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Analysis of Mathematical Problem Solving Ability of Two-Variable Linear Equation System Material in Terms of Learning Style

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Abstract: This study aims to describe the problem-solving ability of two-variable linear equation system material in students with visual, auditorial, and kinesthetic learning styles. This type of research is descriptive qualitative. The subjects of the study were grade VIIIB students of SMPN 1 Gunungsari for the 2023/2024 school year, totaling 20 students, with 5 students of visual learning style, 7 students of auditorial learning style, and 8 students of kinesthetic learning style. The sampling technique is carried out by purposive sampling technique. The research instruments are questionnaires, test questions, and interviews. The data analysis technique used is data reduction, data presentation, and conclusions. Analysis is carried out based on John Dewey's stages, namely facing problems, defining problems, finding solutions, testing several solutions, and choosing the best hypothesis. Based on the results of the study, it was obtained that, students of visual learning style, in general, have high problem-solving skills because they are able to carry out all five stages. Students of auditorial learning style, in general, have high problem-solving skills, where auditorial students are able to carry out all five stages. Meanwhile, the kinesthetic learning style has moderate problem-solving abilities, where kinesthetic students are only able to carry out four stages, because at the stage of choosing the best hypothesis, kinesthetic students are not able to carry it out.

Keywords: Learning Style; Problem Solving Ability; Two-Variable Linear Equation System.

INTRODUCTION

Mathematics has a very important role in everyday life, for example, such as counting and measuring activities (Hidayat, 2019). According to Hidayat (2019), mathematics is the queen of science and arithmetic is the queen of mathematics. In mathematics learning, the most important thing that students must have is problem-solving skills, becausee problem solving is the first step for students to develop Ideas in building new knowledge and develop mathematical skills (Rianto, Yusmin, & Nursangaji, 2017). Problem-solving ability is the ability that students have in order to be able to compile information systematically so that they can solve problems to obtain mathematics learning objectives (Padian, Subarinah, Tyaningsih, & Soeprianto, 2023).

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There are many problem-solving techniques that have been developed by mathematicians and mathematics teachers including the problem-solving stage based on the stages of Polya, Krulik and Rudnick, and John Dewey. In this study, researchers wanted to see the ability to solve problems based on John Dewey's stages, because John Dewey's problem-solving skills based on stages have very complete stages so that they can develop students' mathematical problem solving skills. In addition, there has not been much research on John Dewey's stage-based problem-solving abilities. The stages of John Dewey are: (1) facing problems; (2) defining the problem; (3) finding solution; (4) testing several solutions; (5) choosing the best hypothesis, besides that there has not been much research on problem-solving abilities based on John Dewey's stages (Rianto, Yusmin, & Nursangaji, 2017).

However, the reality is that the mathematical problem-solving ability of junior high school students in Indonesia is still very low. This can be seen from the results of the *Programme for International Student Assessment* (PISA) survey. The results of *the Programme for International Student Assessment* (PISA) survey for mathematics skills from each year Indonesia always scores below the international average and ranks below. The results of the PISA 2018 study Indonesia ranked 73rd out of 79 participating countries with an average score of 379 while the international average score was 487 (OECD, 2019).

The PISA results are similar to those that occurred in schools, especially SMPN 1 Gunungsari. Based on the results of an interview with one of the mathematics teachers of SMPN 1 Gunungsari, information was obtained that the level of mathematical problem solving ability of grade VIII students was still lacking, due to the lack of interest of students in mathematics lessons so that it was difficult to accept the knowledge provided. This is related to teachers who do not know the factors that affect problem-solving abilities. As a result, students still often experience errors in calculations and the use of formulas. It can be seen in Table 1 that the scores obtained by students are still below Minimum Completion Criteria (known with KKM).

Tabel 1. Test Scores of Class VIII Students of SMPN 1 Gunungsari

Minimum Completion Criteria	Class	Multiple Students		Classical Completion
		Complete	Incomplete	
75	VIII-A	0	32	0%
	VIII-B	0	32	0%
	VIII-C	0	32	0%
	VIII-D	0	22	0%
	VIII-E	2	20	9.09%
	VIII-F	0	21	0%

Based on Table 1, it can be seen that the average grade VIII students obtained scores below the predetermined minimum completeness criteria (KKM), namely 75 and only 9.09% met the KKM score. Thus, it can be concluded that the problem-solving ability of grade VIII students of SMPN 1 Gunungsari is still very low.

Mathematics is often related to everyday life whose presentation is presented in the form of story problems, such as in the material of two-variable linear equation systems. In solving the material of a two-variable linear equation system, it takes the ability to understand concepts. So based on Basic Competence (KD) on the Two Variable Liniear Equation System (SPLDV) material, which is solving contextual problems related to the two-variable linear equation system material, it takes the ability to solve mathematical problems that develop, in order to find the best solution to the problem.

According to Umrana, Cahyono and Sudia (2019), one aspect that can affect students' problem-solving ability towards mathematics is learning style, because learning style is a way or technique that students do to understand lessons at school. Every student must have one of the more inclined

learning styles. It is very important for a teacher to recognize the learning style possessed by each student. Therefore, teachers need to know how exactly the path or process of mathematics can be understood or mastered by students. This can help students maximize the resolution of mathematical problems and encourage students to construct knowledge in their minds based on their own learning styles to influence students' logical thinking, analysis and creativity.

According to DePorter and Hernacki (2007: 112), there are three types of learning styles, namely visual learning style (learning by seeing), auditorial learning style (learning by hearing), and kinesthetic learning style (learning by moving and trying). The indicators used in visual, auditorial and kinesthetic learning styles are: (1) how to absorb and process information; (2) personality; (3) social interaction; (4) environmental interactions.

METHOD

The type of research used in this study is qualitative descriptive research, with the aim of this study designed to provide a shadow or explain the problem-solving ability of the two-variable linear equation system material in terms of student learning style. The source of data in this study was 3 grades VIII of SMPN 1 Gunungsari, the subject of data obtained based on consideration and advice from mathematics teachers of SMPN 1 Gunungsari.

Sampling in this study was carried out by *purposive sampling techniques*, namely sampling techniques of data sources with certain considerations. These considerations are based on (1) the research subject has received material on a two-variable linear equation system (2) the subject's ability to communicate well orally so that it is easier to be interviewed to obtain accurate data (3) the research subject is representative of each type of learning style studied. So that the subjects in this study were obtained as many as 20 students of grade VIII.B SMPN 1 Gunungsari for the 2023/2024 academic year. The problem-solving stages used in this study use stages based on John Dewey. The following stage indicators used can be seen in Table 2.

Tabel 2. John Dewey's Troubleshooting Stages Indicator

Troubleshooting	Indicator
Facing problems	a. Able to uncover and write down known things. b. Able to reveal and write things asked
Defining the problem	a. Able to define problems by making examples using their own language. b. Able to create mathematical models.
Finding solutions	a. Able to plan formulas used to solve problems. b. Able to carry out calculations according to the formula used. c. Able to write calculations well.
Testing several solutions	a. Able to plan alternative solutions other than solutions that have been found before. b. Able to use other alternative solutions appropriately.
Choosing the best hypothesis	a. Able to analyze the weaknesses and advantages of solutions that have been found. b. Choose effective problem-solving alternatives. c. Able to draw the conclusions obtained.

The research instrument uses questionnaires, test questions, and interview guidelines. The questionnaire instrument used is a learning style questionnaire consisting of 27 items. The test instrument is in the form of a description question consisting of 2 questions. Before conducting research, the research instrument to be used is tested for validity first. The validity test used is the validity of the contents using Aiken's V index formula.

Analysis of learning style questionnaire data is carried out according to student answers by drawing conclusions about student learning styles as follows: (1) if the highest score in the learning style question group, the conclusion is that the subject is included in the learning style in question, (2) if there are 2 highest and equal values of 2 learning styles, then the subject is grouped in a combination of the two learning styles, (3) if there are 2 highest scores out of 2 slices of learning

styles that are worth 1 point, the subjects are grouped into these 2 learning styles (Turmuzi, Kurniati, &; Azmi, 2021). While the analysis of problem solving test data was carried out according to the truth of students who were guided by the completion instructions according to John Dewey's problem-solving stage and scoring rubric.

The categorization of the results of the level of problem-solving ability into several levels based on Handayani (2020) as follows.

a. High group by formula, ($X \geq Mi + SDi$)
b. Medium group with formula, ($Mi - SDi \leq X < Mi + SDi$)
c. Low group by formula, ($X < Mi - SDi$)

RESULT AND DISCUSSION

The provision of learning style questionnaires was carried out to 3 classes, namely class VIII B, class VIII C and class VIII E. After the data was grouped based on the total score of each learning style, it turned out that there were students who were dominant in both and third types of learning styles. However, this study will only focus on students who have 1 type of learning style. The data on the results of the learning style questionnaire of grade VIII students of SMPN 1 Gunungsari obtained can be seen in Table 3.

Tabel 3. Categories of Learning Style Questionnaire Results of Class VIII Students of SMPN 1 Gunungsari

Class	Learning Style			Total
	Visual	Auditorial	Kinesthetic	
B	7	7	8	22
C	6	7	12	25
E	8	9	2	19

Based on Table 3, it is known that class VIII.B obtained balanced learning style questionnaire results. So that class VIII.B was selected as the subject to be given the question test. Students who received the problem-solving question test were 20 students consisting of 5 visual students, 7 auditorial students, and 8 kinesthetic students. The following are the results of the test of mathematical problem solving ability of two-variable linear equation system material in grade VIII.B students.

Tabel 4. Troubleshooting Ability Test Results

Learning Style	Percentage of Troubleshooting Ability Categories		
	High	Medium	Low
Visual	60%	20%	20%
Auditorial	57.14%	28.57%	14.28%
Kinesthetic	12.5%	75%	12.5%

Based on Table 4, it is found that the percentage of visual students with high problem-solving ability is 60%, medium problem-solving ability is 20% and low problem-solving ability is 20%. The percentage of auditorial students with high problem-solving ability was 57.14%, medium problem-solving ability was 28.57%, and low problem-solving ability was 14.28%. While the percentage of kinesthetic students with high problem-solving ability is 12.5%, medium problem-solving ability is 75%, and low problem-solving ability is 12.5%. Then it can be seen that students who have high problem-solving abilities are possessed by visual students. This is because, during classroom learning, teachers tend to write material on the board, then use the lecture method in delivering the material. So that students with visual learning styles do not find it difficult to accept the material provided, because the delivery of the material is in accordance with their learning style (Hikmatulloh, Subarinah, Novitasari, &; Sridana, 2023).

After the data is analyzed, several subjects are selected who will be interviewed in depth regarding their answers to the problem-solving ability test questions. The selected subjects are representative of each type of learning style and category of problem-solving ability. The subjects of this study were 9 students consisting of 3 students with visual learning styles who had high, medium, and low problem solving abilities, 3 students with auditorial learning styles who had high, medium, and low problem solving abilities, and 3 students with kinesthetic learning styles who had high, medium, and low problem solving abilities.

Students' Mathematical Problem Solving Abilities Visual Learning Style

At the stage of facing problems, students who have a visual learning style are able to know all the information known and asked on the question correctly and explain it by repeating sentences on the problem. This shows that visual students are careful about what is done so that in solving problems, students with visual learning styles allow to understand the problem by rewriting information that is known and asked in the problem. This is similar to Mursari's (2019) statement that students who have a visual learning style are meticulous about details, able to organize the structure available in the problem both explicitly and implicitly so that they can provide answers appropriately. In addition, students visually show that in the face of problems performed very well. This is in line with research conducted by Kurniawan (2019), which states that students' problem-solving abilities in understanding problems are categorized very well.

At the stage of defining the problem, visual students can make examples and transform into mathematical models. This is similar to the opinion of DePorter and Hernacki that (2007: 110), one of the characteristics of someone with a visual learning style is a good planner so as to allow visual students to make good solution formulations and lead to solutions in order to get the right results or answers.

At the finding solution stage, visual students can determine and use the right methods and steps of solving so that the answers obtained are correct. However, in certain problems, visual students cannot carry out the solution discovery stage, because visual students do not understand the concept of the problem, so it is difficult to determine and work on methods and steps to solve it. While other visual students have errors in the steps to solve the second problem, so they cannot complete the steps to the end and cannot get the correct answer. According to Sumartini (2016), mistakes made by students in solving problem solving problems are due to carelessness or lack of caution, errors in transforming information, errors in process skills, and errors in understanding problems.

In the stage of testing several solutions, students with visual learning styles can determine and use other solving steps to solve the problem. However, some other visual students in testing other solutions, there was a mistake in the process of using the completion step so that they could not complete the step until the end.

At the stage of choosing the best hypothesis, visual students with high problem-solving skills are able to carry out the stage of choosing the best hypothesis by determining and writing effective alternatives for them and concluding the final answer correctly. Whereas visual students with moderate and low problem-solving skills cannot carry out the stage of choosing the best hypothesis, visual students cannot determine effective alternatives according to him. When explored through interviews, visual students do not choose the best hypothesis because visual students do not understand how to determine which alternative is effective. This is due to the lack of understanding and experience of students at this stage, so students are confused in carrying out the stage of choosing the best hypothesis. This is in line with the research of Mawaddah and Anisah (2015), that the way of solving problems obtained by students is the result of the knowledge and experience that students have related to the problem they want to find a solution too.

Students' Mathematical Problem Solving Abilities Auditorial Learning Styles

At the stage of facing problems, students with auditorial learning styles are able to write down and explain all known information and asked appropriately and completely. According to Mursari (2019), students with the auditorial learning style category are able to organize the structure contained in the problem by describing or detailing the concept. However, in certain problems auditorial students with high problem-solving skills write mathematical models in the known and asked column, which includes the stages of defining the problem.

At the stage of defining the problem, auditorial students are able to make examples first and then turn them into a complete mathematical model. However, other auditorial students cannot make examples, where the student immediately writes down the mathematical form without explaining first. Some other auditorial students have erroneous changes to their mathematical models. This is in line with the research of Safitri, Prayitno, Hayati and Hapipi (2021), stating that the mistakes made by students in the auditorial learning style category are in the form of mistakes in making examples and making mistakes in making mathematical models. This is because the subject is not careful when doing the questions and does not double-check the steps used before collecting them.

In the finding solution stage, students with auditorial learning styles can determine and complete the completion steps used so as to obtain the right answer. However, in certain problems, auditorial students with moderate and low problem-solving skills do not do the work because the subject does not understand the concept of the problem so that it cannot determine the steps to solve it. While other auditorial students are able to do the work with the completion steps, however, there is an error in calculation due to lack of accuracy in solving problems.

At the stage of testing several solutions, students with auditorial learning style categories are able to determine and write down other solving steps in solving problems. However, some other auditotial students still have errors in the completion steps, so that the student cannot complete it until the end and does not get the correct answer. According to Hadi, Subarinah, Triutami, and Hikmah (2022), stated that the error was due to lack of understanding of the material, lack of accuracy in calculations and lack of accuracy in understanding the problem.

At the stage of choosing the best hypothesis, auditorial students with high problem-solving skills are able to carry out this stage by choosing effective alternatives and concluding the final answer correctly. However, on certain problems, the student can complete the stages but is less complete. When studied through the interview, auditorial students forget to continue the completion step, so they cannot complete it until the end. As for auditorial students with medium and low problem-solving abilities do not work on both problems, because of the confusion of steps that must be done at the stage of choosing the best hypothesis.

Students' Mathematical Problem Solving Abilities Kinesthetic Learning Style

At the stage of facing problems, students with kinesthetic learning style categories are able to write and explain known information and ask appropriately and completely using their own sentences. This can be seen from the answers written and during the interview students kinesthetic learning style does not repeat the sentences contained in the questions. Students with a kinesthetic learning style explain the information contained in the problem slowly and use their fingers as reading pointers on the answer sheet. This is in line with the research of the Prophet, Amrullah, Lu'luilmaknun and Sripatmi (2023), stating that the stages carried out by students with a kinesthetic learning style start from reading statements slowly and pointing to sentences read using fingers.

At the stage of defining the problems, kinesthetic students with high and moderate problem-solving abilities are able to carry out these stages with the steps taken first, namely making examples and converting them into mathematical models appropriately. While other kinesthetic students in carrying out the stage of defining the problem are incomplete, because they do not write down the example first. The kinesthetic student immediately made a mathematical model without explaining the example that had to be made. When explored through interviews, the student was not careful and rushed in completing the settlement so he forgot to make an example first. This is similar to research conducted by Aliffianti, Kurniati, Salsabila, and Turmuzi (2022), suggesting that the errors

that occur by kinesthetic subjects are due to the subject lacking focus and feeling bored so that they rush to do the problem.

At the finding solution stage, students with the kinesthetic learning style category are able to determine and write down methods and solving steps that can be used to solve problems. This is contrary to research conducted by Inastuti, Subarinah, and Kurniawan (2021), which states that at the stage of designing and choosing a solution strategy, kinesthetic students have not been able to show a design or strategy that can be used in determining problem-solving steps. Kinesthetic students with high problem-solving skills and are using the solving steps appropriately and can write down the conclusions of the answers obtained. However, in other kinesthetic students the completion steps are appropriate but incomplete.

At the stage of testing several solutions, students with kinesthetic learning style categories have been able to determine and write down other solving steps that can be used to solve the problem. Kinesthetic students with high problem-solving skills and are working on the solving steps precisely and completely, so as to obtain the right answer. Meanwhile, other kinesthetic students carry out the completion steps correctly but are incomplete, so students do not do the steps until the end and do not get the right answer. After being explored through interviews, the student was not very familiar with the method worked. Therefore, the kinesthetic student cannot complete the completion step until the end.

At the stage of choosing the best hypothesis, kinesthetic students with high problem-solving skills are able to carry out the stage of choosing effective alternatives and can determine the final answer conclusion correctly, but in certain problems the kinesthetic students do not do the work. When explored through the interview, the student forgot to work on the stages of choosing the best hypothesis. Meanwhile, other kinesthetic students do not work on both problems, because students do not understand the steps to be done. This is related to the understanding and experience that students have, where the kinesthetic student does not have the knowledge and experience at the stage of choosing the best hypothesis.

CONCLUSION

Based on the results of research and discussion, the following conclusions were obtained: (1) Students with visual learning styles, in general, have high problem-solving abilities, because visual students are able to carry out the five stages of problem solving according to John Dewey, namely facing problems, defining problems, finding solutions, testing several solutions and choosing the best hypothesis; (2) Students who have an auditorial learning style, in general, have high problem-solving abilities, because they are able to carry out 5 stages of problem solving according to John Dewey, namely facing problems, defining problems, finding solutions, testing several solutions, and choosing the best hypothesis; (3) Students with a kinesthetic learning style have moderate problem-solving abilities, because they are only able to carry out 4 stages of problem solving according to John Dewey, namely facing problems, defining problems, finding solutions, and testing several solutions. Where for the stage of choosing the best hypothesis, students with kinesthetic learning styles have not been able to carry it out.

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The authors declare no conflict of interest.

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