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Exploring Climate Change Problem-Solving Skills Among Junior High Students: An Empirical Analysis from Madura

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Abstract: This study aims to explore the problem-solving skills of junior high school students in Madura in relation to climate change issues. Understanding these skills is crucial for preparing students to tackle environmental challenges effectively.Methodology A descriptive quantitative approach was employed, collecting data from 63 students through a set of problem-solving skill indicators. The indicators measured various aspects of students' abilities to understand, devise plans, carry out those plans, and reflect on their solutions to climate-related problems. The results indicate that 73% of students fall into the low category of problem-solving skills, while only 27% demonstrate moderate skills. Notably, no students achieved high or very high ratings. Specific analysis revealed that students exhibited a moderate understanding of problems but showed low performance in devising plans, executing those plans, and reflecting on their outcomes. These findings highlight significant gaps in students' problem-solving capabilities concerning climate change. The low proficiency across various indicators suggests a need for enhanced educational strategies to develop these essential skills. The analysis indicates that without targeted interventions, students may struggle to effectively address the complexities of climate issues.

Keywords: Climate Change, Problem-Solving Skills, Junior High Students, Madura

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Introduction

Climate change is currently an urgent global issue due to its serious impacts on various aspects of life. The risks associated with climate change are viewed as challenges that threaten human survival (Susilawati, 2021). The increasing frequency of natural disasters, such as floods, droughts, and storms, is often linked to climate change (Kumalasari, 2014). One of the main contributing factors is the rising concentration of greenhouse gases, such as CO_2, CH_4, dan N_2O resulting from human activities, including fossil fuel combustion and deforestation, which accelerate global warming. This warming triggers the melting of polar ice, rising sea levels, and extreme weather conditions that threaten human life in various regions, especially coastal cities (Nur et al., 2024).

Climate change not only damages the environment but also causes suffering for affected communities, both directly and indirectly. The increasing frequency of disasters, such as floods and droughts, results in the loss of homes, livelihoods, and deteriorating physical and mental health for the community (Hidayah et al., 2024). The Meteorology, Climatology, and Geophysics Agency (BMKG) reports that heavy rainfall often triggers major floods, exacerbated by poor urban drainage systems and rapid urbanization, leading to reduced rainwater flow

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capacity. This situation highlights the importance of mitigation and adaptation efforts against climate change (Hidayah et al., 2024).

One crucial step in responding to the increasing challenges of climate change is implementing disaster risk reduction. The aim is to minimize the impact of disasters through preventive and mitigation efforts. Additionally, raising awareness and preparedness among students is also a primary focus, so they are better equipped to face disasters and reduce their vulnerability to their impacts (Lu, Lin, Tan, & Liu, 2022). Disaster mitigation through education can be achieved by teaching students essential skills such as problem-solving, quick decision-making, and adaptability in emergency situations. This education includes introducing disaster risk, mitigation strategies, and emergency response drills. By equipping students with these skills, they can be better prepared to handle disaster situations, mitigate potential impacts, and enhance their resilience and that of their communities against climate change (Setiadi, 2024).

Problem-solving is crucial in the context of climate change as it is a key component in enhancing students' higher-order thinking skills. These skills help students explore the knowledge and abilities they possess to tackle complex problems they may rarely encounter in daily life (Arigiyati & Istiqomah, 2016). The current climate issues necessitate effective problem-solving approaches. Student involvement in real-world problem-solving can enhance their problem-solving skills (Mukarromah et al., 2020). Furthermore, problem-solving is not merely an academic goal but aims to facilitate students in applying various knowledge they learn, including natural sciences, to address increasingly complex global challenges in the modern world (Chotimah, 2018).

Polya (1985) established four steps that can guide students in problem-solving: Understand Problems, Devise A Plan, Carry Out The Plan, and Look Back. Polya's phases of problem-solving are more commonly used for solving mathematical problems compared to others. This is because the phases in Polya's problem-solving process are relatively simple, and the activities in each phase are clearly defined (Rusdi et al., 2019).

As the next generation, junior high school (SMP) students play a vital role in understanding and seeking solutions to this issue. Therefore, the ability to solve problems related to climate change is a skill that should be developed from an early age. Problem-solving skills are one of the essential competencies students must possess. These skills enable students to confront increasingly complex challenges in the future, including global issues like climate change. According to the Partnership for 21st Century Skills, problem-solving skills are one of the core competencies needed (Baker & Baker, 2017). Previous studies have indicated that problem-solving abilities are among the key 21st-century skills that students need to meet future challenges (Care et al., 2015; Martz et al., 2017).

Madura is an area with a high risk of flood disasters, where the impacts of climate change are increasingly felt. One of the main causes of flooding in Madura is extreme rainfall triggered by global warming. Changes in rainfall patterns, both increases and decreases, can lead to disasters such as landslides and floods. On the other hand, reduced rainfall can result in water shortages, leading to drought and crop failures. Therefore, serious attention to changing rainfall patterns is crucial, given their impact on the livelihoods of the Madura community and food security in the region (Fura et al., 2020).

However, research specifically exploring how junior high school students, particularly in areas like Madura, develop problem-solving skills in the context of climate change is still limited. Madura, as a region vulnerable to climate change and other natural phenomena, presents an intriguing case for examining students' problem-solving abilities in addressing this issue. Valid and appropriate instruments are needed to measure junior high school students' problem-solving skills, ensuring that the results accurately and objectively reflect their capabilities (Ridwan et al., 2023).

This study aims to analyze the problem-solving skills of junior high school students in Madura within the context of climate change. The findings from this research are expected to contribute to the development of curricula and more effective learning approaches to enhance problem-solving skills related to climate change issues among students.

Method

Research Design

This research employs a descriptive quantitative method, which is a research approach aimed at illustrating the phenomena occurring both in the present and the past (Sukmadinata, 2010). The descriptive quantitative approach is characterized by its focus on describing conditions or phenomena without the implementation of specific treatments, manipulation, or changes in variables. In this study, no interventions were introduced to the subjects, and there were no control or experimental classes (Sukmadinata, 2012). Instead, the focus was on objectively capturing and reporting the current state of the phenomena under investigation.

The purpose of using this method is to provide a clear and systematic portrayal of the problem-solving skills among students, without altering the natural setting or imposing controlled conditions. This approach allows for a comprehensive understanding of the skill

levels exhibited by the students, as well as the factors influencing their problem-solving abilities within the context of climate change issue.

Data Collection

This preliminary study was conducted at a junior high school (SMP) in Sampang, Madura, involving a total of 62 students. Data collection focused on understanding the students' baseline problem-solving skills without introducing any instructional lessons or interventions. The students participated in assessments designed to measure their ability to address real-world challenges, particularly those related to climate change, using problem-solving skill Polya's indicators.

Data Analysis

The data were analyzed using descriptive statistics, including frequencies, percentages, and means, to identify patterns and trends in the students' problem-solving skills. The students' problem-solving skills were assessed using a scoring system that categorized their performance into four distinct levels: Very High, High, Moderate, and Low. This categorization provides a clearer understanding of the range of abilities exhibited by the students. The criteria used for determining these levels, based on the scores obtained from the assessments, are outlined in Table 1 below:

Table 1: Problem Solving Skill Criteria

Score	Problem Solving Skill Criteria
86-100	Very High
75-85	High
45-74	Moderate
0-44	Low

Result and Discussion

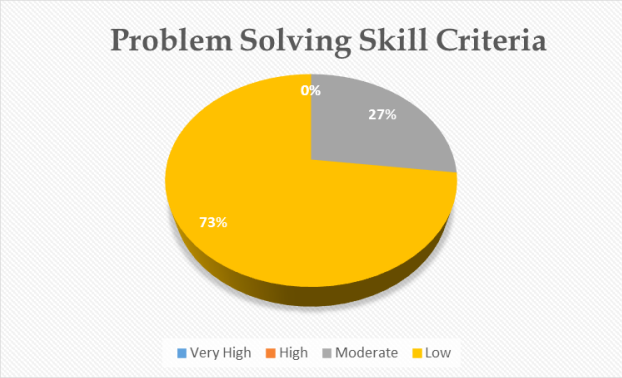

Figure 1: Problem Solving Skill Criteria

Based on the data presented in Figure 1, the distribution of problem-solving skills among the 63 students indicates that 46 students fall into the low category, while 17 students are in the moderate category. No students reached the high or very high categories. These results suggest that the majority of students do not possess adequate problem-solving skills. Approximately 27% of students demonstrate moderate abilities, which still fall below expectations, while the majority (73%) are at a low level, reflecting their limitations in problem-solving. Therefore, the average problem-solving skill of students on the topic of climate change is low.

The dominance of students in the low category highlights the need for improvements in teaching strategies, particularly in developing critical thinking and problem-solving skills. The absence of students in the "High" or "Very High" categories indicates that their ability to solve complex problems has not been well trained. This may suggest that current teaching methods are not optimal in stimulating analytical and evaluative thinking through problem-based learning.

Several factors contribute to the low problem-solving skills, including students' lack of understanding of the fundamental concepts relevant to the problems they face, which makes it difficult for them to solve these problems (Sulistiowati, 2022). Additionally, carelessness in reading the questions can lead to significant errors in problem-solving. Students who are lazy or inattentive in reading the questions will fail to understand the problems presented. Those who do not use reasoning or logic effectively in problem-solving will struggle to find the correct solutions. This is reflected in students' behaviors of being overly rushed and careless in calculations (Esterlina et al., 2022). Discovery-based problem solving can enhance students' reasoning and ability to think independently; in other words, learning through discovery trains cognitive skills to find and solve problems without assistance (Latifah et al., 2018). Traditional teaching methods typically do not actively engage students in problem-solving. For example, a lecture-based approach that only involves the teacher in delivering material without intensive interaction with students results in lower problem-solving skills due to a lack of practical and collaborative practice (Jayadiningrat & Ati, 2018)

Thus, applying scientific knowledge to everyday life and environmental issues is expected to make learning at school more meaningful and guide students to think forward. Therefore, problem-based learning, particularly regarding environmental issues, should be implemented by integrating ESD (Education for Sustainable Development) concepts into Problem-

Based Learning (PBL). The integration of ESD in PBL here means merging ESD issues or combining ESD topics within PBL that will be addressed in groups by students from various scientific perspectives, such as economic, environmental, and socio-cultural angles (Latifah et al., 2018).

The findings of this study were obtained from a problem-solving skills test instrument, adjusted according to the indicators proposed by Polya (1985), which was administered to students and encompassed four indicator aspects: Understand Problems, Devise a Plan, Carry Out the Plan, and Look Back.

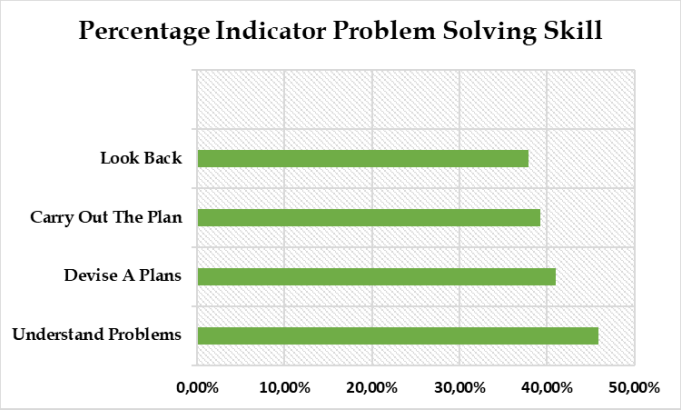

Figure 2: Percentage Problem Solving Skill Indicator

Table 2: Problem Solving Skill Indicator

Problem Solving Skill Indicator	Mastery Criteria
Understand Problems	Moderate
Devise A Plans	Low
Carry Out The Plan	Low
Look Back	Low

The results of the study shown in Figure 2 show the percentage of students' mastery of problem-solving skills based on four indicators, namely Understand Problems, Devise a Plan, Carry Out the Plan, and Look Back.

1. Understand Problems

This indicator shows the highest level of mastery compared to the other three indicators, with a percentage nearing 45%. This suggests that students possess a fairly good ability to identify and understand the problems presented. Although this level of mastery falls within the Moderate category, the relatively high percentage indicates that students are capable of clearly defining problems, which is a crucial initial step in the problem-solving process.

Students' ability to comprehend problems in writing is evident in how they articulate relevant information, including identifying the issues being discussed (Leonisa & Soebagyo, 2022).

Lestanti et al. (2016) emphasize that in addressing problems, including climate change issues, students are expected not only to understand the problem-solving process but also to be skilled in selecting and identifying relevant conditions and concepts. Furthermore, students should be able to seek generalizations, formulate resolution plans, and organize the skills they have previously acquired. These findings are particularly relevant in the context of research in Madura, where solving climate change-related problems requires a deep understanding of concepts and strong strategic skills.

2. Devise a Plan

In this indicator, approximately 30% of students are in the low category regarding their skills in devising problem-solving plans. This result suggests that students are unable to identify the appropriate concepts and tend to focus too much on real-world contexts without considering the necessary abstract steps. This mistake is evident when students pose irrelevant or inaccurate questions. The low percentage reflects students' difficulties in designing solutions or the steps needed to solve problems. The ability to plan solutions is a crucial aspect of problem-solving, as students must be able to think systematically and strategically. These results indicate the need for further intervention to train students in developing critical and creative thinking skills in solution design. Improving these skills will help students face more complex challenges with more directed and effective strategies (Sari & Wijaya, 2017; Arfiana & Wijaya, 2018).

3. Carry Out the Plan

The indicator of executing the plan represents the third stage in the problem-solving process. This stage is crucial because it is where students demonstrate their ability to choose the appropriate solution and implement it correctly (Elvianasti et al., 2022). Students are considered successful in executing the plan if they can not only design but also systematically execute the steps they have planned. However, at this stage, students' mastery tends to be low, with a success rate nearing 30%.

This low percentage indicates significant barriers for students in carrying out the plans they have created. While some students may have a basic understanding of the problems and can design

solutions, many struggle to implement them effectively. These difficulties may arise from various factors, such as a lack of deep understanding of the steps to be taken, an inability to modify plans when facing challenges, or a lack of perseverance in dealing with the complexities of problem-solving.

Lahinda & Jailani (2015) state that a problem can be solved using two to three different strategies. However, students often struggle to determine which strategy is most effective for a given situation. Additionally, during the implementation process, flexible thinking is often required—the ability to adjust approaches when the initial plan does not succeed. This indicates that mastery of the plan execution stage depends not only on theoretical understanding but also on adequate execution skills, the courage to try alternative solutions, and perseverance in carrying out the solution to completion.

These findings are significant in the context of problem-based learning, especially in cases that require strategic thinking, such as climate change. Given the complexity of the challenges faced, students' ability to not only design but also execute their plans effectively is a skill that must be continually practiced and enhanced through more structured and sustained approaches.

4. Look Back

This indicator also reflects low mastery, with a percentage just above 30%. The low level of proficiency in evaluating outcomes suggests that students are not accustomed to reflecting on the solutions they have implemented and assessing their effectiveness. However, reflection is a crucial step in problem-based learning. Through reflection, students can understand mistakes or weaknesses in their approaches and improve their problem-solving processes in the future.

According to Yuwono et al (2018), at the Look Back stage, students should be able to critique the results they obtain by identifying weaknesses in the applied solutions, such as inconsistencies, ambiguities, or inappropriate steps. This finding aligns with research results indicating a low level of evaluation skills among students, highlighting the need for further development of their reflective skills.

Pratikno & Retnowati (2018) also found that not all students can complete problems to this stage. Only students with a high level of achievement are able to solve math problems by following all stages of Polya's method. Learning that emphasizes information-based decision-making in problem-solving can enhance problem-solving skills. This aligns with Taufik's (2010) assertion that problems provide opportunities to increase motivation in students, enabling them to learn more effectively in solving complex issues.

Conclusion

Based on the presented data, the distribution of problem-solving skills among 63 students shows that the majority fall into the low category, with 46 students (73%) demonstrating inadequate problem-solving abilities. Only 17 students (27%) are in the moderate category, while no students reached the high or very high categories. These results indicate that, although a small percentage of students possess moderate skills, this figure still falls short of expectations. Further analysis of the problem-solving skill indicators reveals that the average skill level of students regarding climate change topics is low. In the Understand Problems indicator, students are classified as Moderate, while in the Devise a Plan, Carry Out the Plan, and Look Back stages, their skills are categorized as Low. These findings highlight the need for more effective interventions in education to develop students' problem-solving skills, particularly in addressing complex issues such as climate change. Such efforts are essential to enhance students' abilities to design and implement effective solutions in the future.

Therefore, it is essential to implement teaching strategies that focus on developing these skills, such as Project-Based Learning or a more integrated STEAM approach. Strengthening these skills can also be achieved through interactive and contextual problem-based learning methods, providing scenarios relevant to local or global issues like climate change. The implementation of these strategies is expected to improve student proficiency across all problem-solving skill indicators.

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References

Arfiana, A., & Wijaya, A. (2018). Problem solving skill of students of senior high schools and Islamic high schools in Tegal Regency in solving the problem of PISA based on Polya ' s stage. *Jurnal Riset Pendidikan Matematika*, *5*(2), 211–222.

Baker, R., & Baker, R. (2017). Problemsolving. *Agile UX Storytelling: Crafting Stories for Better Software* Development, 107–116

Care, E., Griffin, P., Scoular, C., Awwal, N., & Zoanetti, N. (2015). Collaborative problem solving tasks.

Assessment and Teaching of 21st Century Skills: *Methods and Approach,* 85–104.

Elvianasti, M., Kharisma, N. A. ., Irdalisa, & Yarza, H. N. (2022). Analisis Kemampuan Pemecahan Masalah Matematis Peserta didik pada Materi Peluang. *Jurnal Penelitian Dan Pembelajaran Fisika*, *8*(1), 1–9. https://doi.org/10.30983/lattice.v2i1.5542

Esterlina, Dahlan, J. A., & Martadiputra, B. A. (2022). Analisis Kemampuan Pemecahan Masalah Siswa Dalam Menyelesaikan Masalah Non-Rutin Statistik. *Jurnal Pembelajaran Matematika Inovatif*, *6*(4), 95–115. https://doi.org/10.22460/jpmi.v6i4.17808

Fura, A. N. A. J., Wiyono, R. U. A., & Indarto, I. (2020). Kecenderungan dan Perubahan Hujan Ekstrem Harian di Pulau Madura. *Jurnal Ilmu Lingkungan*, *18*(1), 89–96. https://doi.org/10.14710/jil.18.1.89-96

Hidayah, T. N., Hasanuddin, Y. H., & Purbaningrum, D. G. (2024). Analisis Dampak dan Peran Perempuan dalam Bencana Perubahan Iklim di Indonesia. *Arus Jurnal Sosial Dan Humaniora (AJSH)*, *4*(2), 792–799. http://jurnal.ardenjaya.com/index.php/ajshhttp://jurnal.ardenjaya.com/index.php/ajsh

Jayadiningrat, M. G., & Ati, E. K. (2018). Peningkatan Keterampilan Memecahkan Masalah Melalui Model Pembelajaran Problem Based Learning (Pbl) Pada Mata Pelajaran Kimia. *Jurnal Pendidikan Kimia Indonesia*, *2*(1), 1–10. https://doi.org/10.23887/jpk.v2i1.14133

Kumalasari, N. R. (2014). Kapasitas Adaptasi terhadap Kerentanan dan Bencana Peruhaban Iklim di Tambak Lorok Kelurahan Tanjung Mas Semarang. *Jurnal Pembangunan Wilayah dan Kota*, 10(4), 476-487.

Lahinda, Y., & Jailani, J. (2015). Analisis Proses Pemecahan Masalah Matematika Siswa Sekolah Menengah Pertama. *Jurnal Riset Pendidikan Matematika*, 2(1), 148–161. https://doi.org/10.21831/jrpm.v2i1.7157

Lestanti, M. M., Isnarto, I., & Supriyono, S. (2016). Analisis Kemampuan Pemecahan Masalah Ditinjau dari Karakteristik Cara Berpikir Siswa dalam Model Problem Based Learning. *Unnes Journal of Mathematics Education*, 5(1). https://doi.org/10.15294/UJME.V5I1.9343

Lu, S.-J., Lin, Y.-C., Tan, K. H., & Liu, Y.-C. (2022). Revolutionizing elementary disaster prevention education and training via augmented reality-enhanced collaborative learning. *International journal of engineering business management*, 14. doi:10.1177/18479790211067345

Latifah, I., Nugraha, M. G., & Wijaya, A. F. C. (2018). Integrasi ESD (Education Sustainable Development) dalam Pembelajaran Problem Based Learning (PBL) Untuk Meningkatkan Penguasaan Konsep Siswa SMP. *Prosiding Seminar Nasional Fisika (SINAFI)*, 75–81.

Leonisa, I., & Soebagyo, J. (2022). Strategi Siswa dan Langkah Polya dalam Penyelesaian Masalah Matematis Berbasis HOTS. *Proximal: Jurnal Penelitian Matematika Dan Pendidikan Matematika*, *5*(2), 77–86. https://doi.org/10.30605/proximal.v5i2.1852

Marina, F., Maulina, P., & Fadhlain, S. (2021). Manajemen komunikasi bencana BPBD Nagan Raya pada situasi terdapat potensi bencana. *Jimsi: Jurnal Ilmiah Mahapeserta didik Komunikasi*, 1(1), 14–22. http://jurnal.utu.ac.id/JIMSI/article/view/34 49

Martz, B., Hughes, J., & Braun, F. (2017). Creativity and problem-solving: Closing the skills gap. *Journal of Computer Information Systems*, 57(1), 39–48

Mukarromah, M., Budijanto, B., & Utomo, D. H. (2020). Pengaruh Model Challenge Based Learning terhadap Kemampuan Berpikir Kritis Siswa SMA pada Materi Perubahan Iklim. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *5*(2), 214–218.

Nur, S., Fatimah, H., & Zakaria, ZakariaSyamsidar, H. (2024). Peran Perempuan Dalam Upaya Mitigasi Bencana Perubahan Iklim. *An-Nisa'*, *17*(1), 33–40. https://doi.org/10.30863/an.v17i1.6730

Ridwan, I. M., Kaniawati, I., Suhandi, A., Ramalis, T. R., Rizal, R., & Sujarwanto, E. (2023). Tes Kemampuan Pemecahan Masalah pada Tema Perubahan Iklim: Analisis Rasch Model. *DIFFRACTION: Journal for Physics Education and Applied Physics*, *5*(1), 37–46. https://doi.org/10.37058/diffraction.v5i1.7738

Rusdi, M., Bennu, S., & Jaeng, M. (2019). Penerapan Langkah-langkah Pemecahan Masalah Menurut Polya untuk Meningkatkan Hasil Belajar Siswa pada Materi Perbandingan Berbalik Nilai di Kelas VII A SMP Labschool UNTAD Palu. *Jurnal Elektronik Pendidikan Matematika*, *6*(2015), 365–375.

Setiadi, W. (2024). Jogja Youth : Responding to Climate Change Through Disaster Risk Reduction in Learners Kaum Muda Jogja : Merespons Perubahan Iklim melalui Pengurangan Risiko Bencana pada Peserta Didik. *E-Proceeding: Indonesia Social Responsibility Award*, 9–18.

Sulistiowati, D. L. (2022). Faktor Penyebab Kesulitan Siswa dalam Memecahkan Masalah Geometri Materi Bangun Datar. *Jurnal Multidisiplin Ilmu*, *1*(5), 941–951.

Susilawati, S. (2021). Dampak perubahan iklim terhadap kesehatan. *E-SEHAD*, *1*(2), 25–31.

Pratikno, H., & Retnowati, E. (2018). How Indonesian Students Use the Polya's General Problem Solving Steps. *Southeast Asian Mathematics Education Journal*, 8(1), 39–48. https://doi.org/10.46517/seamej.v8i1.62

Sari, R. H. N., & Wijaya, A. (2017). Mathematical literacy of senior high school students in Yogyakarta. *Jurnal*

Riset Pendidikan Matematika, 4(1), 2017, 100-107. doi:10.21831/jrpm.v4i1.10649

Sukmadinata, N. S. (2010). Metode Penelitian Pendidikan. Bandung: *Remaja Rosda Karya*

Sukmadinata, N. S. (2012). Metode Penelitian Pendidikan. PT. *Remaja Rosdakarya*

Taufik, A. (2010). Inovasi Pendidikan Melalui Problem Based Learning. Jakarta*: Kencana.*

Yuwono, T., Supanggih, M., & Ferdiani, R. D. (2018). Analisis Kemampuan Pemecahan Masalah Matematika dalam Menyelesaikan Soal Cerita Berdasarkan Prosedur Polya. *Jurnal Tadris Matematika*, *1*(2), 137–144. https://doi.org/10.21274/jtm.2018.1.2.137-144