be realized through formal and non-formal

education. Elementary school to college is formal education, a lot of knowledge can be learned on the bench of education. Mathematics education is one of them.

Mathematics education is taught from elementary school and continues to higher education. The purpose of learning mathematics is to provide an understanding of mathematical concepts, use reasoning, problem-solving, communicate ideas with symbols, tables, diagrams, or other media to clarify situations or problems, and have an attitude of appreciating the usefulness of mathematics in life (Wahyudin, 2016). The development of competence in mathematics includes the ability in mathematics material and the ability to do math (NCTM, 2000).

The material or topics discussed in the class or school are adjusted to the level and ability in mathematics, while the ability to do math includes mathematics as problem-solving, mathematics as ability, mathematics as reasoning, and mathematical connections (NCTM, 2000). Solving problems in learning mathematics must be familiarized to students to the highest stage. Various forms of knowledge and the use of knowledge or epistemic knowledge of students are possible to expand the knowledge of the discipline and use their understanding for the realization of students' problem-solving abilities and intentionally work towards future outcomes that are valued for sustainable contributions to well-being (OECD, 2019).

Ruseffendi (2006) suggests that problem-solving skills are very important in mathematics, not only for those who will pursue or study mathematics in the future but for anyone who will apply it in everyday life or other fields. According to Gagne's learning theory (Suherman et al., 2003), the highest stage in learning is problem-solving. Problem-solving requires students to deal with non-routine problems and are required to be able to arrange steps in solving these problems. Problem-solving is one of the objectives of learning mathematics by mathematicians, educators, and observers of mathematics education, so that problem-solving skills are important for every student to have.

One of the skills that must be mastered by students is the ability to solve mathematical problems because important skills in learning mathematics such as applying rules to non-routine problems, finding patterns can be developed better through problem-solving activities (Suherman, et al, 2003:89). Isnawati stated that problem-solving skills are very important not only for those who will study mathematics in the future but also for those who will apply it in other fields of study as well as in everyday life (Rostika and Junita, 2017). One of the knowledge that is expected by 2030 from the OECD and is also a required 21st-century skill is problem-solving ability. The ability to solve any problem is also a high-level thinking skill as a transfer of knowledge in the realm of knowledge that students must know and contains basic elements (Dirjen GTKKPK, 2018).

Indonesian children currently have only low and middle performers, while Indonesian children do not have high performers. From year to year, PISA results also show that most 15-year-old students do not have basic literacy (reading, math, and science). The latest PISA 2018 results, the average math score of Indonesian children only reached 379 from the OECD average score of 487 (OECD, 2019). This score indicates that Indonesia is at level 1 of problem-solving ability.

Students will not have good competitiveness if in learning students are not trained in 21st-century life skills, namely, students are not accustomed to making comparisons, making data assessments, critical thinking, making conclusions, solving problems, and applying their knowledge in real-life contexts and situations. which is still foreign. To prepare for the future of the nation's children who can compete in the 21st century, it is necessary to explore what kind of problem-solving abilities children have to find a solution. The problem-solving abilities seen in this study are based on high, medium, low categories and are referred to from the Polya procedure. The following steps need to be considered in the problem-solving process, namely: (1) how students understand the problem; (2) how students develop a settlement plan; (3) how students carry out the completion plan; and (4) how to evaluate the results and solutions made (Polya, 1973). Sabirin suggested that the lack of students in analyzing problems, evaluating the results, and seeing the completion process were the students' weaknesses in solving problems (Yuwono et al., 2018).

Nissa suggests that learning by solving problems students process and reason in doing creativity to think for learning about new things in mathematics for greater understanding (Indriani, Nurcahyono, Agustiani 2018). Various kinds of research that have been carried out on the analysis of problem-solving abilities including (Sapitri et al., 2019) studied based on open-ended questions and in terms of interest in learning, the results showed that students' mathematical problem-solving abilities in solving open-ended questions on circle material in terms of high, medium, and low learning interests were all at the medium category, (Mita & Tambunan Izzati, 2019) studied the PISA questions, the results showed that the problem-solving ability based on Newman's stages could be carried out at all stages by most students, (Indriani et al., 2018) based on the ideal step of problem-solving with the results showing that high-ability subjects can pass all solving steps, it's just that they are still constrained in implementing strategies, moderately capable subjects still have difficulty in writing information but understand the problem, while capable subjects only understand the problem and know the information without having a strategy to solve it.

Utami and Wutsqa's research (2017) analyzed problem-solving abilities and self-efficacy, the results of which showed that the mathematical problem-solving abilities of eighth-grade students of State Junior High Schools in Ciamis Regency were at low criteria. Yuwono, Supanggih, Ferdiani (2018) story questions are based on the Polya procedure with the result that students are said to have reached the stage of understanding the problem if they can know what is known and asked about the questions correctly, reach the stage of making plans if with prior knowledge they can develop strategies that make it easier to understand the problem. completing the given questions, reaching the stage of implementing the plan when students have carried out the calculation process according to the plan and reaching the stage of reviewing if students can make conclusions from the results of their work, while what is done in this study is based on the category level with the Polya procedure.

The results of interviews conducted with teachers of mathematics subjects at SMP Negeri 1 Soe revealed that not many students have good abilities in solving non-routine questions, teachers also do not familiarize students with solving non-routine questions. Students are not used to and do not have good abilities in solving problem-solving problems, while the current

form of learning evaluation is almost entirely in the form of problem-solving. This study aims to analyze students' problem-solving abilities based on the category level through the Polya procedure, describing students' problem-solving abilities based on the upper, middle, and lower category levels. Sumartini (2016) suggests that to improve students' problem-solving abilities, it is necessary to be supported by appropriate learning methods. Therefore, this analysis is carried out to be used as a reference in preparing more appropriate strategies or methods in the learning process to reach students from various categories, especially students with lower categories so that they can solve a problem well.

METHOD

This research is descriptive research with a qualitative approach. The subjects in this study consisted of 31 students of SMP Negeri 1 Soe class VIII in the odd semester of the 2019/2020 school year. The instruments used are question sheets and interview sheets. The data was collected in the form of the results of students' problem-solving ability tests and interviews. Students are then grouped based on the level of problem-solving ability with high, medium, and low categories based on the standard deviation. Students were then taken randomly from each category of two people to be interviewed to get an idea of the problem-solving abilities of each category. The data analyzed are the results of student work and interviews. The subjects who became the source of this research data were students. The data analysis technique uses the concept of Miles and Huberman, namely, reducing data, presenting data, and drawing conclusions. The triangulation technique is used to see the validity of the data. The triangulation used in this study is technical triangulation, which is to compare the results of student work with the results of interviews and then analyzed them based on Polya's steps.

Data collection methods used are tests, interviews, and documentation. The test method is used to find out how the problem-solving abilities of eighth-grade students of SMP Negeri 1 Soe are. The interview used in this study is a semi-structured interview. The interview method was used to obtain data regarding the students' ability to complete the mathematical problem-solving ability test given by the researcher. Documentation is important data related to the state and operations of the object of research, such as archives. The documentation method is used to strengthen the data obtained by the researcher during the observation.

RESULTS AND DISCUSSION

Results

The results of this study were discussed based on the level of high, medium, and low categories, which were seen from the students' scores in solving problem-solving problems. Of the 31 people who were used as subjects in the high-value category 3 people, the medium value category 20 people, and the low-value category 8 people, then submitted per category.

1. Subjects with high-value categories

Subjects with a high score category for understanding the problem (understanding the problem), making a plan of completion (devising a plan), it can be implemented well and in carrying out the plan of completion (carrying out a plan) there are still other parts that are

forgotten especially the conclusion, and for rechecking the results (looking back) the subject did not do it at all. It is clear on the answer sheet that students can find out information from the questions, know the meaning of the questions correctly, can manage the information needed, present the steps for completion correctly, but do not complete the plan properly, make conclusions and do not re-check the process. The results of student work in the high-value category are as presented in Figure 1.

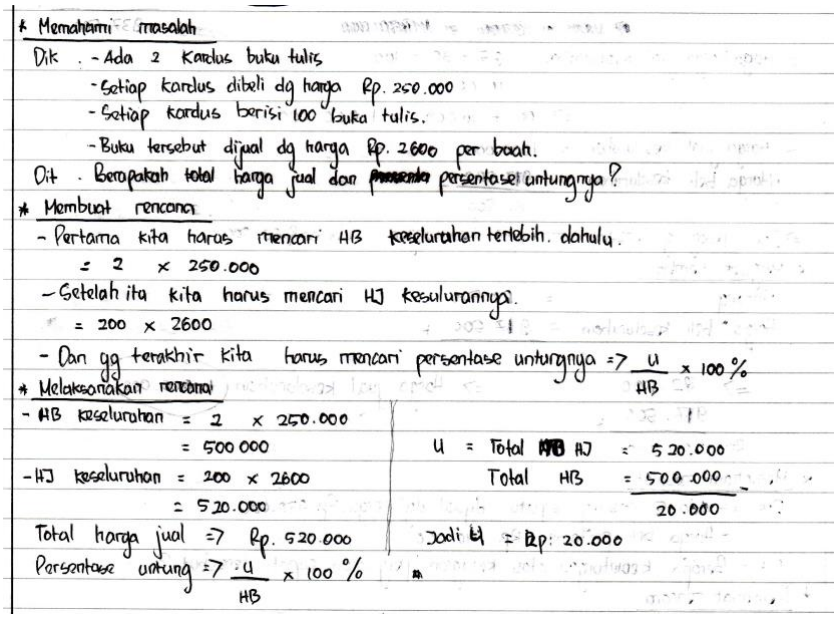

Figure 1. Student Work Results with High-Value Category

Indicators of mathematical problem-solving abilities that are not done by students in the high score category are not re-checking while the other students can do it well. The achievement of this subject is following his statement when interviewed that the subject does not experience problems in solving the problem so that the subject of the high-value category already has good initial abilities in solving problem-solving problems, even though he does not re-check because he feels right and is also not used to it. recheck because it will waste time to solve other problems.

This result is in line with the research of Indriani, Nurcahyono, Agustiani (2018) which says that highly skilled subjects can go through all the solving steps, but they are still constrained in implementing the strategy. The difference is in the results of this study the subject did not experience problems in implementing the strategy but in making conclusions and re-checking the results.

2. Students with medium grades

Students with moderate value categories to understand the problem (understanding the problem) it is clear on the answer sheet that students can find information from the problem. In the stage of understanding the problem, students can find any information from the question and can find the purpose of the question correctly, so that this stage can be achieved properly. In the stage of making a settlement plan (devising a plan), students can process the

information needed, but cannot find the information needed, so the subject cannot make a complete plan properly. Carrying out a completion plan (carrying out a plan), at this stage students are less able to present the completion steps correctly because at the stage of making a complete plan the subject has not automatically been able to make it, so this stage cannot be achieved properly and at the stage of re-checking the results (looking back), also cannot be done. The results of student work in the medium value category are as presented in Figure 2.

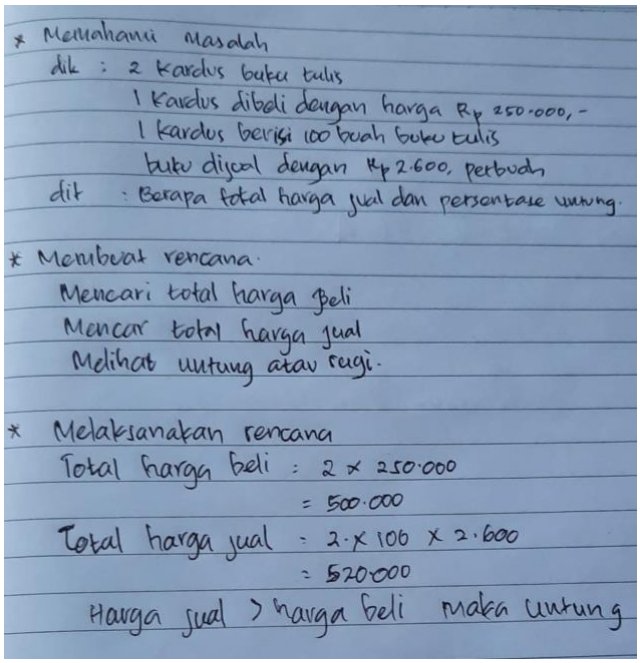

Figure 2. Student Work Results with Medium Grade Category

Based on the results of interviews with the subject regarding the answer, the subject stated that the subject was biased in exploring what information and the purpose of the question, however, it was still very difficult to make a settlement plan if not assisted by friends or teachers. The subject also stated that if a friend or teacher had helped him, the subject would find it difficult to implement the plan because it was not made by himself so it was not well understood. The next stage is also said that students can continue their completion if they get help from their friends or through the help of the teacher. Based on the results of work and interviews, it can be said that students with moderate grade categories still have difficulty in planning, so that more guidance is needed in the stage of finding the information needed and students cannot re-check the results they have done.

This result is also in line with the research of Islamiah et al. (2018) which suggests that the subject is still confused in applying the relevant strategies to solve the problem then there are still subjects who are less careful in doing calculations. Likewise, the research results of Indriani et al. (2018) suggest that moderately capable subjects still have difficulty in writing information but understand the problem.

3. Students with low grades

Students with low score categories, to understand the problem (understanding the problem), students can find out what information is contained in the problem, but students cannot find the purpose of the question correctly, so this stage cannot be achieved properly. In the stage of making a plan of completion (devising a plan) students cannot process the information obtained and cannot find the information needed, so this stage cannot be achieved properly. In the stage of carrying out a settlement plan (carrying out a plan), students cannot perform the presentation of the completion correctly, because at the previous stage it was also not possible to do so so that this stage could not be achieved properly. In the stage of rechecking the results (looking back) students did not do it at all. The results of students' work in the low-value category as presented in Figure 3.

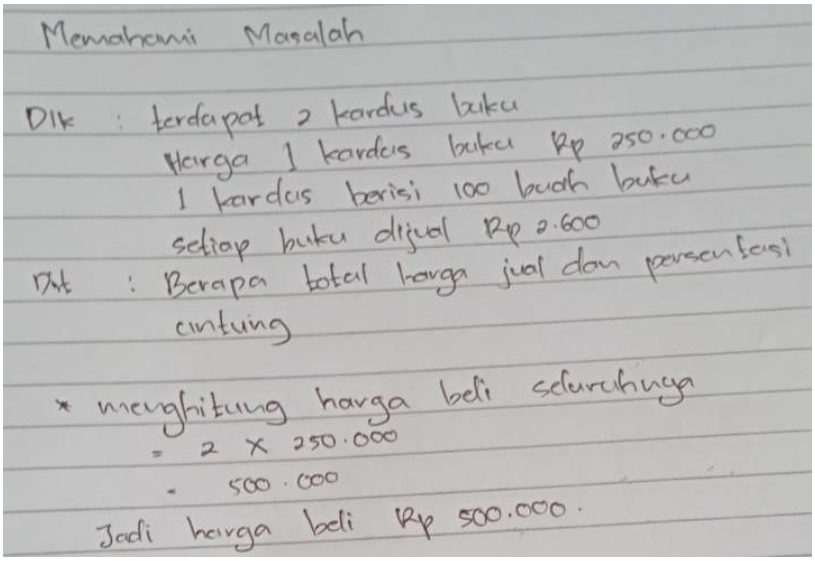

Figure 3. Student Work Results with Low Grade Category

The results of interviews with students with low grades regarding the answers to questions stated that the subject was still very difficult to understand the question, the subject had just been able to find the existing information but could not find the exact purpose of the question given. The subject also processes the information obtained from the questions but it is difficult to find and know what is needed. Subjects also have difficulty presenting according to the correct completion steps, so they feel no need to re-check their work.

Discussions

Based on the results of job analysis and interviews on subjects with low-value categories, it appears that their problem-solving abilities are still very low because they are still difficult to identify problems, especially at the stage of finding questions from the meaning of the questions correctly. Students also have difficulty at the stage of making plans and implementing plans so that they cannot proceed to the next stage.

These results are also in line with Andayani and Lathifah's (2019) research that on the indicators of making a mathematical model, choosing a solution strategy, solving problems,

and re-checking the results of the answers only some students can work on at this stage. Likewise, what was stated by Indriani, Nurcahyono, Agustiani (2018) who stated that low-ability subjects only understand problems and know information without having a strategy to solve them.

CONCLUSION

Based on the results of research and data analysis carried out, it can be concluded that students with high score categories can find all the information from the questions, find the meaning of the questions correctly, can process the information needed, show the correct completion steps even though they have not been fully carried out, but the subject did not check the process and answers and did not arrive at the conclusion correctly. These results indicate that students with high score categories have been able to solve problems even though they are still not perfect. Students with the medium grade category, at the stage of understanding the problem, have been able to carry it out, but when making a completion plan and implementing the plan there are still mistakes made, and still having difficulty in finding the information needed so that it takes longer work time or requires help from other friends. The next stage is to re-check the students cannot do it, it is also said that students can continue the solution if they get help from their friends or through the help of the teacher. These results indicate that students with moderate value categories have sufficient problem-solving abilities. Students with low grades have difficulty processing information on questions because they are only able to find what is in the questions, but cannot understand the questions from the meaning of the questions given. Students also have difficulty presenting solutions according to the correct steps, so they feel no need to re-check their work. These results indicate that students with low-value categories have very poor problem-solving abilities.

The basic ability that is an important part of learning mathematics, especially in preparing the 21st century generation, is the problem-solving ability, this basic ability becomes necessary for students to have and pay attention to develop student's problem-solving abilities, students should be introduced more to non-routine questions and more often students are accustomed to working on problem-solving problems with the Polya procedure so that it becomes a student's habit in solving their life problems.

Based on the results obtained, it is suggested that in learning should pay attention to the abilities of students so that in planning learning methods or models and strategies are used so that they can trigger students to solve a problem well. Students are also better faced with various non-routine questions in learning.

REFERENCES

Andayani F., Lathifah A. N., (2019). Analisis Kemampuan Pemecahan Masalah Siswa SMP dalam Menyelesaikan Soal pada Materi Aritmatika Sosial. *Jurnal Cendekia: Jurnal Pendidikan Matematika.* Vol. 3, (1),1-10

Dirjen GTK, (2018). *Buku Pegangan Pembelajaran Berorientasi pada Ketrampilan Bepikir Tingkat Tinggi.* Jakarta: Kementrian Pendidikan dan Kebudayaan.

Indriani, F., Nurcahyono N. A., Agustiani, N., (2018). Analisis Kemampuan Pemeahan Masalah Siswa Berdasarkan Langkah Ideal Problem Solving. *PYTHAGORAS* 7(2) 56-67.

Islamiah N., dkk. (2018) Analisis Hubungan Kemampuan Pemecahan Masalah Matematis Dan *Self Confidence* Siswa SMP. *Journal On Education.* Vol 1(1). 47-57

Mita, D. S., Tambunan, L. R., Izzati N., (2019). Analisis Kemampuan Pemecahan Masalah Peserta Didik dalam Menyelesaikan Soal PISA. *Jurnal Ilmiah Pendidikan Matematika.* Vol 1 (2) 25-33.

NCTM. (2000). *Principles and Standards for School Mathematics.* Reston: National Council of Teachers of Mathematics, Inc.

OECD. (2019). OECD Future of Education and Skills 2030 Concept.

OECD. (2019). Programme For Internasional Student Assessment (PISA) Results From PISA 2018.

Polya, G. (1973). *How to Solve It* (2nd ed.). Princeton, New Jersey: Princeton University Press.

Rostika D, Junita H. (2017). Peningkatan Kemampuan Pemecahan Masalah Siswa SD dalam Pembelajaran Matematika dengan Model Diskursus Multy Representation (DMR). EduHumaniora: Jurnal Pendidikan Dasar Vol. 9 (1) 35-46.

Ruseffendi, E. T. (2006). *Pengantar Kepada Membantu Guru Mengembangkan Kompetensinya dalam Pengajaran Matematika untuk Meningkatkan CBSA*. Bandung: Tarsito. Retrieved from http://onesearch.id/Record/IOS3107.10571.

Sapitri, Y., Utami, C., Mariyam, (2019). Analisis Kemampuan Pemecahan Masalah Matematis Siswa dalam Menyelesaikan Soal *Open-Ended* pada Materi Lingkaran ditinjau dari Minat Belajar. *Variabel.* Vol 2 (1) (16-23).

Suherman, E, H. dkk. (2003). *Strategi Pembelajaran Mateatika Kontemporer*. Bandung: UPI.

Sumartini, T.S. 2016. Peningkatan Kemampuan Pemecahan Masalah Matematis Siswa melalui Pembelajaran Berbasis Masalah. Jurnal Pendidikan Matematika STKIP Garut. Vol. 8, No. 3.

Trianto. (2008). *Mendesain Pembelajaran kontekstual*. Jakarta: Cerdas Pustaka Publisher.

Undang-undang no 20 pasal 3 tahun 2003, tentang Sistem Pendidikan Nasional.

Utami, R. W., Wutsqa, D. U. (2017). Analisis Kemampuan Pemecahan Masalah Matematika dan *Self-Efficacy* Siswa SMP Negeri di Kabupaten Ciamis. *JRPM.* Vol 4 (2) 166-175.

Wahyuddin. (2016).”Ananlisis Kemampuan Menyelesaikan Soal Cerita Matematika Ditinjau dari Kemampuan Verbal”.*βeta,* 9(2):148-160.

Yuwono, T., Supanggih, M., Ferdiani R. D., (2018) Analisis Kemampuan Pemecahan Masalah Matematika dalam Menyelesaikan Soal Cerita Berdasarkan Prosedur Polya. *Jurnal Tadris Matematika* Vol 1(2) 137-144.