JURNAL PENDIDIKAN DAN PENGAJARAN
Volume 57 Nomor 3 2024, 551-562
E-ISSN: 2549-2608; P-ISSN: 2301-7821
DOI: https://doi.org/10.23887/jpp.v57i3.80361

Problem Solving Learning with Drawing a Diagram Strategy to Improve Mathematical Reflective Thinking Skills

Yusuf Sodhiqin[1*], Haryanto[2], Abdul Muin[3]

[1,2] Graduate Program in Educational Technology, Yogyakarta State University, Yogyakarta, Indonesia
[3] Math Education of Tarbiya Faculty, Syarif Hidayatullah State Islamic University, Jakarta, Indonesia
*Corresponding author: yusufsodhiqin.2022@student.uny.ac.id

Abstrak

Pembelajaran matematika di sekolah saat ini cenderung terbatas pada penghafalan rumus dan latihan rutin, yang menyebabkan kurangnya keterlibatan kognitif siswa. Diperlukan inovasi pembelajaran yang dapat mengembangkan kemampuan berpikir reflektif matematis. Penelitian ini bertujuan untuk mengetahui perbedaan peningkatan kemampuan berpikir reflektif matematis antara siswa yang diajarkan menggunakan strategi pemecahan masalah dengan menggambar diagram dan siswa yang diajarkan dengan metode ekspositori. Penelitian ini menggunakan desain quasi-experiment dengan Randomized Posttest Only Control Group Design, melibatkan populasi 288 siswa kelas VIII. Dua kelompok dipilih secara acak kluster, masing-masing terdiri dari 36 siswa; satu kelompok sebagai eksperimen dan lainnya sebagai kontrol. Data dikumpulkan melalui tes tertulis kemampuan berpikir reflektif matematis dan dianalisis menggunakan uji t sampel independen untuk melihat perbedaan signifikan antar kelompok. Hasil penelitian menunjukkan bahwa siswa yang diajar dengan strategi menggambar diagram mengalami peningkatan signifikan dalam kemampuan berpikir reflektif matematis dibandingkan dengan kelompok kontrol. Penelitian ini menyimpulkan bahwa strategi menggambar diagram efektif dalam meningkatkan kemampuan berpikir reflektif matematis dan membantu siswa dalam memecahkan masalah secara sistematis.

Kata Kunci: *Pemecahan masalah, Menggambar diagram, Kemampuan berpikir reflektif matematis*

Abstract

Mathematics learning in schools today tends to be limited to formula memorization and routine exercises, leading to a lack of cognitive engagement of students. Learning innovations are needed that can develop mathematical reflective thinking skills. This study aims to determine the difference in the improvement of mathematical reflective thinking skills between students who are taught using problem-solving strategies by drawing diagrams and students who are taught by the expository method. This study used a quasi-experiment design with a Randomized Posttest Only Control Group Design, involving a population of 288 grade VIII students. Two groups were randomly selected from clusters, each consisting of 36 students; one group as an experiment and the other as a control. Data were collected through a written test of mathematical reflective thinking ability and analyzed using an independent sample t-test to see significant differences between groups. The results showed that students who were taught with diagramming strategies experienced a significant improvement in mathematical reflective thinking skills compared to the control group. This study concludes that the diagramming strategy is effective in improving mathematical reflective thinking skills and helping students in solving problems systematically.

Keywords: Problem Solving, Drawing A Diagram, Mathematical Reflective Thinking Skills.

History:
Received : June 12, 2024
Accepted : October 06, 2024
Published : October 25, 2024

Publisher: Undiksha Press

1. INTRODUCTION

A good education is an education that aimed at humanizing. Humanizing means to form and build human characters, as mentioned in the national education system, so that they are independent and responsible human beings. Independence and responsibility can be formed through various learning activities. Independence gained in the study raises awareness as a goal to achieve. Through consciousness, a person will monitor and control the thinking process. Thus, the thinking capacity will be increased and continuously trained. One high-level thinking skill that is currently being pursued maximumly in mathematics learning is the ability to think reflectively. This is consistent with the statement that: "the ability to think mathematically is one measure achievement of mathematics learning goals, especially the ability to think in a high level (high order thinking skills), such as critical thinking, creative, logical, analytical and reflective" (Kurniawati et al., 2023; Rohman et al., 2021). Reflective thinking is a process of individual activity in learning through a process of analysis, evaluation, motivation, and obtaining deep meaning. Reflective thinking occurs when individuals experience doubts in solving problems but there is still enthusiasm to find solutions. Connective reflective thinkers overcome confusion by connecting all mathematical concepts, principles, and processes related to mathematical problems or solutions (Kholid et al., 2022; Sa'dijah et al., 2020). Students may be aware of and able to control their own thinking processes while doing math activities. Therefore, it is important to develop reflective thinking skills in mathematics, particularly in the problem-solving process.

In mathematics education, "Mathematical reflective thinking abilities can be identified through a person's thinking process in describing, identifying, interpreting, evaluating, predicting, and drawing conclusions in mathematical situations" (Jaenudin et al., 2017; Putri et al., 2020). Describing means explaining the given situation or problem using relevant mathematical concepts. Identifying means selecting and determining the mathematical concepts or formulas involved in non-trivial mathematical problems. Interpreting means providing an interpretation of the situation or problem. Evaluating means investigating the validity of an argument. Predicting means estimating a problem's solution or alternative solutions. Drawing conclusions means making general decisions about a problem.

Students' mathematical reflective thinking abilities will emerge and become apparent when faced with non-routine, non-trivial math problems. The problems presented to students allow them to develop their thinking skills. Currently, there are many mathematics teaching approaches that emphasize changing teaching methods and prioritizing active student engagement. However, reality in the field, some teachers still instruct students to acquire concepts without prompting them to think about how to obtain those concepts. This can be seen in cases where Teachers only provide mathematical formulas and then ask students to memorize them to solve problems (Ningrum & Minarti, 2022; Siregar et al., 2023).

There are a number of teachers teaching without training the students on how to get the concept. Research on classroom observation VIII at MTs in South Jakarta found that, overall, the teacher only explained and asked the students to take a note on the teacher's explanation. Then, the students are instructed to work on the common problems with similar type of questions. Other results are shown from preliminary studies and review of students' work regarding the ability in mathematical reflective thinking. Results of pre-study in class VIII indicated that out of 36 students, there are only three students who received grades above KKM with value – less than 50 for the average grade. Therefore, only 8.33% of the students were able to resolve the problem. Specifically, the results of previous studies conducted by Fadhila's daughter in one of the junior high schools located in South Tangerang City, Banten concluded that the average ability of the students using metacognitive approach in reflective thinking is higher than the average of those who use conventional learning. In other words, this finding proves that the ability to think reflectively in mathematics are not developed in the conventional learning (Jaenudin et al., 2017; Putri et al., 2020).

Based on the problems mentioned above, teachers should be able to choose the learning strategies that can stimulate reflective thinking in learning math and improve learning outcomes. Suyitno stated that problem-solving model learning models improved higher-level thinking (HOT) skills. A problem-solving model with higher-order thinking allows the students to experience maximum use of knowledge and skills. As a result, the significance of learning is tasted (Anggoro et al., 2023; Ventistas et al., 2024). Learning the problem-solving approach potentially trains learners in facing personal and group problems together. The students learn how to identify the causes and the alternatives to solve the problems. The orientation of the investigation and discovery of learning is based on problems solved together. Learners must conduct an investigation to seek, analyze and define problems, develop hypotheses, collect and analyze data, and draw conclusions (Andini et al., 2021; Djudin, 2020). Thus, it can be concluded that learning problem-solving teaches students how to overcome barriers through learning experiences by conducting discovery and investigation so that they can construct their knowledge. One method that can help teachers teach problem-solving learning is a method of drawing a diagram which is by combining the use of a diagram to represent a problem. The diagram can establish a connection between the fixers and the problem. Diagram is designed to help children understand the issues and use strategies to provide appropriate solutions that can be justified on the basis of the concept. Diagrams are used for various purposes such as a line to symbolize the object, a line in spacing and timing, a scale, a map or directions, connecting objects, and a sketch (Puspitasari et al., 2018; Yayuk et al., 2020).

The process uses a diagram called translation. During the translation process, there is potential to acquire knowledge through information reorganization and make further conclusions. The knowledge gained depends on three components: information processing, selective combining, and selective comparison (Sa'diyah et al., 2020; Zulianto & Budiarto, 2020). Information processing means connecting the relevant information to be presented. Selective combination refers to how the new information is incorporated as a discrete form. It focuses on the relationship that compares new knowledge with prior knowledge of the diagram. The component focuses on the importance of knowledge about the type of diagram that plays a role in solving the problems. Thus, we can conclude that the method of drawing a diagram is a method used by students when they are solving problems. This diagram helps students build connections with the problem so that they can be understood easily. This is because the diagram can describe the connection of the information in the issues. The problem-solving method of drawing a diagram consists of four stages from Shapiro: (a) understand the problem; (b) plan the making of drawing a diagram as a solution; (c) run the solution by drawing a diagram; and (d) review (Hasibuan & Hakim, 2022; Huda et al., 2017). The learning phase is very supportive of each other. The first stage is to understand the problem in which the students identify the problems such as relevant information as initial capital in problem-solving. After the students were asked to explain what is required or completed on the issues presented, this initial stage is to facilitate the students in improving their reflective thinking ability on indicators to describe and identify math problems. The second stage is planning to draw a diagram as a solution. In this stage, the students were asked to identify the mathematical concepts involved and the charts that will be used following the concepts related to the problem. This stage can facilitate students to improve their math reflective thinking ability.

The next stage is to run the solution by drawing a diagram. In this stage, the students visualize the problem by drawing a diagram selected following the relevant math concepts. After that, students perform mathematical calculations if needed to get the final results. This stage can enhance students' mathematical ability in reflective thinking on indicators to describe and identify problems. The final stage is to revisit in which the students were asked to review the answers following the request. Furthermore, students are asked to make a decision or conclusion. The final stage is to improve students' mathematical reflective thinking on indicators to evaluate and make conclusions. The novelty of this study is that this study focuses on an in-depth exploration of the use of problem-solving learning strategies by drawing diagrams to improve mathematical reflective thinking skills, which still rarely receive attention in the educational literature. This study examines how diagramming strategies in problem-solving help students develop better mathematical reflective thinking skills. This study aims to explore and explain how the use of diagramming strategies can interact with a more in-depth mathematical learning process and improve students' analytical skills. By identifying the challenges and opportunities students face in the application of these strategies, it is hoped that this research can provide deeper insights into the significant contribution of these methods in developing students' reflective and cognitive thinking skills, as well as helping them solve mathematical problems in a more effective and structured way.

2. METHODS

The method used in this study is a randomized quasi-experimental with a posttest conducted only on the control group. The design has a control group, but it cannot fully function to control external variables that affect the implementation of the experiment (Arib et al., 2024). The sampling method uses cluster random sampling by taking two of the eight classes, one class as the experimental class and the other class as the control class. Cluster sampling involves obtaining a random sample of clusters from the population, with all members of each selected cluster invited to participate (a is false). It is necessary to construct a sampling frame listing all clusters in the population. A sample of a fixed number of clusters is selected at random from this list. Each cluster has the same probability of being selected, independently of all others (Firmansyah, 2022; Nitte & Bulu, 2022). The experimental class was treated by using the methods of problem-solving learning by drawing a diagram, while the control class was given conventional learning with an expository method. Both classes were given reflective thinking ability tests at the end of learning. If there was a significant difference between the results of the experimental class with grade control, the treatment accorded significant influence. The study design shown in Table 1.

Table 1. Research Design

Group	Treatment	Posttest
E	Xe	O
C	Xc	O

The target population in this study was all students at one of the MTs in South Jakarta. The population of inaccessibility was the entire eighth-grade students in the MTsN, totaling 288 students. The sample selected is grade VIII with the detailed information; VIII - 6 as the experimental class, consisting of 36 students and grade VIII - 5 as the control class, consisting of 36 students as well. The instrument used in this study was in the form of test capabilities of mathematic reflective thinking. Arranged in the form of test item description and it was given after learning is complete. The test questions are arranged in the form of descriptions that have been adjusted based on indicators of mathematical reflective thinking skills. The questions provided include four aspects of reflective thinking, each with its own reflective thinking indicators: describing, identifying, evaluating, and drawing conclusions. Some of the questions are adopted from various grade VIII mathematics textbooks. The test blueprint for mathematical reflective thinking skills that has been prepared is shown in the Table 2.

Table 2. Blueprint of Mathematical Reflective Thinking Skills Test

Basic Competences	Indicators	Items Number
Developing students'	Describe the form of the linear equation for the diagonal of a rectangle that passes through two of its vertices	7
mathematical reflective thinking	Describe the shape formed by the intersection points of the graphs of the given linear equations.	1

Basic Competences	Indicators	Items Number
skills related to the topic of linear equations	Identify situations or problems related to the perpendicularity between two straight lines	2
	Identify the intersection point between two sides of an isosceles triangle based on the equations of the lines representing one of these triangle sides	4
	Evaluate situations or problems related to the parallelism of two straight lines.	8
	Evaluate situations or problems related to the equation of a line passing through a point and perpendicular to another line.	5
	Make conclusions about the position of two straight lines based on their slopes.	3
	Make conclusions about the relationship between two points based on the solutions obtained from three presented linear equations.	6

The mathematical reflective thinking skills test questions that have been created are piloted first before being used to measure validity, reliability, discriminative power, and difficulty level of the questions. The pilot test was conducted with Grade IX students who had covered the material included in the test questions. The summary of the pilot test results is described in Table 3.

Table 3. Result of Validity

Items Number	Validity	
	***R* - score**	**Description**
1	0.448	Valid
2	0.559	Valid
3	0.139	Invalid
4	0.305	Invalid
5	0.512	Valid
6	0.516	Valid
7	0.544	Valid
8	0.504	Valid

After conducting validity, item differentiation, and difficulty level calculations, reliability testing was performed on 6 questions used as the instrument for mathematical reflective thinking skills. Based on the reliability test results, a reliability coefficient of 0.52 was obtained. This value falls within the range of $0.40 < \leq 0.60$ for r11. These results indicate that the degree of reliability of the mathematical reflective thinking skills instrument is considered moderate. Therefore, the instrument used is sufficiently effective in measuring students' mathematical reflective thinking skills. The chosen data analysis techniques in this research are two-fold: descriptive statistics and quantitative analysis. Descriptive statistics involve the description or provision of information about a dataset or condition. The analysis technique using descriptive statistics in this study is to present the variables being studied one by one. The quantitative analysis technique in this study involves processing the data obtained from the mathematical reflective thinking skills test administered to both the experimental and control groups. The hypothesis is tested by using the t-test independent sample.

3. RESULTS AND DISCUSSION

Result

The results of the mathematical reflective thinking skills test for students indicate that from a maximum score of 24, the experimental class achieved a highest score of 23 and a lowest score of 6, while the control class achieved a highest score of 14 and a lowest score of 1. The difference between the highest scores in both classes is 17, indicating a significant disparity in the highest mathematical reflective thinking skills scores between the two classes. Similarly, the lowest scores in mathematical reflective thinking skills in both classes also show a considerable difference, which is 13. The data from the calculation of mathematical reflective thinking skills test results for both experimental and control classes are presented in Table 4.

Tabel 4. The Posttest Result of Reflective Thinking Mathematically

No	Indicator	Ideal Score 36 Students	Experimental Class			Control Class		
			Score 36 students	Mean	Mean (%)	Score 36 students	Mean	Mea n(%)
1	Describe	288	157	4.36	54.52	105	2.92	36.46
2	Identify	144	112	3.11	77.78	72	2.00	50.00
3	Evaluate	288	156	4.34	54.17	48	1.33	16.67
4	Make Conclusions	144	81	2.25	56.25	55	1.53	38.20
	Total	**864**	**506**	**14.06**	**58.56**	**280**	**7.78**	**32.40**

Table 4 shows the distribution of data from 36 students in the experimental class and 36 students in the control class after learning problem-solving by drawing a diagram in the experimental class. The average ability to think reflectively in mathematical problem-solving learning with drawing a diagram method was equal to 14.06 or 58.56%, while the reflective thinking ability taught with conventional learning using the expository method was equal to 7.78 or 32.40 %.

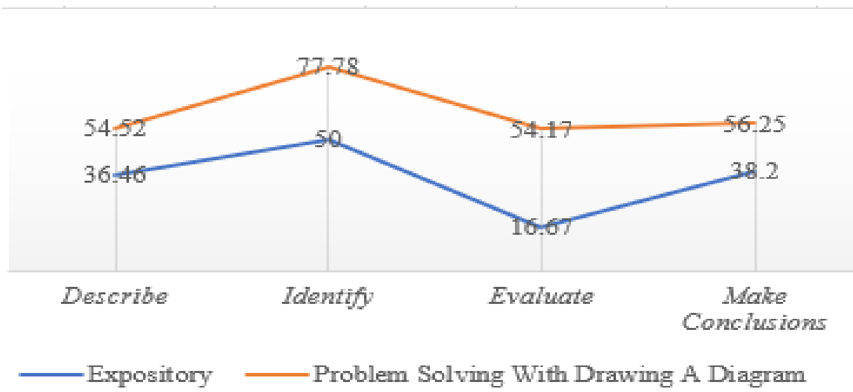

Figure 1. Comparison of Indicator Percentage Achievement of Reflective Thinking Ability Between Convensional Class with Experiment Class

Data on test results showed that the aspect of reflective thinking with the highest percentage obtained by the two classes was on identifying aspect, 77.78% of the experimental class and 50% of the control class. Aspects of reflective thinking with the lowest percentage in the two classes were evaluating aspects, the experimental class was at 54.17% and 16.67% was in the control class. The percentage gained by the second grade on the ability to evaluate was equal to 37.50%. It can be seen from the aspect of evaluating the achievement scores obtained in the second class. The maximum score was 288. The experimental class obtained a score of 156, while the control class obtained a significantly lower which was only 48. The percentage difference between the two classes in evaluating the aspects was far different from the reflective thinking which has a difference of 18.06%, the aspect of identifying with a difference of 27.78%, and the aspects of concluding by a margin of 18.05%. When viewed from some indicators of the ability to think reflectively, generally students who use the problem-solving learning method of drawing a diagram state that they make better results than those who use conventional learning. The differences in percentage on each indicator measured was presented in Figure 1.

Discussions

The use of problem-solving learning with the method of making a drawing diagram demonstrates better mathematical reflective thinking skills compared to those after conventional learning (Surya & Syahputra, 2017; Tambunan, 2019). Students using problem-solving learning with the method of making a drawing diagram can provide answers and reasons accurately according to the question requirements. Conversely, students using conventional learning do not provide answers accurately, completely, and in detail (Evita et al., 2019; Krupa et al., 2015). This difference may be attributed to the connection between the stages of problem-solving learning with the method of making a drawing diagram and the reflective thinking indicators measured in this research.

The learning stages begin with presenting a problem on the Student Discussion Sheet (LDS), which is solved in groups. In the initial stage, students are asked to identify the information presented in the problem and then explain what will be solved within that problem. The next stage involves planning a solution using the make drawing a diagram method. In this stage, students in groups are asked to identify mathematical concepts and related diagrams according to the presented problem. This stage greatly assists students in developing reflective thinking processes as they are required to independently identify concepts like linear equation from a real-world problem. The third stage is implementing the solution using the make drawing a diagram method. Together in groups, students depict the presented problem according to the concepts and diagrams identified earlier. The final stage is reviewing. In groups, students are asked to double-check the accuracy of their answers through assignments on the Student Discussion Sheet (LDS). Afterwards, students are asked to generalize their answers to the learning material they have obtained. Students conclude through analyzing the information they have obtained in the previous stages. After completing the LDS, students then present the results of their discussions Students ask questions and express their opinions during the presentation process. This presentation and discussion foster interaction among students, teachers, and learning resources.

The results of this research are similar to previous research which stated that students who learned by using problem-solving strategies draw a better picture than those using conventional learning (Hayati et al., 2022; Sumartini, 2016). Students learning problem-solving can draw a picture in systematic thinking and reasoning in solving. Similarly, the learning problem solving by drawing a diagram method also focuses on the process of thinking to solve the problem. Specifically, it identifies the problem and reason with the help of a drawing sketch to facilitate understanding in solving problem. On the other hand, there is a difference between this study and another similar study. This can be seen from the percentage of each aspect measured in this research. Previous research yielded percentage results of 88.64% for the describing aspect, 50.76% for the identifying aspect, 65.26% for the evaluating aspect, and 49.24% for the concluding aspect, whereas this study yielded percentage results of 54.52% for the describing aspect, 77.78% for the identifying aspect, 54.17% for the evaluating aspect, and 56.25% for the concluding aspect. This comparison of percentages indicates that this study achieved higher results for the identifying and concluding aspects compared to previous research, but lower results for the describing and evaluating aspects (Hendriana et al., 2019; Sümen, 2023).

Another difference is shown through the percentage difference in the evaluating indicator measured between the experimental class and the control class. Although the evaluating indicator in this study has the lowest percentage, the percentage difference in the evaluating indicator significantly differs from other indicators in this study. For comparison, the percentage difference in the evaluating indicator measured in this study differs from previous research. Previous research yielded a percentage difference of 10.13% in the evaluating aspect, which is not significantly different from the differences in other aspects such as describing at 14.42%, identifying at 11.70%, interpreting at 9.83%, predicting at 11.05%, and concluding at 8.61%. In contrast, this study shows a much larger percentage difference of 37.5% and differs from other aspects such as describing at 18.06%, identifying at 27.78%, and concluding at 18.05%. The comparison of significantly different percentage differences between the evaluating aspect and other aspects measured in this study indicates a significant improvement in students' evaluating skills through problem-solving learning with the make drawing a diagram method compared to evaluating skills in conventional learning. The significant difference in the evaluating aspect can be indicated by the problem-solving learning process using the make drawing a diagram method, which consistently encourages students to check the accuracy of their answers, especially in the drawing process, to ensure that the diagrams created are sufficient and appropriate in addressing the problem (Grigg & Benson, 2014; McNeill et al., 2016). This activity is presented in the Student Discussion Sheet (LDS) through activities such as assignments to assess and reconsider the work done in solving the problem. However, this evaluation activity never appears in conventional learning, where students typically only practice exercises without reviewing their answers. The LDS used in conventional learning also does not include questions that train students to review their answers, merely concluding at the end of the activity. This provides more opportunities for evaluation activities to occur in problem-solving learning with the make drawing a diagram method.

The existence of a considerable margin on the evaluated aspects can be indicated in the learning process using problem-solving methods in drawing a diagram (Heideman et al., 2017; Pradiarti, 2022). This was accustomed to checking the truth of the answers, especially in the process of drawing, whether the image created is sufficient and appropriate to answer the problems. The activity is displayed in the Student Discussion Sheet (LDS) through activities such as the assignment and reconsidering the work that has been done to resolve the problem. However, these evaluation activities never appeared on conventional learning, because conventional learning students merely exercise without revisiting the answer. Discussion Sheet Students (LDS) used did not include questions that train students to revisit their answers, merely conclude at the end of the activity. It provides an opportunity to evaluate the activity that occurred more frequently in the problem-solving learning method of drawing a diagram. The high ability to evaluate problem-solving learning with drawing the diagram method was strengthened by the translation process in the use of the diagram. The process was not limited to accessing and connecting previous knowledge with new learning as an excuse to give an answer (Bone et al., 2022; Evidiasari et al., 2019). The process makes it easy to associate students' existing concepts to give reasons when checking the truth. This is consistent with the statement that in mathematics learning and teaching, the image plays an important role as a tool to support reflection and the means to communicate ideas (Mirlanda et al., 2020; Nirwana et al., 2021). The results of this study make an important contribution to understanding the effectiveness of problem-solving learning strategies by drawing diagrams in improving mathematical reflective thinking skills. This study shows that diagramming strategies have a significant role in helping students develop better conceptual understanding and more structured problem-solving skills. This strategy not only helps students in visualizing mathematical problems, but also encourages them to think more reflectively in evaluating and analyzing solutions.

The application of this strategy is increasingly attracting attention because of its ability to improve mathematical reflective thinking skills, which are very important in mastering complex mathematical concepts. This shows that the visual approach can enrich the learning process and improve student learning outcomes. These findings could provide the basis for further research on how visualization-based learning strategies such as diagramming can be applied in a variety of mathematical contexts and other disciplines. One of the limitations of this research is the influence of variations in students' ability to draw diagrams and the level of understanding of basic concepts, which can affect the results of strategy implementation. The recommendation for further research is to further explore how this strategy can be integrated with other learning methods to improve learning outcomes, as well as evaluate its impact on groups of students with different ability levels. Future research may also consider a more interdisciplinary approach that combines mathematics, visual education, and cognitive psychology to enrich understanding of reflective thinking processes in mathematics.

4. CONCLUSION

Based on the analysis and discussion described in the previous chapter, the conclusions of this study are ability to think reflectively using learning problem-solving methods by drawing a diagram is overall higher than those using conventional learning. Learning problem solving by drawing a diagram method is specifically well applied to enhance the students' abilities in reflective thinking on evaluating indicators. The results obtained from the percentage were the difference between the two indicators in evaluating a larger class than the other indicators.

5. ACKNOWLEDGE

Finally, the author would like to express his gratitude to **BPPT** (Center for Higher Education Funding) and **LPDP** (Lembaga Pengelola Dana Pendidikan) for supporting the publication as stated in decision letter number: 00370/J5.2.3/BPI.06/9/2022.

6. REFERENCES

Andini, S. R., Putri, V. M., Devi, M. Y., & Erita, Y. (2021). Mendesain Pembelajaran PKn dan IPS yang Inovatif dan Kreatif dengan Menggunakan Model Pembelajaran Pada Tingkat Sekolah Dasar. *Jurnal Basicedu*, *5*(6), 5671–5681. https://doi.org/10.31004/basicedu.v5i6.1760.

Anggoro, A. F. D., Hendriana, H., & Yuliani, A. (2023). Structural Model Between Mathematical Reasoning and Mathematics Problem-Solving Abilities of Junior High

School Students. *Journal of Honai Math*, *6*(1), 71–75. https://doi.org/10.30862/jhm.v6i1.405.

Arib, M. F., Rahayu, M. S., Sidorj, R. A., & Afgani, M. W. (2024). Experimental Research Dalam Penelitian Pendidikan. *Innovative: Journal Of Social Science Research*, *4*(1), 5497–5511. https://doi.org/10.31004/innovative.v4i1.8468.

Bone, E. K., Bouck, E. C., & Smith III, J. P. (2022). Using the VA Framework to Teach Algebra to Middle School Students With High-Incidence Disabilities. *Journal of Special Education Technology*, *37*(3), 384–398. https://doi.org/10.1177/01626434211019388.

Djudin, T. (2020). An easy way to solve problems of physics by using metacognitive strategies: A Quasy-Experimental Study on Prospective teachers in Tanjungpura University-Indonesia. *Journal of Teaching and Teacher Education*, *8*(1), 19–27. https://doi.org/10.12785/jtte/080103.

Evidiasari, S., Subanji, S., & Irawati, S. (2019). Students' Spatial Reasoning in Solving Geometrical Transformation Problems. *Indonesian Journal on Learning and Advanced Education (IJOLAE)*, *1*(2), 38–51. https://doi.org/10.23917/ijolae.v1i2.8703.

Evita, E., Syahid, A., & Nurdin, N. (2019). Understanding Students' Learning Outcomes Differences Through the Application of the Market Place Activity Type of Cooperative Learning Model and the Application of Conventional Learning Models. *International Journal of Contemporary Islamic Education*, *1*(1), 67–85. https://doi.org/10.24239/ijcied.Vol1.Iss1.5.

Firmansyah, D. (2022). Teknik Pengambilan Sampel Umum dalam Metodologi Penelitian: Literature Review. *Jurnal Ilmiah Pendidikan Holistik (JIPH)*, *1*(2), 85–114. https://doi.org/10.55927/jiph.v1i2.937.

Grigg, S. J., & Benson, L. C. (2014). A coding scheme for analysing problem-solving processes of first-year engineering students. *European Journal of Engineering Education*, *39*(6), 617–635. https://doi.org/10.1080/03043797.2014.895709.

Hasibuan, A. C. U., & Hakim, D. L. (2022). Kemampuan Pemecahan Masalah Matematis Siswa Dengan Tahapan Polya. *Didactical Mathematics*, *4*(1), 156–162. https://doi.org/10.31949/dm.v4i1.2014.

Hayati, R., Fachrurazi, F., Karim, A., & Marzuki, M. (2022). Peningkatan Kemampuan Pemecahan Masalah menggunakan Model Problem Based Learning Berbantuan Video Pembelajaran Di Sekolah Dasar. *Jurnal Absis: Jurnal Pendidikan Matematika Dan Matematika*, *5*(1), 621–629. https://doi.org/10.30606/absis.v5i1.1558.

Heideman, P. D., Flores, K. A., Sevier, L. M., & Trouton, K. E. (2017). Effectiveness and adoption of a drawing-to-learn study tool for recall and problem solving: Minute sketches with folded lists. *CBE—Life Sciences Education*, *16*(2), ar28. https://doi.org/10.1187/cbe.16-03-0116.

Hendriana, H., Putra, H. D., & Hidayat, W. (2019). How to design teaching materials to improve the ability of mathematical reflective thinking of senior high school students in Indonesia? *Eurasia Journal of Mathematics, Science and Technology Education*, *15*(12). https://doi.org/10.29333/ejmste/112033.

Huda, W. N., Suyitno, H., & Wiyanto, W. (2017). Analysis of Mathematical Problem Solving Abilities in Terms of Students' Motivation and Learning Styles. *Journal of Primary Education*, *6*(3), 209–217. https://doi.org/10.15294/jpe.v6i3.21069.

Jaenudin, J., Nindiasari, H., & Pamungkas, A. S. (2017). Analisis Kemampuan Berpikir Reflektif Matematis Siswa Ditinjau Dari Gaya Belajar. *Prima: Jurnal Pendidikan Matematika*, *1*(1), 69–82. https://doi.org/10.31000/prima.v1i1.256.

Kholid, M. N., Swastika, A., Ishartono, N., Nurcahyo, A., Lam, T. T., Maharani, S., Ikram, M., Murniasih, T. R., Majid, M., Wijaya, A. P., & Pratiwi, E. (2022). Hierarchy of students' reflective thinking levels in mathematical problem solving. *Acta Scientiae*, *24*(6), 24–59. https://doi.org/10.17648/acta.scientiae.6883.

Krupa, E. E., Webel, C., & McManus, J. (2015). Undergraduate Students' Knowledge of Algebra: Evaluating the Impact of Computer-based and Traditional Learning Environments. *Primus*, *25*(1), 13–30. https://doi.org/10.1080/10511970.2014.897660.

Kurniawati, M., Purwaningsih, W. I., & Yuzianah, D. (2023). Analisis Kemampuan Berpikir Reflektif Siswa Climber dalam Menyelesaikan Soal Literasi Numerasi SMP. *Didactical Mathematics*, *5*(2), 597–603. https://doi.org/10.31949/dm.v5i2.6678.

McNeill, N. J., Douglas, E. P., Koro-Ljungberg, M., Therriault, D. J., & Krause, I. (2016). Undergraduate students' beliefs about engineering problem solving. *Journal of Engineering Education*, *105*(4), 560–584. https://doi.org/10.1002/jee.20150.

Mirlanda, E. P., Nindiasari, H., & Syamsuri, S. (2020). Pengaruh Pembelajaran Flipped Classroom Terhadap Kemampuan Penalaran Matematis Ditinjau Dari Gaya Kognitif Siswa. *Prima: Jurnal Pendidikan Matematika*, *4*(1), 11–21. https://doi.org/10.31000/prima.v4i1.2081.

Ningrum, R. O. D., & Minarti, E. D. (2022). Analisis Kesalahan Siswa Dalam Menyelesaikan Soal Persamaan Linier Dua Variabel Di Smp Al-Mahmud Plus-Cililin. *Jurnal Pembelajaran Matematika Inovatif*, *5*(1), 33–42. https://doi.org/10.22460/jpmi.v5i1.33-42.

Nirwana, N., Susanti, E., & Susanto, D. (2021). Pengaruh Penerapan Somatis, Auditori, Visual, dan Intelektual Terhadap Kemampuan Komunikasi Matematis Siswa. *Ideas: Jurnal Pendidikan, Sosial, Dan Budaya*, *7*(4), 251–258. https://doi.org/10.32884/ideas.v7i4.451.

Nitte, Y. M., & Bulu, V. R. (2022). Pemetaan implementasi pendidikan karakter di sekolah dasar se-kota Kupang. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *6*(1), 38–47. https://doi.org/10.33394/jk.v6i1.2326.

Pradiarti, R. A. (2022). Kemampuan Pemecahan Masalah Matematis Siswa SMP ditinjau dari Gaya Kognitif. *Mosharafa: Jurnal Pendidikan Matematika*, *11*(3), 379–390. https://doi.org/10.31980/mosharafa.v11i3.729.

Puspitasari, L., In'am, A., & Syaifuddin, M. (2018). Analysis of students' creative thinking in solving arithmetic problems. *International Electronic Journal of Mathematics Education*, *14*(1), 49–60. https://doi.org/10.12973/iejme/3962.

Putri, F., Muin, A., & Khairunnisa, K. (2020). Pengaruh Pendekatan Metakognitif Dan Kemampuan Awal Matematis Terhadap Kemampuan Berpikir Reflektif Matematis Siswa. *ALGORITMA: Journal of Mathematics Education*, *1*(2), 134–145. https://doi.org/10.15408/ajme.v1i2.14074.

Rohman, M. A., Utami, R. E., & Indiati, I. (2021). Analisis Kemampuan Berpikir Kreatif Matematis Siswa Ditinjau dari Self Concept. *Imajiner: Jurnal Matematika Dan Pendidikan Matematika*, *3*(2), 88–98. https://doi.org/10.26877/imajiner.v3i2.7243.

Sa'dijah, C., Kholid, M. N., Hidayanto, E., & Permadi, H. (2020). Reflective thinking characteristics: a study in the proficient mathematics prospective teachers. *Infinity Journal*, *9*(2), 159–172. https://doi.org/10.22460/infinity.v9i2.p159-17242-6596/1783/1/012102.

Sa'diyah, U., Nizaruddin, N., & Muhtarom, M. (2020). Translasi Antar Representasi Matematis Visual Ke Verbal Dalam Memahami Konsep Pada Materi Spldv Ditinjau Dari Kemampuan Matematika Tinggi. *Imajiner: Jurnal Matematika Dan Pendidikan Matematika*, *2*(4), 266–275. https://doi.org/10.26877/imajiner.v2i4.6122.

Siregar, A., Nasution, B. N., Sihotang, D. R. A., Arif, I. I., & Frisnoiry, S. (2023). Analisis

Kesalahan dan Kesulitan Siswa Dalam Menyelesaikan Soal pada Materi Persamaan Trigonometri. *Nautical : Jurnal Ilmiah Multidisiplin*, *2*(2), 114–118. https://doi.org/10.55904/nautical.v2i2.720.

Sumartini, T. S. (2016). Peningkatan Kemampuan Pemecahan Masalah Matematis Siswa melalui Pembelajaran Berbasis Masalah. *Mosharafa: Jurnal Pendidikan Matematika*, *5*(2), 148–158. https://doi.org/10.31980/mosharafa.v5i2.391.

Sümen, Ö. Ö. (2023). Reflective Thinking in The Problem-Solving Process: A Model Proposal. *Sakarya University Journal of Education*, *13*(1), 6–23. https://doi.org/10.19126/suje.970213.

Surya, E., & Syahputra, E. (2017). Improving High-Level Thinking Skills by Development of Learning PBL Approach on the Learning Mathematics for Senior High School Students. *International Education Studies*, *10*(8), 12–20. https://doi.org/10.5539/ies.v10n8p12.

Tambunan, H. (2019). The Effectiveness of the Problem Solving Strategy and the Scientific Approach to Students' Mathematical Capabilities in High Order Thinking Skills. *International Electronic Journal of Mathematics Education*, *14*(2), 293–302. https://doi.org/10.29333/iejme/5715.

Ventistas, G., Ventista, O. M., & Tsani, P. (2024). The impact of realistic mathematics education on secondary school students' problem-solving skills: a comparative evaluation study. *Research in Mathematics Education*, *8*(1), 46–56. https://doi.org/10.1080/14794802.2024.2306633.

Yayuk, E., Purwanto, As'Ari, A. R., & Subanji. (2020). Primary school students' creative thinking skills in mathematics problem solving. *European Journal of Educational Research*, *9*(3), 1281–1295. https://doi.org/10.12973/eu-jer.9.3.1281.

Zulianto, R., & Budiarto, M. T. (2020). Kemampuan Translasi Representasi Matematis Siswa SMP Dalam Menyelesaikan Soal Kontekstual. *JKPM (Jurnal Kajian Pendidikan Matematika)*, *5*(2), 313. https://doi.org/10.30998/jkpm.v5i2.6442.