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Analysis of Problem-Solving Abilities in Completing Story Problems on Combination Material Based on Student Learning Styles

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Abstract

Analysis of mathematical problem-solving abilities is a detailed observation effort of students' abilities in solving mathematical problems. Combinations in mathematics cause difficulty in understanding information and getting the main idea of sentences; therefore, knowing students' learning styles helps them choose an appropriate approach. This research aims to describe problem-solving abilities in solving combination material story problems based on the visual, auditory, and kinesthetic learning styles of class XII MIA students. This research uses qualitative methods with research instruments consisting of learning-style questionnaire sheets, test sheets, interview transcripts, and member check sheets. The research subjects consisted of a visual, an auditory, and a kinesthetic student. The research results show problem-solving abilities: 1) visual students understand problems, formulate plans, arrange to problem-solve, and review the results; 2) auditory students understand problems, prepare plans, arrange problem-solving, and review the results; 3) kinesthetic students understand problems, make plans, organize problem-solving, and not check the results. These results show that visual and auditory subjects can answer mathematical problems well and correctly. However, the kinesthetic subject is unable to solve mathematical problems. In conclusion, these results provide a detail that increases students' and teachers' awareness that kinesthetic students need extra support to improve their problem-solving ability.

Keywords: Problem-Solving Abilities, Mathematical Problems, Learning Styles, Combination

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INTRODUCTION

According to the National Council of Teachers of Mathematics (NCTM), five ability standards for learning mathematics include communication, problem-solving, connection, representation, and reasoning (Fennell & Rowan, 2015). According to the mathematics learning process, students must be able to solve a problem orally and in writing. Problems in mathematics are often found in the form of stories or questions. Mathematics story problems generally contain mathematical concepts such as multiplication, addition, subtraction, and division. Problem-solving abilities are related to story problems because they include contextual problems related to students' daily activities and solutions using mathematical methods (Oktasya et al., 2022; Simamora, 2022). Mathematics requires problem-solving abilities to improve the quality of learning and the results, several factors influence students' ability to solve problems. One of the factors is students' varying learning styles, knowing the type of student learning style has a positive side on the learning process and helps students become effective problem solvers (Cahyani, 2016; Widiyanti, 2011).

Students have problem-solving abilities if they can understand the problem, plan for problem-solving, operate the plans they have made, and interpret and double-check the

solutions they obtain. Students' problem solving abilities can be identified through analysis of students' answers. Student answers can be written in the Polya stages of solving a problem that must be arrange, including (1) Understanding the Problem, which is the first step taken when students want to solve a problem. (2) Planning a Solution, activities that can be carried out are, students write down plans that will be used to solve the problem. (3) Implementing the Plan, implementing the completion plan will be easier if the plan made is correct. (4) Re-examine the process and results obtained. The process of problem solving abilities between one student and another will definitely experience differences (Andanik & Fitrianawati, 2019; Astutiani et al., 2019).

The independent curriculum directs teachers to create quality learning according to students' needs and learning environment freely, i.e. teachers are free to choose, create, use, and develop lesson plan formats according to situations and conditions (Hutabarat et al., 2022). Consequently, knowing the special characteristics of students, including their learning styles, is very useful in the learning process. Teachers who understand students' learning styles can be helped in overcoming learning problems by selecting learning methods that suit the learning styles of the majority of students in the class being taught. Apart from that, students who know their learning style will easily determine an efficient learning process so that they understand and solve problems more quickly and easily.

Several studies have been arranged regarding problem solving abilities in mathematics, students' problem solving abilities using subjects based on gender, giving results that mathematical problem-solving abilities can be seen from the scores obtained by male and female students. The average score obtained from female students was 80.12 and the average score obtained from male students was 74.57. In terms of average grades, female students are better than male students (Davita & Pujiastuti, 2020). Then, in research conducted by Rezeki et al., (2021) regarding the analysis of problem-solving abilities in solving HOTS mathematics questions on the subject of student opportunities, the results showed that students' abilities in solving mathematical problems still had many deficiencies, including in terms of understanding the problem. The results of the research are the percentage of students' answers to problem solving steps: understanding the problem 37%, planning a solution 51%, resolving the problem 68%, and checking again 21%. So it can be seen that students' mathematical problem solving abilities in solving HOTS questions on the subject of probability in the sub-material of permutations and combinations are still low in understanding the problem, quite good in planning the solution, quite good at the problem solving stage, and quite low in checking again. Furthermore, Meilani & Diana (2022) in their research on the analysis of problem solving abilities in terms of students' emotional intelligence, the results showed that students with high emotional intelligence were able to solve problems correctly and appropriately according to problem solving indicators, students with moderate emotional intelligence were able to provide solutions. However, there are still misunderstandings in the initial stages of problem solving, such as in the process of interpreting information hence that they provide inappropriate solutions, students with low emotional intelligence are not able to solve problems because they do not understand the concept so the results they provide do not lead to the right solution. On the other hand, this research contributes to the analysis of mathematical problem solving using special polya stages of combination material at class XII high school level which was not found as a subject of previous research by considering the learning styles of students.

The learning style used in this research is the learning style according to Bobi De Porter and Mike Hernacki which is divided into three, visual, auditory and kinesthetic learning styles. Visual learning style is a learning style by looking, observing and viewing. Auditory learning style is a style of learning by listening. Meanwhile, kinesthetic learning style is a style of learning by moving, working and touching. The basic competencies in the syllabus expect students to be able to solve contextual problems related to combination material. Combination material is also material that is tested in the final school exam, but based on initial observation data, several problems were found, students were not able to solve the mathematical problems

that had been given, students were unable to understand all the information from the questions, it was difficult to write down what was asked about the questions and they made mistakes. in understanding the meaning of sentences in story problems. Consequently, it is considered important to carry out research to find out the extent of problem solving abilities possessed by students, especially in combination material so that it can become an evaluation material for teachers to improve the learning process better and its relationship to learning styles.

METHOD

This research is a qualitative descriptive study. This research used purposive sampling by considering the dominant learning style of students and the willingness of the subject students, accordingly that the subjects of this research were 3 students of class XII MIA SMA Negeri 1 Sirenja, 1 subject with a visual learning style, 1 subject with an auditory learning style and 1 student with a kinesthetic learning style. The research instrument used in this study was a learning style questionnaire with a total of 20 statements, and 3 choices for each statement, with each choice representing 1 type of learning style. The results of the questionnaire will show the student's learning style tendencies. This learning styles questionnaire was adapted from Chislett & Chapman (2005), which has been validated by validator lecturers. Then, a mathematical problem solving ability test sheet is used, which consists of 1 story question with combination material that directs students to use the Polya stages in solving them on the answer sheet provided. The next instrument is a structured interview guide from Nahdiyah (2018), which has been validated by the lecturer and a member check sheet which is used to check the suitability of the data. Data analysis is carried out by 1) Data collection period, carried out through instruments that have been created and then sorting out important data, 2) Data reduction, is the process of reducing data that is less relevant to the research focus, 3) Displaying data, reduction results data is presented in various visual ways subsequently that the data can clarify the data, 4) Drawing conclusions or verification, is done by looking back at the report that you want to achieve (Raco, 2018). The data credibility technique used is member check, a data credibility technique by checking data on research subjects. Checking is agreed upon by giving a test in the form of a combination of questions and then conducting an interview. If the data obtained by the researcher is following what was intended by the research subject then the data is considered credible. However, if the data obtained does not match what the subject intended, the researcher will conduct in-depth discussions with the subject until credible data is obtained.

RESULTS AND DISCUSSION

Result

From the results of subject selection by considering class, questionnaire results and willingness, 3 research subjects were selected with learning style results in table 1, as follows;

Table 1. Students' Learning Styles of Research Subject

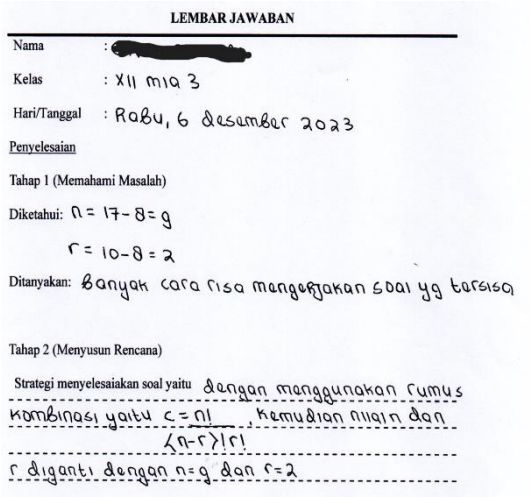
Students	Learning Style			Note
	Visual	Auditorial	Kinestetik	
GR	11	5	4	Visual
AR	7	10	3	Auditorial
TS	5	6	9	Kinestetik

When presenting the data, the term P will be given for the researcher and GR, AR, and TS for each subject. In an effort to select the amount of research data, coding was carried out as shown in Table 2.

Table 2. Coding

Kode	Code Meaning
P	Researcher
S	Research subject
Ti	Stage i problem solving abilities. Example T1 means Polya's stage 1 problem solving ability
Tij	Stage ij problem solving abilities. Example T11 means problem solving ability stage 1 Polya question 1
Tij-k	Stage ij problem solving ability with k as a rebuttal/return question asked by the research subject. Example T11-1 means problem solving ability stage 1 Polya question 1 with 1 rebuttal/question back from the subject
GR	The initials of the visual learning style subject
AR	Initials of the subject name auditory learning style
TS	Initials of the subject's name kinesthetic learning style
P-Tij-k-GR	Researcher, visual learning style subject, problem solving ability at stage ij with k as rebuttal/return question asked by the research subject. Example P-T11-1-GR means problem solving ability stage 1 Polya 1st question with 1 rebuttal/question back from the visual learning style subject
P-Tij-k-AR	Researcher, visual learning style subject, problem solving ability at stage ij with k as rebuttal/return question asked by the research subject. Example P-T11-1-AR means problem solving ability stage 1 Polya 1st question with 1 refutation/return question from the subject of auditory learning style
P-Tij-k-TS	Researcher, visual learning style subject, problem solving ability at stage ij with k as rebuttal/return question asked by the research subject. Example P-T11-1-TS means problem solving ability stage 1 Polya 1st question with 1 rebuttal/question back from the kinesthetic learning style subject

The following is an explanation of the test results and interviews of research subjects. First, the GR subject. The results of the GR subject test show that the GR subject is able to complete the stage of understanding the problem, can formulate a plan, is able to arrange problem-solving and can re-examine the results of the work by writing conclusions, as seen in Figures 1 and 2.



LEMBAR JAWABAN

Nama : [redacted]

Kelas : XII MIA 3

Hari/Tanggal : Rabu, 6 Desember 2023

Penyelesaian

Tahap 1 (Memahami Masalah)

Diketahui: n = 17 - 8 = 9

r = 10 - 8 = 2

Ditanyakan: Banyak cara Risa mengerjakan soal yg tersisa

Tahap 2 (Menyusun Rencana)

Strategi menyelesaiakan soal yaitu dengan menggunakan rumus kombinasi yaitu $C = \frac{n!}{(n-r)!r!}$, kemudian nilai n dan r diganti dengan n=9 dan r=2

Figure 1. GR Stage 1 and Stage 2 Subject Answers

Based on the answers written by GR in Figure 1, it can be seen that GR subjects with a visual learning style can complete stage 1, understanding the problem correctly. GR subjects are able to identify things that are known, *n* as the total element and *r* as the selected element. GR subjects were able to write what was asked in the question correctly. Furthermore, GR subjects can also complete stage 2, preparing a plan. GR subjects are able to develop a solution strategy using a combination formula and can write the formula correctly, then explain the process of entering n and r values into the formula. The GR subject presents the sequence of steps correctly and leads to the correct answer.

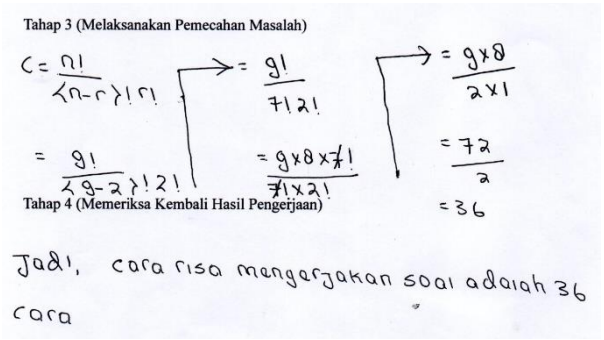


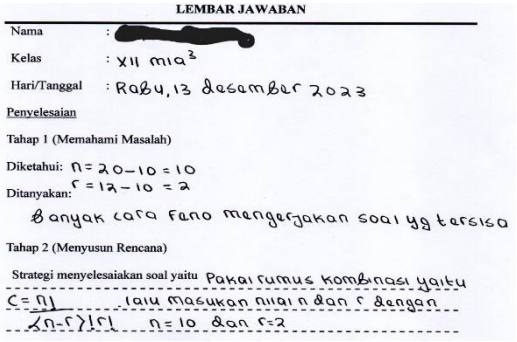
Figure 2. GR Stage 3 and Stage 4 Subject Answers

Based on the answers written by the GR subject in Figure 2, it can be seen that the GR subject can complete stage 3, arrange problem solving correctly. At this stage the GR subject rewrites the formula and enters the values into the formula then performs factorial multiplication and factorial division correctly and obtains the correct answer. GR subjects are able to arrange the correct process and get the correct results. Next, in stage 4, checking the work results again, the GR subject writes the conclusions correctly. At this stage, to ensure that the GR subject rechecks the results of their work, the researcher conducts an interview, with the GR subject's answers as follows;

> *"The first one is based on the formula, I got it, then after that I wrote it, he has a conclusion below I wrote it because I think it's right then if to convince it, I recalculated it, I have a way of working that is 72/2 and then I look again from the beginning of the path, like that, sis. Then I'm also sure because when I reread the question like this, it's the right one, so it's all right in my opinion."*

According to the results of interviews with GR subjects, it was found that GR subjects re-checked the results of problem-solving to ensure the correctness of the results and wrote down their conclusions. According to the results of the tests and interviews conducted, the results obtained were that GR subjects with a visual learning style were able to understand problems, were able to formulate problem solving plans, were able to carry out problem solving plans, and recheck and draw conclusions.

So that students' problem solving abilities in solving combination material story problems in terms of the visual learning style are very good, because students can solve the questions correctly and according to the Polya stages. Second, the AR subject. The results of the AR subject test show that the AR subject can complete the stage of understanding the problem, can formulate a plan, is able to carry out problem-solving, and can re-examine the results of the work by writing conclusions, as seen in Figures 3 and 4.


LEMBAR JAWABAN

Nama : [redacted]

Kelas : XII MIA 3

Hari/Tanggal : Rabu, 13 desember 2023

Penyelesaian

Tahap 1 (Memahami Masalah)

Diketahui: n = 20−10 = 10

Ditanyakan: r = 12−10 = 2

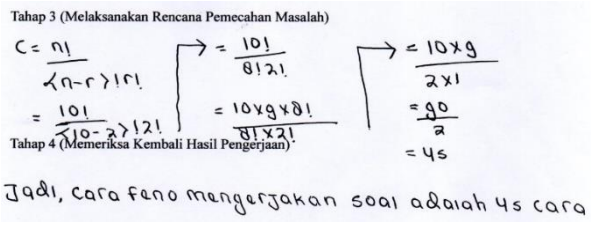
Banyak cara fano mengerjakan soal yg tersisa

Tahap 2 (Menyusun Rencana)

Strategi menyelesaiakan soal yaitu Pakai rumus kombinasi yaitu C = n! / (n−r)!r! ..... yaitu masukan nilai n dan r dengan n=10 dan r=2

Figure 3. AR Subject Answers Stage 1 and Stage 2

Based on the answers written by AR in Figure 3, it can be seen that AR subjects with an auditory learning style can complete stage 1, understanding the problem correctly. AR subjects are able to identify things that are known, *n* as the total element and *r* as the selected element and are able to write down the things asked in the question correctly. Furthermore, AR subjects can also complete stage 2, namely drawing up a plan. AR subjects are able to develop a solution strategy using a combination formula and can write the formula correctly, then explain the process of entering *n* and *r* values into the formula. The AR subject presents the sequence of steps correctly and leads to the correct answer.


Tahap 3 (Melaksanakan Rencana Pemecahan Masalah)

C = n! / (n−r)!r!

= 10! / (10−2)!2!

= 10! / 8!2!

= 10×9×8! / 8!×2!

= 10×9 / 2×1

= 90 / 2

= 45

Tahap 4 (Memeriksa Kembali Hasil Pengerjaan)

Jadi, cara fano mengerjakan soal adalah 45 cara

Figure 4. AR Subject Answers Stage 3 and Stage 4

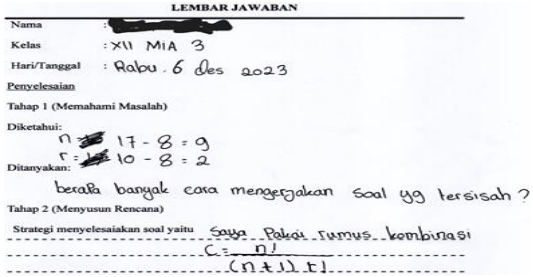
Based on the answer written by AR in Figure 4, it can be seen that the AR subject can complete stage 3, arrange problem solving correctly. At this stage the AR subject rewrites the combination formula and enters the values into the formula then performs factorial multiplication and factorial division correctly and obtains the correct answer. AR subjects are able to carry out the correct process and get the correct results. Next, in stage 4, checking the work results again, the AR subject wrote the conclusion correctly. At this stage, to ensure that AR students recheck the results of their work, the researcher conducted an interview, with the GR subject's answers as follows;

> *"So with me rechecking. So I check again and I remember this formula again whether it is right or wrong because I already feel right. Then also often I am given by Mrs. Tasks So if for the formula I remember the formula like that, then after that I check back also the steps according to me are correct my calculations are like that. that's why I wrote the conclusion kak 36 way."*

According to the results of interviews with AR subjects, it was found that AR subjects re-checked the results of problem-solving to ensure the correctness of the results and wrote down their conclusions. According to the results of tests and interviews conducted, the results obtained were that AR subjects with an auditory learning style were able to understand problems, were able to formulate problem-solving plans, were able to carry out problem-solving plans, and recheck and draw conclusions. Therefore, students' problem solving abilities in solving combination material story problems in terms of auditory learning style are very good, because students can solve questions correctly and according to the Polya stages.

Third, the TS subject. The test results for TS subjects show that TS subjects can complete the understanding of the problem stage, are less able to plan, can arrange problem-

solving, and are unable to re-examine the results of their work by writing conclusions, as seen in Figures 5 and 6.


LEMBAR JAWABAN

Nama : [redacted]

Kelas : XII MIA 3

Hari/Tanggal : Rabu, 6 Des 2023

Penyelesaian

Tahap 1 (Memahami Masalah)

Diketahui:

n = 17 - 8 = 9

r = 10 - 8 = 2

Ditanyakan:

berapa banyak cara mengerjakan soal yg tersisah ?

Tahap 2 (Menyusun Rencana)

Strategi menyelesaiakan soal yaitu saya pakai rumus kombinasi

C = n!

(n+1).t1

Figure 5. TS Subject Answers Stage 1 and Stage 2

Based on the answers written by TS in Figure 5, it can be seen that TS subjects with a kinesthetic learning style can complete stage 1, understanding the problem correctly. TS subjects are able to identify things that are known, *n* as the total element and *r* as the selected element and are able to write down the things asked in the question correctly. Next, in stage 2, making a plan, the TS subject was unable to complete it correctly. TS subjects were able to develop a solution strategy using a combination formula but could not write the combination formula correctly, TS subjects also did not write down the process of entering *n* and *r* values into the formula. The sequence of solution steps presented by the TS subject is correct, but leads to the wrong answer.

Based on the answers written by TS in Figure 6, it can be seen that subject TS was unable to complete stage 3, arrange problem solving correctly. At this stage, the TS subject re-wrote the wrong combination formula and entered the *n* and *r* values in the wrong formula, and then did factorial multiplication and factorial division correctly but was unable to get the correct answer. Subject TS carried out the wrong procedure and could not be completed. Next, in stage 4, checking the work results again, the TS subject did not write a conclusion. At this stage, to ensure that TS students recheck the results of their work, the researcher conducted an interview, with the TS subject's answers as follows;

> *"Not sure sis, because I didn't get to the final score.... Oh yes sis I remember like added sorry sis."*

According to the results of interviews with TS subjects, it was found that TS subjects were unable to complete the problem solving implementation correctly so they were unable to double check and write conclusions. According to the results of the tests and interviews conducted, the results obtained were that TS subjects with a kinesthetic learning style were able to understand problems, were unable to formulate problem-solving plans, were able to carry out wrong problem-solving plans, and did not double-check and did not draw conclusions. Therefore, students' problem-solving abilities in solving combination material story problems in terms of the kinesthetic learning style are good, because students can solve questions according to the Polya stages, however, they are unable to make plans according to procedures which leads to wrong answers.

Discussion

GR subject who has a tendency towards a visual learning style show good problem solving abilities including understanding the problems of the problem by being able to write down and state what is known or what is asked about the problem, being able to prepare problem-solving plans, and making plans according to procedures with the correct sequence of steps. so that it leads to the correct answer, can arrange the problem-solving plan by carrying out the correct process and getting the correct results, and finally checking the results of the problem-solving again by re-examining the multiplication and division process to see the correctness of the process and writing down the conclusion. These results are in line with research conducted by Umrana et al., (2021) that the mathematical problem solving abilities of

students with a visual learning style according to Polya's stages are able to understand problems, plan problem solving, arrange problem solving plans and recheck answer results, p. This is also in line with Setiadi (2011) research that the visual learning style can solve problems until the final stage.

AR subject who tends towards an auditory learning style also show good problem-solving abilities as well as GR subjects, including understanding the problems of the questions by being able to write down and state what is known or what is asked about the questions, being able to prepare problem-solving plans and making plans according to procedures. with the correct sequence of steps so that they lead to the correct answer, being able to arrange the problem-solving plan by arranging the correct process and getting the correct results, and finally checking the results of the problem-solving again by re-examining the multiplication and division process to see the correctness of the process and write the conclusion. These results are in line with research conducted by Umrana et al., (2021) that the mathematical problem solving abilities of students with an auditory learning style according to Polya's stages are able to understand problems well, create problem solving plans, carry out problem solving plans and re-examine the results of problem solving. Research Anggraini et al., (2021) writes that students with visual and kinesthetic learning styles have the same problem-solving abilities in understanding problems, preparing plans, and implementing plans. This is also in line with research by Inastuti et al., (2021) who wrote that the results of the analysis of the stages of problem solving ability, students with visual and auditory learning styles, have been able to reach the stage of understanding questions/problems, designing and choosing solving strategies, and solving problems. with a mathematical model, but has not yet reached the stage of re-checking the solution obtained.

TS subject who tends to have a kinesthetic learning style show poor problem-solving abilities, including understanding the problems of the questions by being able to write down and mention what is known or what is asked about the questions, less able to prepare problem-solving plans and being unable to make plans according to procedures and leading to wrong answers, TS students carry out the wrong problem-solving plan so they get wrong results, and finally, TS subjects do not check the results again and do not write conclusions. In line with research by Al-Hamzah & Awalludin (2021) Mathematical problem-solving abilities with a kinesthetic learning style type, able to understand problems by writing down what is known and what is asked, less ability to plan problems by knowing the formula first, able to complete the steps, and less able to re-examine the results of existing problem-solving. Similar to research Imamuddin et al., (2019), the problem-solving abilities of students who have visual or auditory learning styles are higher than students who have a kinesthetic learning style.

CONCLUSION

Based on the results of the research data analysis and discussions carried out, it can be concluded that the problem-solving ability in solving combination material story questions in terms of the learning style of class XII students at SMA Negeri 1 Sirenja is; 1) students' problem-solving abilities with a visual learning style, namely, being able to understand problems, being able to formulate plans, being able to carry out problem-solving, and rechecking the results of work. 2) problem-solving abilities of students with an auditory learning style, namely, being able to understand problems, being able to formulate plans, being able to carry out problem-solving, and rechecking the results of work. 3) problem-solving abilities of students with a kinesthetic learning style, namely, being able to understand problems, being able to make plans, being unable to carry out problem-solving, and not checking the results of work again.

RECOMMENDATION

For students, this research is expected to provide an overview of their problem-solving abilities subsequently that they can be motivated to improve their problem-solving abilities on

combined material based on their learning style. For teachers, it is hoped that this research can add information regarding students' problem-solving abilities, by knowing aspects of students' problem-solving abilities in combination, teachers can consider the learning strategies that will be used according to students' learning styles thus that students can obtain learning in an appropriate and optimal way. Future researchers can identify obstacles for students with a kinesthetic learning style, related to the difficulties faced when solving mathematical problems, especially in combination material and mathematics in general.

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