EduMa: Mathematics Education Learning And Teaching
July 2024, Vol 13 No 1 Page 90 – 97
https://syekhnurjati.ac.id/jurnal/index.php/eduma/eduma/article/view/13505
p-ISSN: 2086-3918, e-ISSN: 2502-5209
Published by Tadris Matematika IAIN Syekh Nurjati cirebon

EduMa
MATHEMATICS EDUCATION LEARNING AND TEACHING

Analyzing Mathematical Problem-Solving Abilities in Set Theory: A Case Study of Seventh-Grade Students

Christina Monika Samosir[1*], Tatang Herman[2]

1, 2 Department of Mathematics Education, Universitas Pendidikan Indonesia, Indonesia

*Corresponding author: Silau Marawan Barat Desa Silau Marawan, Simalungun, North Sumatera, 21168, Indonesia. e-mail addresses: Christinamonika.2@upi.edu

a r t i c l e i n f o

How to cite this article:

Samosir, CM., & Herman, T. (2024). Analysis of Problem-Solving Ability on Set Material. *Eduma : Mathematics Education Learning And Teaching*, 13(1), 90 - 97. doi:10.24235/eduma.v13i1.13505

Article history:

Received: 04 28, 2023

Accepted: 06 06, 2024

Published: 07, 2024

a b s t r a c t

This study aims to analyze and describe the mathematical problem-solving abilities of students in set theory, specifically within a seventh-grade class at a private school in Bandung. The research employed a qualitative case study approach, collecting data through tests and documentation. A diagnostic test served as the primary instrument for evaluating students' problem-solving skills. The findings reveal distinct patterns in how students approach mathematical problems, correlating with their achievement levels. High-achieving students consistently followed Polya's four stages of problem-solving: understanding the problem, devising a plan, carrying out the plan, and looking back to reflect on their solution. In contrast, moderate-achieving students generally adhered to the first two stages, namely understanding the problem and carrying out the plan, often omitting the reflective stage. Low-achieving students predominantly focused on the initial stage of understanding the problem, struggling to advance beyond this point. The study highlights that the ability to understand the problem is the most developed skill among students, as it is the step where most students succeeded. However, devising a plan was identified as the most challenging aspect, with the fewest students able to correctly formulate a strategy for solving the problems. These findings suggest that while understanding is a common strength, there is a need for targeted interventions to improve students' abilities to plan and execute problem-solving strategies effectively.

Keywords:
Problem-Solving Ability, Set Material.

INTRODUCTION

The main focus and goal of learning mathematics is problem solving (Latifah & Luritawaty, 2020). In line with the idea of NCTM (2000), the basic qualification that students must possess is problem-solving ability. Problem-solving is important to learn because it helps individuals to think analytically, think logically, apply their experiences and knowledge, think critically and creatively, and develop other mathematical abilities. Problem-solving allows students to think analytically in making decisions and to improve their thinking skills when encountering new situations (Szabo et al., 2020). Improving mathematical problem-solving ability can be a solution to overcome problems in the field of mathematics and in everyday life. Solving abilities must be trained by carrying out activities included in problem-solving activities (Samosir & Dasari, 2022).

Despite the importance of problem-solving ability, Indonesian students are still classified as having low proficiency in finding solutions to the problems they face. PISA (Program for International Student Assessment) surveyed 600.000 students aged 15 and up from 79 countries. Indonesia is rated seventh from bottom, 73rd out of 79 countries, with a score 379 (OECD, 2019). Evidence of low student mathematical problem-solving was also obtained from several studies (Indahsari & Fitrianna, 2019; Mulyanti et al., 2018; Nuryana & Rosyana, 2019; Rahmani & Widyasari, 2018; Samosir et al., 2020; Suryani et al., 2020).

Problem-solving is the collaboration of previously owned knowledge and new knowledge to solve a problem (Alifah & Aripin, 2018). So, steps and mental activity are needed to be able to solve a problem. For this reason, in order to make it easier for students to find solutions, a process is needed in the form of steps or phases, one of which is the step or phase of Polya.

Polya (1978) identified four phases in problem-solving, namely: understanding the problem, devising a plan, carrying out the plan, and looking back. Understanding the problem is the first phase. Understanding the problem is crucial because pupils may be unable to solve the problem appropriately if they do not comprehend the problem. Students must also be able to devise a plan. Their ability to devise this strategy is heavily reliant on their prior problem-solving expertise. The more experience they have in solving problems, the more probable it is that they will be innovative in developing ideas or plans to solve a problem. After drawing up a problem-solving plan, solving the problem is carried out according to the plan that has been made. The final phase in the problem-solving process is to review what has been done. In this way, mistakes can be reduced to the most appropriate solution (Samosir & Dasari, 2022). According to Lasak (2017) Polya's steps have a positive effect on problem-solving abilities, which means that Polya's steps can improve students' mathematical problem-solving abilities.

The set is the material taught in the first semester of junior high school math lessons. In student-set materials, many use various kinds of symbols, notations, and diagrams. Set material is material that is closely related to everyday life, but some students still find it difficult to master and understand the set material. There are still many students who experience difficulties and errors in solving set material questions (Aulia, 2020; Lusiana, 2017; Ratnasari et al., 2019; Sundari, R., Andhany, E., & Dur, 2019; Walingkas & Sulangi, 2022). By knowing students' abilities, teachers can plan a solution that can be used to minimize mistakes made by students in solving problems, especially in set material. Therefore, it is important to conduct research on the analysis of the mathematical problem-solving abilities of seventh grade junior high school students on set material that is guided by problem-solving indicators based on the Polya procedure.

METHODS

This study used a qualitative research method, which aims to identify and analyze mathematical problem-solving abilities and to find out students' mistakes in solving problems in set material based on the Polya procedure. The subjects in this study were seventh-grade students at one of Bandung's private junior high schools, totaling 27 students. Then, by purposive sampling, as many as six students were divided into three categories: two students with high abilities, two students with moderate abilities, and two students with low abilities. To categorize high, medium, and low abilities, the researcher checked the normality of the data, and the result was that the data were not normally distributed. So, the researcher looked for the quartile values of the data using SPSS.

Table 1
Categorization of Students Scores

Scores	Category
$x > k3$	High Abilities
$k1 \leq x \leq k3$	Moderate Abilities
$x < k1$	Low Abilities

The data collection techniques used were (1) diagnostic tests, in which students were given problem-solving questions to work on, (2) interview, and (3)documentation. Activities in data analysis include three things, namely: data reduction, data display, and conclusion or verification. In this case, the researchers made four problem-solving ability test questions. Question 1 was created to see the students' ability in understanding the problem. Question 2 is made to see the ability of students in devising a plan. Question 3 is made to see the ability of students in carrying out the plan. And question number 4 to see the ability of students in looking back.

RESULT AND DISCUSSION

The research was conducted in seventh-grade at a private junior high school in Bandung with set materials. The indicators used by researchers are indicators of the mathematical problem-solving ability based on the Polya procedure, which consist of the stages of understanding the problem, devising a plan, carrying out the plan, and looking back. The following is the proportion of students in each category based on the categorization in Table 1.

Table 2
Percentage of Students in Each Category

Category	Percentage
High Abilities	14.8 %
Moderate Abilities	70.3 %
Low Abilities	14.8 %

From Table 2, it can be seen that the majority of students are in the medium category, namely 70.3%. While students in the high category and low category were each 14.8%. Furthermore, researchers analyzed student answers to each question. In question number 1, a question that focuses on students' ability to understand the problem, there are 77.8% of students who can answer correctly. In question number 2, which focuses on students' ability to devise a plan, 29.6% of students can answer correctly. In question number 3, a question that focuses on students' ability to carry out the plan, there are 37% of students who can answer correctly. For number 4, the question that focuses on

seeing students' abilities in looking back, there are 33.3% of students who can answer correctly.

Based on the data above, it can be seen that the ability that students master the most is the ability to understand the problem. Meanwhile, the ability with the least correct students is the ability to devise a plan. In this study, six subjects were selected from 27 students. These 6 subjects were selected from three categories: high, medium, and low ability, and in each category, 2 subjects were taken.

Table 3
List of Selected Subjects Based on Scores

No	Subject Code	Category
1	TS (S1)	High
2	RG (S2)	High
3	DA (S3)	Moderate
4	SD (S4)	Moderate
5	DK (S5)	Low
6	SA (S6)	Low

The following is a discussion regarding some of the mistakes made by the selected subjects based on problem-solving indicators.

Stage 1: Understanding the Problem

Based on the results of the answers by the six selected subjects, the two subjects in the high category and the two subjects in the medium category were able to understand the problem properly. For students in the low category, S5 and S6, students can answer even though it is not quite right. There are some parts they did wrong. Subjects S5 and S6 experienced errors because what they wrote did not match the information provided. Subjects S5 and S6 did not pay attention to the requirements of the questions, or the way the questions were interpreted was not quite right. Subjects S5 and S6 did not understand well how to name the members of a set. Students' difficulties in the aspect of understanding the problem, namely (1) students still do not understand the concept of the material being taught, (2) students are still not thorough and seem perfunctory.

Stage 2: Devising a Plan

At the stage of devising a plan, only S1 and S2 carried out the stages well; they were able to understand what information and methods should be used to solve the problem given. Student mistakes at this stage were made by S3, S4, S5, and S6.

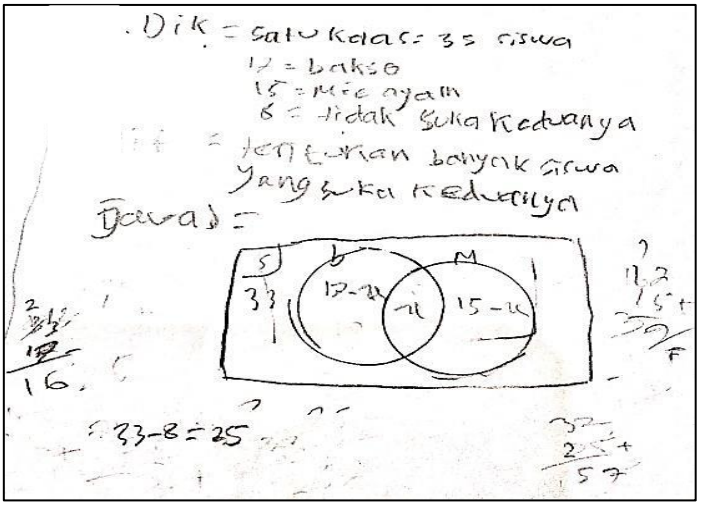

Figure 1
S3's answer

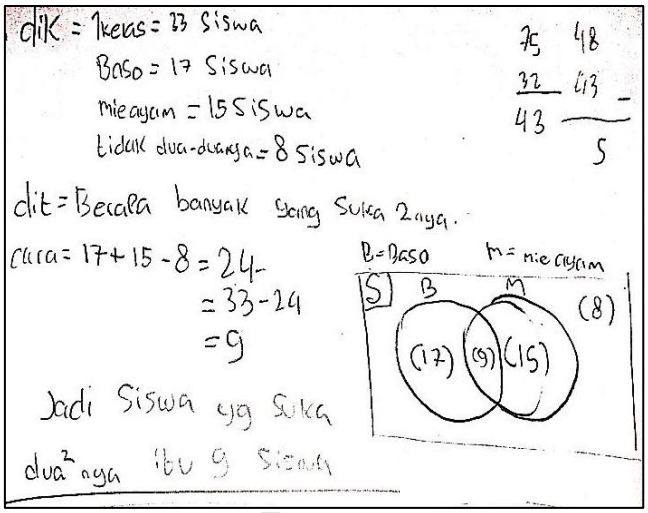

Figure 2
S4's answer

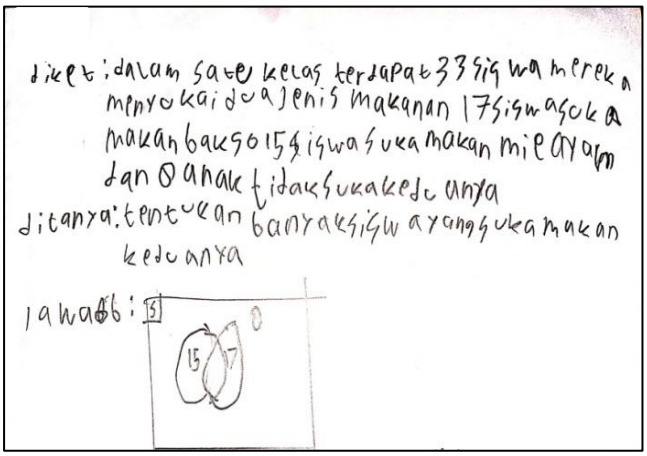

Figure 3
S5's answer

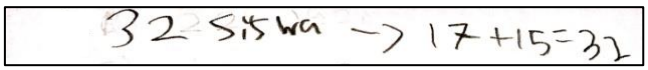

Figure 4
S6's answer

Problem number 2 focuses on the students' ability to devise a plan. In solving this problem, S3, S4, S5, and S6 experienced difficulties because the question asked students to determine how many students like to eat both. This is, of course, a non-routine question for students. At this stage, the strategy planned by S3, S4, S5, and S6 is not quite right. These subjects could not distinguish between the many students who only like to eat meatballs and the total number of students who like to eat meatballs, or between the number of students who only like to eat chicken noodles and the total number of students who like to eat chicken noodles. This lack of understanding that makes these subjects difficult to devise a plan. Students' difficulties in the devising a plan, namely (1) students do not know the various kinds of problem-solving strategies, so it is difficult to devise a plan, and (2) students lack practice questions.

Stage 3: Carrying Out the Plan
At the stage of solving this problem, students who are able to reach this stage are S1, S2, S3, and S4. These students are able to draw Venn diagrams, calculate, and get results correctly. Student mistakes at this stage were made by S5 and S6. At the stage of solving the problem, S5 and S6 have not been able to describe the Venn diagram, calculate it, and get the results correctly.

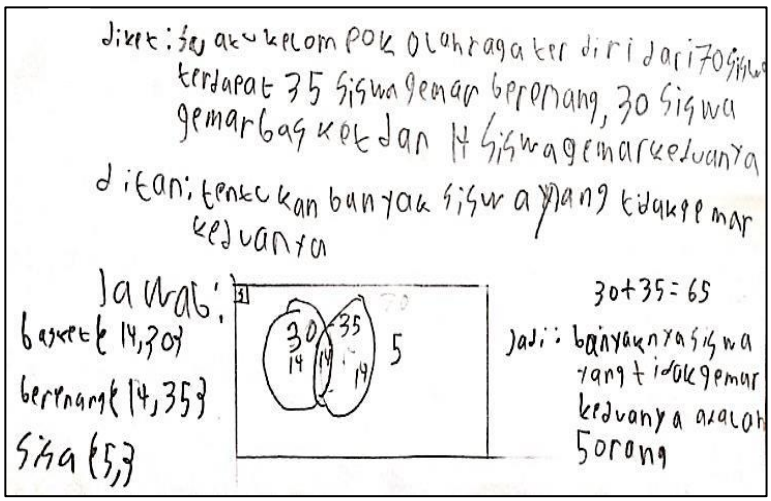

Figure 5
S5's answer

S5 and S6 write the solution, but it's not quite right. At S5, it can be seen that students are not able to plan solutions properly, which results in them not being able to solve problems according to plan. S6 seem careless when solving problems. Students' difficulties in the aspect of carrying out the plan, namely (1) students' low ability in understanding material about sets (2) students' habits that are less thorough in solving problems.

Stage 4: Looking Back
At the stage of looking back, students who were able to reach this stage were S1, S2, and S3. S4, S5, and S6 still experienced difficulties in the aspect of looking back. The students have difficulties because they do not know how to look back properly. Most students do not know whether the answer is in accordance with the question. Students' difficulties in the aspect of looking back, namely (1) students do not know how to look back correctly, and (2) students' habits are not good by not wanting to re-check.
The results of the analysis of problem-solving abilities still contained many mistakes because, according to students, the questions given were too difficult. Based on the indicators of mathematical problem-solving abilities, the students' answers were not maximized, as seen from the results of the tests given. Students still have difficulty and do not understand well the concept of set. This can be seen from the answers of students who still have many imperfect answers and cannot answer correctly according to what is asked.
This section will discuss research findings on students' mathematical problem-solving abilities. Researchers found that the ability with which most students are most successful is the ability to understand the problem. Meanwhile, the ability with the least correct students is the ability to devise a plan. Further findings show that high-achieving students solve problems through the four steps of Polya, namely understanding the problem, devising a plan, carrying out the plan, and looking back. Moderate-achieving students solve problems through the two steps of Polya, namely understanding the problem and carrying out the plan. Low-achieving students solve problems through one simple step, namely understanding the problem. This is in line

with research conducted by Antika & Surya (2016) regarding the application of Polya's steps in solving word problems on social arithmetic material in junior high school. Students' problem-solving abilities in the moderate group look better than those in the low group.

CONCLUSION AND IMPLICATION

Conclusion

Based on the results of the analysis and discussion, it was concluded that the problem-solving abilities when solving set problems still had many students experiencing difficulties. Researchers found that the ability with which most students are most successful is the ability to understand the problem. Meanwhile, the ability with the least correct students is the ability to devise a plan. Researchers also found that high-achieving students solve problems through the four steps of Polya, namely understanding the problem, devising a plan, carrying out the plan, and looking back. Moderate-achieving students solve problems through the two steps of Polya, namely understanding the problem and carrying out the plan. Low-achieving students solve problems through one simple step, namely understanding the problem.

Implication

The results of this study indicate that students still have difficulty devising a plan. Therefore, the teacher must provide a lot of practice questions with various problem-solving strategies. Thus, students are familiar with various types of problem-solving strategies, which has implications for their ease in devising a plan. Thus, students can easily solve math problems, especially with set material.

REFERENCES

Alifah, N., & Aripin, U. (2018). Proses Berpikir Siswa Smp Dalam Memecahkan Masalah Matematik Ditinjau Dari Gaya Kognitif Field Dependent Dan Field Independent. *Jurnal Pembelajaran Matematika Inovatif*, 1.

Antika, S., & Surya, E. (2016). *Penerapan Langkah Polya dalam Menyelesaikan Soal Cerita pada Materi Aritmatika Sosial di SMP*. May, 1–23.

Aulia, M. A. (2020). *Pengaruh Pendekatan Kontekstual terhadap Kemampuan Memecahkan Masalah Matematika pada Siswa SMP*. June, 2–9.

Indahsari, A. T., & Fitrianna, A. Y. (2019). Analisis Kemampuan Pemecahan Masalah Siswa Kelas X Dalam Menyelesaikan Spldv. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, 2(2), 77. https://doi.org/10.22460/jpmi.v2i2.p77-86

Lasak, P. (2017). The effects of Polya's problem solving process on mathematics problem solving skills and achievement of mathematics student teachers. *Proceedings of ISER 58th International Conference,* June, 27–30.

Latifah, S. S., & Luritawaty, I. P. (2020). Think Pair Share sebagai Model Pembelajaran Kooperatif untuk Peningkatan Kemampuan Pemecahan Masalah Matematis. *Mosharafa: Jurnal Pendidikan Matematika*, 9(1), 35–46. https://doi.org/10.31980/mosharafa.v9i1.641

Lusiana, R. (2017). Analisis Kesalahan Mahasiswa Dalam Memecahkan Masalah Pada Materi Himpunan Ditinjau Dari Gaya Kognitif. *Jurnal Penelitian Dan*

Pembelajaran Matematika, 10(1), 24–29. https://doi.org/10.30870/jppm.v10i1.1290

Mulyanti, N. R., Yani, N., & Amelia, R. (2018). Analisis Kesulitan Siswa Dalam Pemecahan Masalah Matematik Siswa Smp Pada Materi Teorema Phytagoras. *JPMI (Jurnal Pembelajaran Matematika Inovatif),* 1(3), 415. https://doi.org/10.22460/jpmi.v1i3.p415-426

NCTM. (2000). Principe and standards for school mathematics.

Nuryana, D., & Rosyana, T. (2019). Analisis Kesalahan Siswa Smk Dalam Menyelesaikan Soal Pemecahan Masalah Matematik Pada Materi Program Linear. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 3(1), 11–20.

OECD. (2019). *Indonesia Education at a Glance*. OECD: Country Note, 1–5. https://www.oecd.org/education/education-at-a-glance/

Polya, G. (1978). How to solve it: a new aspect of mathematical method second edition. *In The Mathematical Gazette (Vol. 30, p. 181).* http://www.jstor.org/stable/3609122?origin=crossref

Rahmani, W., & Widyasari, N. (2018). Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa Melalui Media Tangram. *FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika,* 4(1), 17. https://doi.org/10.24853/fbc.4.1.17-23

Ratnasari, S., Setiawan, W., Siliwangi, I., Terusan, J. L., Sudirman, J., Tengah, C., Cimahi, K., & Barat, J. (2019). Analisis Kesulitan Belajar Siswa Pada Materi Himpunan. *Journal on Education*, 1(2), 473–479. https://doi.org/10.22460/jpmi.v5i6.1841-1848

Samosir, C. M., Solfitri, T., & Armis, A. (2020). Penerapan Model Pembelajaran Berdasarkan Masalah untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa Kelas VII A SMP PGRI Pekanbaru Tahun Pelajaran 2019/ 2020. *JURING (Journal for Research in Mathematics Learning),* 3(4), 403. https://doi.org/10.24014/juring.v3i4.10312

Samosir, C. monika, & Dasari, D. (2022). Systematic Literature Review: The Effect of Math Anxiety On Mathematical Problem-Solving Ability. *Didaktik: Jurnal Guru Sekolah Dasar*, 8, 99–105. https://doi.org/https://doi.org/10.33084/tunas.v8i1.4305

Sundari, R., Andhany, E., & Dur, S. (2019). Analisis kesulitan siswa dalam menyelesaikan soal cerita materi himpunan ditinjau dari tahapan newman. *AXIOM: Jurnal Pendidikan Dan Matematika*, 8(2), 187–194.

Suryani, M., Jufri, L. H., & Putri, T. A. (2020). Analisis Kemampuan Pemecahan Masalah Siswa Berdasarkan Kemampuan Awal Matematika. *Mosharafa: Jurnal Pendidikan Matematika*, 9(1), 119–130. https://doi.org/10.31980/mosharafa.v9i1.605

Szabo, Z. K., Körtesi, P., Guncaga, J., Szabo, D., & Neag, R. (2020). Examples of problem-solving strategies in mathematics education supporting the sustainability of 21st-century skills. *Sustainability (Switzerland),* 12(23), 1–28. https://doi.org/10.3390/su122310113

Walingkas, D., & Sulangi, V. R. (2022). *Kesalahan Siswa Menyelesaikan Masalah Pada Materi Himpunan ; Studi Kualitatif Pada Siswa SMP Negeri 1 Tompaso Baru*. 1(1).