UJME 15 (2) 2026: 69-79
UNNES JOURNAL OF MATHEMATICS EDUCATION
https://journal.unnes.ac.id/journals/ujme
ISSN: 2252-6927 (print); 2460-5840 (online)

Analysis of Students' Mathematical Problem-Solving Process in Geometry Learning Assisted by Augmented Reality

Delia Putri Ramadhani[a,*], Ishaq Nuriadin[a]

[a] *Mathematics Education FKIP Universitas Muhammadiyah Prof. Dr. Hamka, Jalan Tanah Merdeka No. 20, Jakarta City, 13830, Indonesia*

** E-mail address: ptrramadhani9@gmail.com*

ARTICLE INFO

Article history:
Received 10 July 2026
Received in revised form 19 July 2026
Accepted 24 July 2026

Keywords:
Assembler Edu; Augmented Reality; Geometry Learning; Mathematical Problem Solving; Polya's Stages

Abstract

This study was motivated by students' difficulties in solving problems related to geometry, particularly in understanding mathematical concepts and visualizing geometric objects. Augmented Reality through the Assembler Edu app helps students visualize these concepts interactively. This study aims to analyze students' process to solve math problems in geometry with the help of Augmented Reality. The research design used was a descriptive qualitative method focusing on 3 representative eighth-grade students (selected from high, medium, and low performance categories for in depth analysis) from Class VIII at a junior high school in Jakarta, Indonesia. Data were collected through mathematical problem-solving tests assisted by the Assembler Edu application and semi-structured interviews based on Polya's problem-solving stages. The results showed that 7 students (24.14%) were categorized as having high, 6 students (20.69%) as medium, and 16 students (55.17%) as low. Students in the high category were able to complete all stages of Polya's problem-solving framework. Students in the medium category successfully understood the problems, devised appropriate solution plans, and carried out the required calculations but experienced difficulties in evaluating their solutions and formulating conclusions. In contrast, students in the low category experienced difficulties in devising appropriate solution strategies, applying mathematical concepts, and evaluating their answers. The findings also revealed that students perceived Assembler Edu as helpful in visualizing geometric objects while solving geometry problems, although many students still experienced difficulties in completing all the stages of Polya's problem-solving process.

© 2026 Published by Mathematics Department, Universitas Negeri Semarang

1. Introduction

Mathematical problem-solving process is one of the essential competencies that students need to develop in the 21st century because it enables them to think critically, logically, and systematically when solving mathematical and real-life problems (Lesi & Nuraeni, 2021). This capability is considered a fundamental cognitive skill that should be nurtured from secondary education to equip students with the capacity to handle modern complexities (Kurniasari & Sritresna, 2022). Fundamentally, problem-solving is not merely a technical skill but a comprehensive learning process where students receive, respond to, and overcome various cognitive challenges encountered during instruction (Hartinah et al., 2019; Rasmitadila et al., 2021; Suparman et al., 2022). When students master this ability, it triggers an intrinsic motivation that fosters greater enthusiasm and engagement toward mathematics (Nugraha & Basuki, 2021). Furthermore, it serves as a primary determinant of a student's success in grasping advanced mathematical structures (Zakiyah et al., 2019).

Therefore, many students have difficulty solving math problems, especially those involving geometry, which is often considered difficult because the concepts are too abstract and require visualizing three-dimensional objects (Busrah & Hafis, 2023; Yanty Putri Nasution, 2017). In the classroom context, these

To cite this article:
Ramadhani, D. P. & Nuriadin, I. (2026). Analysis of Students' Mathematical Problem-Solving Process in Geometry Learning Assisted by Augmented Reality. *Unnes Journal of Mathematics Education*, *15*(2), 69-79. doi: 10.15294/ujme.v15i2.58857

obstacles often manifest when students attempt to translate the teacher's explanations into concrete mental models, leading to failures in applying geometric principles to real-world scenarios, such as calculating the surface area or volume of complex shapes (Lestari et al., 2021; Marasabessy et al., 2021). In addition, differences in students' levels of geometric thinking can affect their problem-solving stages (Widiyaningsih et al., 2020). Students' limited ability to visualize geometric shapes makes it difficult for them to grasp essential information, formulate solution strategies, and apply geometric principles effectively (Lestari et al., 2021; Marasabessy et al., 2021).

Polya's problem-solving stages are among the most widely used frameworks for analyzing student's mathematical problem-solving process. These stages consist of (1) understanding the problem; (2) formulating a plan; (3) implementing the plan; and (4) evaluating the solution (Kartini et al., 2020; Malikah, 2023). These steps help students' analyze their thought processes systematically. By operationalizing Polya's framework, educators can clearly trace where the cognitive breakdown occurs when students face non-routine tasks. However, based on findings in the field, students often face challenges, particularly when understanding the questions, determining strategies, and verifying whether their answers are correct or not (Fatmala et al., 2020; Madzkiyah & Arifin, 2024; Pebrianti et al., 2023). Empirical evidence indicates that students frequently commit calculation errors, misinterpret the core problem requirements, and rarely engage in the crucial final step of looking back or verifying their solutions (Fatmala et al., 2020; Pebrianti et al., 2023). To mitigate these persistent hurdles, an innovative instructional approach that bridges abstract text and spatial visualization is urgently required.

In the modern era, technology drives innovative learning, one such technology is Augmented Reality, which has garnered attention, particularly in mathematics education. Augmented Reality helps users view virtual objects directly and in real time (Miyanti et al., 2023). Through AR, virtual elements in the form of two-dimensional or three-dimensional objects can be seamlessly simulated and integrated into a real-world environment (Uno, 2024). In geometry lessons, augmented reality can help students visualize abstract objects on a more concrete and interactive way, enabling them to understand mathematical concepts accurately (Walkington et al., 2025; Widyasari & Mastura, 2020). This technology strengthens students' spatial visualization skills, making previously complex geometric properties considerably more accessible and detailed (Sodikin et al., 2024). For instance, students can dynamically observe shape transformations and structural changes based on modified variables (Angraini et al., 2022). In this study, AR was implemented using the Assembler Edu app. Through interactive 3D visualizations, students can view geometric shapes from various angles while exploring geometry concepts in a more tangible and easily understandable way.

Several studies have shown that Assembler Edu-based educational media is quite effective in helping students understand mathematical concepts. In addition, this media is also said to improve students' reasoning abilities, learning outcomes, and critical thinking skills (Khayroiyah et al., 2026; Nadjla & Wahyuni, 2024; Ruslan et al., 2024; Ulkhoiroh, 2025). Furthermore, Augmented Reality can support geometry learning by providing interactive and immersive learning experiences that facilitate students' understanding of geometric concepts (Uriarte-Portillo et al., 2023). Extensive literature confirms that AR integration effectively addresses the challenges of learning abstract math concepts (Syahida et al., 2020). For example, utilizing AR for 3D shapes like cubes and cuboids significantly improves conceptual understanding and student interest (Umam et al., 2024). Similarly, dedicated AR applications like 'LearnGeoAR' have been shown to drastically boost spatial visualization abilities in school settings (Nadzeri et al., 2024). Ultimately, learning geometry through AR fosters a more meaningful understanding while simultaneously elevating students' learning motivation (Hadi et al., 2024; Meilindawati et al., 2023). Furthermore, studies specifically analyzing students' mathematical problem-solving processes in geometry lesson supported by Assembler Edu remain limited. Therefore, this study focuses on analyzing students' mathematical problem-solving process in geometry using Augmented Reality through the Assembler Edu application.

2. Methods

This study used a descriptive qualitative approach design to analyze students' mathematical problem-solving process to geometry problems with the aid of Augmented Reality. The study was conducted at a junior high school in Jakarta and involved 29 students in Class VIII during the 2025/2026 school year. To

conduct a deep qualitative analysis, 3 representative subjects one from each of the high, medium, and low categories were selected from the class using purposive sampling for further evaluation.

The research employed two data collection techniques, mathematical problem-solving test and semi-structured interviews. The test, designed to identify students' mathematical problem-solving process based on Polya's framework, assesses problem comprehension, strategy planning, plan execution, and answer verification. To gain a deeper understanding of these skills, the researchers also supplemented the data with semi-structured interviews conducted with the 3 selected representative subjects. The research instrument was developed based on Polya's problem-solving process.

The researchers applied a triangulation method by comparing the results of the math problem-solving tests with interview data to ensure the validity of the data (Huberman, 1994). This triangulation was conducted to verify the consistency of students' responses and to obtain a more comprehenssive understanding of their mathematical problem-solving processes.

The research procedure began with administering a mathematical problem-solving test in which students used the Assembler Edu application solely as a visual aid to observe three-dimensional representations of the geometric objects presented in the test. The application was intended only to facilitate the visualization of geometric objects, while students recorded their answers on the provided answer sheets.

The assessment of students' written answers was conducted using a scoring rubric based on Polya's four-stage model to ensure objective evaluation. Instead of a simple correct-or-wrong system, each stage was scored on a scale from 0 to 4. This detailed scaling was used to capture variations in students' problem-solving steps and mathematical accuracy. The complete scoring criteria for each stage of Polya's problem-solving process are presented in Table 1.

Table 1. Scoring Rubric for Students' Mathematical Problem-Solving Process Based on Polya's Framework

Polya's Stages	Description of Student Response	Score
Understanding the Problem	Correctly and completely writes down both what is given and what is asked in the problem.	4
	Write down what is given and what is asked, but one of them is incomplete or slightly incorrect.	3
	Correctly writes down only what is given or only what is asked.	2
	Writes down what is given and/or what is asked, but the information is inaccurate.	1
	Does not write down what is given or what is asked at all.	0
Devising a Plan	Correctly and completely writes down the mathematical model or formula leading to the right solution.	4
	Writes the correct mathematical model or formula, but it is incomplete, leading to an incorrect solution.	3
	Writes an incorrect mathematical model or formula, but it is fully completed, leading to a wrong solution.	2
	Writes a mathematical model or formula that is both incorrect and incomplete, leading to a wrong solution.	1
	Does not write down any mathematical model or formula used.	0
Carrying out the Plan	Solves the problem using the correct procedure and performs all calculations accurately.	4
	Uses the correct procedure to solve the problem but makes errors in the calculations.	3

	Does not follow a structured procedure but manages to get the correct calculation and answer.	2
	Solves the problem using an incorrect procedure and inaccurate calculations.	1
	Provides no mathematical solution or execution at all.	0
Looking Back	Writes down the correct conclusion and performs an accurate verification of the answer.	4
	Writes the conclusion correctly but is slightly inaccurate in stating the final answer asked.	3
	Writes the conclusion correctly but fails to state the correct final answer, or vice versa (correct answer but no conclusion).	2
	Writes a conclusion and/or answer verification that is vague or incorrect.	1
	Does not write down any final conclusion or verification of the answer.	0

Source: Adapted from (Mawardi et al., 2022)

After completing the test, students' responses were scored and categorized into three levels of mathematical problem-solving process based on the criteria presented in Table 2 (Davita & Pujiastuti, 2020). To calculate these levels, the raw test points obtained by each student were first converted into a standardized scale out of 100. Following the formula adapted from Mawardi et al. (2022), the equation is defined as follows:

$$Final\ score = \frac{Total\ Score\ Obtained}{Maximum\ Score} \times 100$$

Where the maximum score represents the highest possible points a student could achieve across all stages of Polya's problem-solving process. These calculated final scores were then used as the empirical basis for interpreting and classifying the students' abilities. One representative student from each category was then selected for semi-structured interviews to obtain more comprehensive information regarding their mathematical problem-solving processes.

The data obtained were analyzed using a qualitative data analysis model consisting of data reduction, data presentation, and drawing conclusions (Huberman, 1994), to describe students' mathematical problem-solving process according to Polya's problem-solving stages.

Table 2. Criteria for Students' Mathematical Problem-Solving Process Categories

Score Interval	Category
$80 \leq x \leq 100$	High
$60 \leq x < 80$	Medium
$x < 60$	Low

Source: Adapted from (Davita & Pujiastuti, 2020).

3. Results & Discussions

Students' answers were grouped into three categories: high, medium, and low. The distribution of students' mathematical problem-solving abilities in each category is presented in Table 3.

Table 3. Distribution of Students' Mathematical Problem-Solving Process

Category	Number of Students	Percentage
High	7	24.14%
Medium	6	20.69 %
Low	16	55.17 %
Total	29	100.00 %

Based on the results of the mathematical problem-solving test administered to 29 students, 7 students (24.14%) were classified into the high category, 6 students (20.69%) into the medium category, and 16 students (55.17%) into the low category. Findings show that most students have relatively low mathematical problem-solving performance. Therefore, the researchers selected one representative student from each category for further in-depth study, in order to describe their problem-solving process in accordance with Polya's steps.

To provide a more detailed description of students' mathematical problem-solving process, the written response of the representative student in the high category is presented in Figure 1.

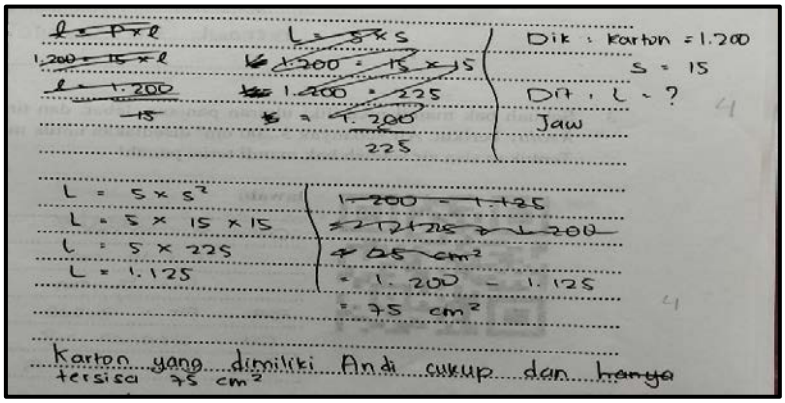


Figure 1. Student Answer in the High Category

Figure 1 shows that students in the high category successfully completed all four of Polya's steps. These students' written answers are presented in Figure 1. At the understanding the problem stage, the student correctly identified the given and required information. The student used the surface area formula of an open cube to choose a suitable strategy during the plan-making phase. Additionally, the student methodically calculated the necessary cardboard area of 1,125 cm^2 throughout the plan execution stage, leaving 75 cm^2 of cardboard unused.

In the final stage, the student was able to conclude that Andi had enough cardboard to make a storage box without a lid, and the student accurately calculate the amount of cardboard Andi had left. Based on the test results, the student was able to correctly complete all stages of Polya's problem-solving model.

The interview results revealed that before working on the problem, the student understood the question being asked. He said, "I read the problem and understood it, then wrote down what was given and what was being asked." The student also said that before writing down the formula used, he first identified the type of three-dimensional shape, stating, "I figured out what shape it was, then I recalled the formula for that three-dimensional shape."

The student explained that augmented reality through the Assembler Edu app helped and facilitated the problem-solving process, particularly in determining the correct formula. He stated, "This app helps me clearly visualize three-dimensional shapes and helps me determine the formulas, especially for volume problems." Additionally, after completing all the problems, the student double-checked his answers to ensure their accuracy: "After I finished all the problems, I checked everything again from the beginning."

These interview findings indicate that the student systematically applied the stages of mathematical problem solving by understanding the problem, identifying the known and required information, selecting the appropriate formula, carrying out the calculations, and reviewing the final answers. In addition, the student perceived Assembler Edu as helpful in supporting geometry learning, particularly in identifying three-dimensional shapes and determining the appropriate formulas. This finding is consistent with Malikah (2023), who reported that students with high mathematical problem-solving process tend to apply problem-solving stages systematically and obtain accurate solutions.

Overall, the consistency between the answers on the written exam and the interview results indicates that the student was able to apply all of Polya's stages systematically. Figure 2 displays the representative student's written response for the medium category.

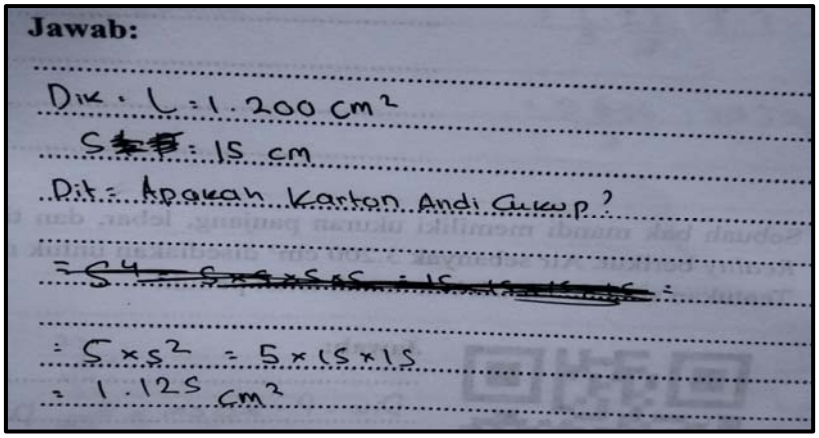


Figure 2. Student Answer in the Medium Category

Figure 2 shows the answer of a student in the medium category. Based on the test results, the students successfully completed several steps. In the step of understanding the question, the student was able to identify the information provided namely, that the area of the cardboard is $1{,}200\ cm^2$ and length of the cube's side is $15\ cm$, and to identify the question being asked whether Andi's cardbard is enough to make an open cube.

During the planning stage, the student was able to apply mathematical concepts accurately using the appropriate formulas, namely $5s^2$. Furthermore, at the carrying out the plan stage, the student substituted the edge length of $15\ cm$ into the formula and correctly calculated the required cardboard area as $1{,}125\ cm^2$.

However, at the looking back stage, the student did not demonstrate any verification or evaluation of the obtained result. The student also did not compare the required cardboard area with the available cardboard area or provide a final conclusion addressing the problem. The test results showed that students were able to understand the questions, formulate a solution strategy, and perform calculations correctly, but still had difficulty evaluating the results obtained and drawing a final conclusion.

The interview results revealed that the first step the student took was to identify the information provided and what was being asked in the problem. As he said, "I gathered all the information provided in the problem and what was being asked." Regarding the use of Assembler Edu, the student said, "The app is easy to access and helpful because the images are clearer and easier to understand." He also explained that he determined the correct formula by recalling the formula for the surface area of a cube, stating, "I remembered the formula for the surface area of a cube, then I used that formula."

However, after receiving the answer, the student admitted that he did not always check his work, saying, "Sometimes I do, sometimes I don't." He also admitted, "Sometimes I forget to write a conclusion at the end." This is consistent with the test results, which show that the student was able to understand the problem, formulate an appropriate plan, and perform the calculations correctly, but failed to complete the final step that is, checking the work. Consequently, although the student successfully completed the first three stages of Polya's problem-solving framework, he experienced difficulties in evaluating the obtained result and formulating a final conclusion. This finding is in line with Wahab A et al. (2024), who reported

that students frequently encounter difficulties in interpreting results, evaluating solutions, and writing clear conclusions during the looking back stage. Consequently, students may complete the calculations correctly but fail to provide an appropriate final conclusion that answers the problem.

Overall, both the results of the written test and the interview results indicate that the main difficulty students faced was in evaluating the solutions they had arrived at and writing the correct conclusions. The written response of the representative student in the low category is presented in Figure 3.

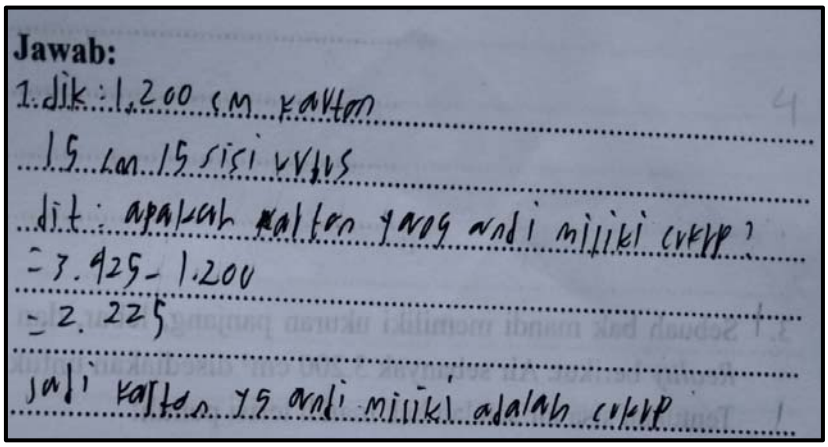


Figure 3. Student Answer in the Low Category

A student in the low category's response is displayed in Figure 3. The student in the low category was only able to complete the first step of Polya's problem-solving procedure, according to the findings of the mathematical problem-solving test. At the understanding the problem stage, the student identified the known information, namely the cardboard area of $1{,}200\ cm^2$ and the cube edge length of $15\ cm$. The student also stated the question being asked, which was whether the available cardboard was sufficient to construct an open-top cube.

However, at the devising a plan stage, the student was unable to determine an appropriate strategy for solving the problem. The student did not write the formula for the surface area of an open-top cube, indicating a lack of understanding of the mathematical concept required to solve the problem.

During the implementation phase (carrying out the plan), the student made a computational error by inappropriately subtracting the values of coordinates without a sound mathematical basis. Consequently, the chosen method became irrelevant to the context of the question, making a valid solution impossible to achieve.

Moving to the final evaluation stage (looking back), the student prematurely concluded that the available cardboard would be enough to build the cube. However, because this deduction did not stem from a correct mathematical procedure, the student could not verify the validity of the result or critically assess whether the answer truly addressed the core problem.

These collective findings suggest that the student struggled to connect the data provided in the prompt with the necessary mathematical principles during the planning phase (devising a plan). This cognitive gap ultimately prevented them from structuring a workable solution layout and arriving at a precise conclusion.

The qualitative data from the interview deeply aligned with these results. At first, the student mentioned that their initial step was to look for what was known in the problem. When prompted further about what specific data they usually targeted, the student simply remarked, "The given information." Regarding their experience using the Assembler Edu platform, the student noted, "It helped because I could see it more clearly," adding that one of the main perks was that "it is very advanced because it has 3D."

Nevertheless, when pressed on how they actually figured out the correct formula to use, the student was unable to clarify their thought process and merely confessed, "I don't know." This reaction highlights a clear struggle in mapping out mathematical concepts and designing a functional workflow. This phenomenon mirrors the study by Latifah et al. (2021), which underscores that students frequently face hurdles when choosing formulas, building mathematical models, and drawing accurate inferences during problem-solving tests.

Furthermore, although the student claimed that they attempted to fix mistakes by "doing it again," they remained stuck and could not fix the flawed logic. This interview insight perfectly matches the written test data, where the student consistently failed to map out a proper strategy and botched the execution. Such a trend is heavily supported by Rahmawati et al. (2024), who pointed out that learners with low problem-solving category typically struggle to choose the right strategy, integrate applicable concepts, and review their final output. As a direct consequence of these deficiencies, students are highly prone to using faulty procedures that yield wrong answers (Rahmawati et al., 2024).

In summary, the evidence demonstrates that while the student succeeded in isolating what was given and what was asked, a major roadblock persisted in converting that raw data into a functional mathematical strategy, which ultimately derailed the entire solution and its final conclusion.



Figure 4. Student using Assembler Edu Web-AR as a visual aid during the geometry test

To give a clearer picture of how the technology was used during the test, Figure 4 shows a student actively using the Assembler Edu app. Here, the AR app worked strictly as a 3D visual aid without changing how the test was run. Students just needed to scan the provided QR code to see a realistic 3D model of the geometric shape from different angles right on their phone screen. As seen in the photo, the student looked at the digital 3D model on their screen while writing down their mathematical steps on the paper answer sheet.

This real-time visual really helped students in the early stages of Polya's steps, especially in understanding the problem and making a plan. By looking at the 3D shape, students didn't have to struggle imagining abstract shapes in their heads. They could easily see the edges, surfaces, and hidden corners that are usually hard to spot in flat 2D textbook drawings. Even though the app doesn't give away the formulas or answers, this clear visualization guides the students' thinking process, helping them get a solid idea of the shape before they start doing the math.

4. Conclusion

This study analyzed students' mathematical problem-solving process in geometry using the Assembler Edu application. The results showed that students' mathematical problem-solving process varied across Polya's problem-solving stages. Students in the high category successfully completed all four stages of Polya's framework. Students in the medium category were able to understand the problems, devise appropriate solution plans, and carry out the required calculations correctly, but still experienced difficulties in evaluating their solutions and formulating conclusions. Meanwhile, students in the low category experienced difficulties in devising appropriate solution strategies, applying relevant mathematical concepts, and evaluating their solutions. These findings indicate that students' mathematical problem-solving process in geometry assisted by Assembler Edu differ according to their performance category, with the most prominent difficulties occurring at the devising a plan and looking back stages. The interview findings revealed that students perceived Assembler Edu as helpful in visualizing geometric objects, which facilitated their understanding of the concepts learned during geometry instruction. These findings indicate that Assembler Edu can support students in visualizing geometric objects during the mathematical problem-solving process. However, students still require guidance in developing appropriate solution strategies and

evaluating their solutions. Therefore, although Assembler Edu helps students understand and visualize geometric concepts, teachers should provide more structured guidance to help students transform the given information into appropriate problem-solving strategies, perform reflection on their solutions, and formulate conclusions at the final stage of the problem-solving process.

References

Angraini, L. M., Alzaber, A., Sari, D. P., Yolanda, F., & Muhammad, I. (2022). Improving Mathematical Critical Thinking Ability Through Augmented Reality-Based Learning. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(4), 3533. https://doi.org/10.24127/ajpm.v11i4.5968

Busrah, Z. (2023). *INTEGRASI KONSEP GEOMETRI MELALUI ETNOMATEMATIKA PADA ALAT PERTANIAN TRADISIONAL SUKU BUGIS*.

Davita, P. W. C., & Pujiastuti, H. (2020). Anallisis Kemampuan Pemecahan Masalah Matematika Ditinjau Dari Gender. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *11*(1), 110–117. https://doi.org/10.15294/kreano.v11i1.23601

Fatmala, R. R., Sariningsih, R., & Zanthy, L. S. (2020). Analisis Kemampuan Pemecahan Masalah Matematis Siswa Smp Kelas VII Pada Materi Aritmetika Sosial. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *4*(1), 227–236. https://doi.org/10.31004/cendekia.v4i1.192

Hadi, H., Zahrani, D., & Mataram, U. (2024). *Peningkatan Hasil Belajar Geometri Dan Aritmatika Sosial Improving Geometry and Social Arithmetics Learning Outcomes for Fifth-Grades Students Using Augmented*. *4*(2), 135–141.

Hartinah, S., Suherman, S., Syazali, M., Efendi, H., Junaidi, R., Jermsittiparsert, K., & Umam, R. (2019). Probing-prompting based on ethnomathematics learning model: The effect on mathematical communication skills. *Journal for the Education of Gifted Young Scientists*, *7*(4), 799–814. https://doi.org/10.17478/jegys.574275

Huberman, M. &. (1994). An analytic approach for discovery. In *CEUR Workshop Proceedings* (Vol. 1304, pp. 89–92).

Kartini, H. A., Ario, M., & Sari, R. N. (2020). Pengaruh Pendekatan Pembelajaran Problem Solving Model Polya terhadap Kemampuan Pemecahan Masalah Matematis Siswa Kelas VIII SMP Muhammadiyah Rambah. *Jurnal Pendidik Indonesia*, *1*(1), 17–24. https://doi.org/10.61291/jpi.v1i1.4

Khayroiyah, S., Dwi, D. F., & Irwansyah. (2026). *PENGEMBANGAN MEDIA PEMBELAJARAN BERBASIS AUGMENTED REALITY DENGAN APLIKASI ASSEMBLR EDU UNTUK MENINGKATKAN PENALARAN MATEMATIS SISWA*. *11*.

Kurniasari, D., & Sritresna, T. (2022). Kesulitan pemecahan masalah matematis siswa berdasarkan self-esteem pada materi statistika. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, *1*(1), 47–56. https://doi.org/10.31980/powermathedu.v1i1.1915

Latifah, T., Afriansyah, E. A., Barat, J., & Barat, J. (2021). *Kesulitan dalam kemampuan pemecahan masalah matematis siswa pada materi statistika*. *3*(2), 134–150.

Lesi, A. N., & Nuraeni, R. (2021). *Perbedaan Kemampuan Pemecahan Masalah Matematis dan Self-Confidence Siswa antara Model TPS dan PBL*.

Lestari, S., Ikhsan, M., & Umam, K. (2021). Kesulitan Siswa SMP Kelas IX dalam Menyelesaikan Soal Limas. *Jurnal Peluang*, *9*(1), 9–14. https://doi.org/10.24815/jp.v9i1.27951

Madzkiyah, A. F., & Arifin, S. (2024). *Students ' Problem - Solving Skills Based on Polya ' s Stages*. *7*(2), 92–100.

Malikah, S. (2023). Analisis kemampuan pemecahan masalah matematis Siswa pada barisan dan deret aritmetika berdasarkan teori Polya. *Primatika : Jurnal Pendidikan Matematika*, *12*(2), 89–98. https://doi.org/10.30872/primatika.v12i2.2579

Marasabessy, R., Hasanah, A., & Juandi, D. (2021). Bangun Ruang Sisi Lengkung dan Permasalahannya dalam Pembelajaran Matematika. *EQUALS: Jurnal Ilmiah Pendidikan Matematika*, *4*(1), 1–20. https://doi.org/10.46918/equals.v4i1.874

Mawardi, K., Arjudin, A., Turmuzi, M., & Azmi, S. (2022). Analisis Kemampuan Pemecahan Masalah Matematika pada Siswa SMP dalam Menyelesaikan Soal Cerita Ditinjau dari Tahapan Polya. *Griya Journal of Mathematics Education and Application*, *2*(4), 1031–1048.

https://doi.org/10.29303/griya.v2i4.260

Meilindawati, R., Zainuri, Z., & Hidayah, I. (2023). Penerapan Media Pembelajaran Augmented Reality (Ar) Dalam Pembelajaran Matematika. *JURNAL E-DuMath*, *9*(1), 55–62. https://doi.org/10.52657/je.v9i1.1941

Miyanti, V., Muhidin, A., & Ardiatma, D. (2023). Implementasi Metode Markerless Augmented Reality Sebagai Media Promosi Home Furnishing Berbasis Android. *MALCOM: Indonesian Journal of Machine Learning and Computer Science*, *4*(1), 71–77. https://doi.org/10.57152/malcom.v4i1.1019

Nadjla, A. A., & Wahyuni, D. (2024). *The Use of Assemblr edu as an Interactive Learning Medium to Improve Mathematical Critical Thinking Skills*. *2023*, 1–8.

Nadzeri, M. B., Musa, M., Meng, C. C., & Ismail, I. M. (2024). The Effects of Augmented Reality Geometry Learning Applications on Spatial Visualization Ability for Lower Primary School Pupils. *International Journal of Interactive Mobile Technologies* , *18*(16), 104–118. https://doi.org/10.3991/ijim.v18i16.47079

Nugraha, M. R., & Basuki, B. (2021). Kesulitan Kemampuan Pemecahan Masalah Matematis Siswa SMP di Desa Mulyasari pada Materi Statistika. *Plusminus: Jurnal Pendidikan Matematika*, *1*(2), 235–248. https://doi.org/10.31980/plusminus.v1i2.1259

Pebrianti, A., Usdiyana, D., Dedy, E., & Sudihartinih, E. (2023). Kesulitan Siswa Dalam Menyelesaikan Soal Pemecahan Masalah Ditinjau Dari Kemampuan Awal Matematika Siswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(3), 3530. https://doi.org/10.24127/ajpm.v12i3.7400

Rahmawati, N. K., Triyono, A., Kusuma, A. P., & N Putri, I. (2024). Types and Factors of Student Difficulty Solving Algebra Problems Based on Polya Stages. *Logaritma : Jurnal Ilmu-Ilmu Pendidikan Dan Sains*, *12*(2), 231–250. https://doi.org/10.24952/logaritma.v12i2.13397

Rasmitadila, Widyasari, Prasetyo, T., Rachmadtullah, R., Samsudin, A., & Aliyyah, R. R. (2021). General teachers' experience of the Brain's natural learning systems-based instructional approach in inclusive classroom. *International Journal of Instruction*, *14*(3), 95–116. https://doi.org/10.29333/iji.2021.1436a

Ruslan, R., Djam'an, N., & Muhtar, M. N. G. I. (2024). Pengaruh Model Problem Based Learning berbasis Assemblr EDU Augmented Reality terhadap Hasil Belajar Geometri Siswa Kelas VII. *Issues in Mathematics Education (IMED)*, *8*(1), 74–78. https://doi.org/10.35580/imed.v8i1.1794

Sodikin, Santoso, G., Darmawati, A., & Setiawati. (2024). Eksplorasi Dimensi Mahasiswa: Matematika Bangun Ruang dalam Tiga Dimensi. *Jurnal Pendidikan Transformatif*, *3*(1), 53–62. https://jupetra.org/index.php/jpt/article/view/1118%0Ahttps://jupetra.org/index.php/jpt/article/download/1118/399

Suparman, A. R., Rohaeti, E., & Wening, S. (2022). Development of Attitude Assessment Instruments Towards Socio-Scientific Issues in Chemistry Learning. *European Journal of Educational Research*, *11*(4), 1947–1958. https://doi.org/10.12973/EU-JER.11.4.1947

Ulkhoiroh, S. (2025). PENGEMBANGAN MEDIA PEMBELAJARAN AUGMENTED REALITY BERBANTUAN ASSEMBLR EDU PADA MATA PELAJARAN MATEMATIKA UNTUK MENINGKATKAN PEMAHAMAN KONSEP SISWA KELAS V. *Jurnal Inovasi Penelitian*, *1*(0.1101/2021.02.25.432866), 1–15.

Umam, K., Khotimah, H., Purwanto, S. E., Azhar, E., Fatayan, A., & Nuriadin, I. (2024). Augmented Reality dan Artificial Intelegence untuk Pemeblajaran dalam Persepektif Guru Matematika. *JagoMIPA: Jurnal Pendidikan Matematika Dan IPA*, *4*(2), 273–279. https://doi.org/10.53299/jagomipa.v4i2.595

Uno, W. A. (2024). Pengembangan Media Pembelajaran Interaktif Berbasis Augmented Reality untuk Meningkatkan Pemahaman Konsep IPA. *Jurnal Pendidikan Dan Pembelajaran*, *4*(1), 28–33.

Uriarte-Portillo, A., Zatarain-Cabada, R., Barrón-Estrada, M. L., Ibáñez, M. B., & González-Barrón, L. M. (2023). Intelligent Augmented Reality for Learning Geometry. *Information (Switzerland)*, *14*(4). https://doi.org/10.3390/info14040245

Wahab A, A., Kusuma, Y. S., Juandi, D., Turmudi, T., Buhaerah, B., & Syaiful, S. (2024). Understanding Students' Struggles in Solving Mathematical Problems: A Systematic Literature Review Using Polya's Framework. *Jurnal Pendidikan Progresif*, *14*(3), 1728–1753. https://doi.org/10.23960/jpp.v14.i3.2024118

Walkington, C., Nathan, M. J., Washington, J., Hunnicutt, J., Darwin, T., Daughrity, L. A., & Schenck, K. (2025). Comparing learning geometry using a tablet to head-mounted display augmented reality: How and when dimensionality matters. *Education and Information Technologies*, *30*(4), 5397–5426. https://doi.org/10.1007/s10639-024-13008-z

Widiyaningsih, E., Zaenuri, D., Pascasarjana, K., & Kelud, J. (2020). Unnes Journal of Mathematics Education Research Problem-Solving Ability and Self-Efficacy Based On Geometry Thinking Level In Van Hiele Learning. *Ujmer*, *9*(2), 2020–2156. http://journal.unnes.ac.id/sju/index.php/ujmer

Widyasari, N., & Mastura, L. I. (2020). Improving Geometry Thinking Ability through Augmented Reality Based Learning Media. *Eduma : Mathematics Education Learning and Teaching*, *9*(1), 80. https://doi.org/10.24235/eduma.v9i1.5304

Yanty Putri Nasution, E. (2017). Meningkatkan Kemampuan Spasial Siswa Melalui Pembelajaran Geometri Berbantuan Cabri 3D. *M A T H L I N E : Jurnal Matematika Dan Pendidikan Matematika*, *2*(2), 179–194. https://doi.org/10.31943/mathline.v2i2.45

Zakiyah, S., Hidayat, W., Wahyu Setiawan, dan, Matematika, P., Siliwangi Jalan Terusan Jendral Sudirman, I., & Barat, J. (2019). *Mosharafa: Jurnal Pendidikan Matematika Analisis Kemampuan Pemecahan Masalah dan Respon Peralihan Matematik dari SMP ke SMA pada Materi SPLTV Analysis of Problem Solving Ability and Respons of Transition from Junior to Senior High School in SPLTV Material*. *8*(2). http://journal.institutpendidikan.ac.id/index.php/mosharafa