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Analysis of Mathematical Problem Solving Ability based on John Dewey's Theory from The Perspective of Learning Styles

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Abstract:
Problem-solving ability is a primary objective of mathematics learning and can be improved through systematic steps, as proposed by both Polya and John Dewey, particularly in solving contextual problems related to everyday life. Therefore, this study aims to analyze and describe mathematical problem solving abilities in solving contextual problems on matrix material based on John Dewey's theory, and to compare three learning styles: visual, audio, and kinesthetic learning styles. Researchers conducted non-cognitive diagnostic tests to see students' learning styles and mathematical problem solving ability tests, as well as interviews. Data were collected from 32 students (10 visual, 7 audio, and 15 kinesthetic) in class XI Phase F at Sman 1 Sukakarya. This study is a qualitative study using descriptive qualitative research methods. Nine people were selected as research subjects, consisting of three students from each learning style with high, medium, and low ability categories. Data analysis was taken from problem solving ability tests, questionnaires, and interviews. The results showed that the mathematical problem solving abilities of students with a kinesthetic learning style were overall higher than those with visual and audio learning styles. Although students had various learning styles (visual, audio, and kinesthetic), all students demonstrated similar abilities in solving mathematical problems related to matrices. They were all able to articulate arguments, identify facts, perform calculations, compare results, and determine effective strategies.

Abstract:
Kemampuan pemecahan masalah merupakan tujuan utama pembelajaran matematika dan dapat ditingkatkan melalui langkah-langkah sistematis, baik menurut Polya maupun John Dewey, terutama dalam menyelesaikan soal kontekstual yang dekat dengan kehidupan sehari-hari. Oleh karena itu, penelitian ini bertujuan menganalisis dan mendeskripsikan kemampuan pemecahan masalah matematika dalam menyelesaikan soal kontekstual pada materi matriks berdasarkan teori John Dewey, serta membandingkan tiga gaya belajar, yaitu visual, auditori, dan kinestetik. Peneliti melakukan tes diagnostik nonkognitif untuk mengetahui gaya belajar siswa, tes kemampuan pemecahan masalah matematika, serta wawancara terhadap 32 siswa (10 visual, 7 auditori, dan 15 kinestetik) di kelas XI Fase F SMAN 1 Sukakarya. Penelitian ini merupakan penelitian kualitatif dengan metode deskriptif kualitatif. Subjek penelitian berjumlah 9 siswa, yang terdiri atas 3 siswa dari masing-

masing gaya belajar dengan kategori kemampuan tinggi, sedang, dan rendah. Analisis data diperoleh dari tes kemampuan pemecahan masalah, angket, dan wawancara. Hasil penelitian menunjukkan bahwa kemampuan pemecahan masalah matematika siswa dengan gaya belajar kinestetik secara keseluruhan lebih tinggi dibandingkan dengan siswa bergaya belajar visual dan auditori. Meskipun siswa memiliki gaya belajar yang berbeda (visual, auditori, dan kinestetik), seluruh siswa menunjukkan kemampuan yang relatif sama dalam menyelesaikan permasalahan matematika terkait matriks. Mereka mampu mengemukakan argumen, mengidentifikasi fakta, melakukan perhitungan, membandingkan hasil, serta menentukan strategi yang efektif.

Keywords:
Mathematical Problem Solving Skills, John Dewey's Theory, Learning Style

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INTRODUCTION

Mathematics is an important subject in education and everyday life, as stated by (Ardiawan & Darma, 2023; Diana, Marethi, & Pamungkas, 2020; Katuuk, Sumarauw, & Pulukadang, 2024; Tok, 2013; Wahusna, Sripatmi, & Kurniati, 2022). Mathematical understanding is essential for every individual in the future, both when entering the workforce and in daily life. Mathematical problem solving skills are one of the most needed abilities for individuals to face future challenges (Nehra & Raj, 2025). However, observations and research by Utami (2019). Ani and Rosyidi (2021) show that students have low problem solving skills. They often have difficulty understanding questions and reviewing solutions, especially for contextual questions in the form of stories relevant to real life.

Problem solving skills are not only central to the mathematics curriculum but also one of the main objectives of mathematics learning (Zohra & Lubis, 2025). Several experts, such as Polya, John Dewey, Krulik, and Rudnick, have outlined systematic steps to address low problem solving skills. Nurmeidina, Zaqiyah, Nugroho, Andini, Faiziyah, Adnan, & Syar'i (2025); Yayuk and Husamah (2020); Yunaeti, Arhasy, & Ratnaningsih (2021) emphasizes four steps: (1) understanding the problem, (2) planning a strategy, (3) implementing the plan, and (4) reviewing the solution.

Meanwhile, according to John Dewey (1933), propose a more structured cycle, which begins with (1) formulating and analyzing the problem, then (2) formulating a hypothesis or tentative answer, then (3) collecting data to support or reject the hypothesis, then (4) testing the hypothesis, and ending with (5) determining the most appropriate solution.

On the other hand, mathematics is not limited to abstract problems. There are also contextual problems relevant to students' daily lives that are packaged in stories. Contextual questions in the form of story problems are challenges that students often face. Inastuti, Subarinah, Kurniawan, & Amrullah (2021) state that contextual mathematics questions present everyday problems that students often encounter. Thus, the process of solving them becomes more meaningful because students can relate them to their real lives. In line with Sarjana, Hayati, & Wahidaturrahmi (2020), contextual questions can also hone students' thinking patterns because they are encouraged not only to solve problems but also to truly understand each step in the process. Although we know that in their daily lives, students will encounter different problems depending on each individual.

Every student is born different from one another. This is especially true in classroom learning, such as different ways of receiving material and different ways of solving mathematical problems. Thus, differences in receiving and processing information when solving mathematical problems are greatly influenced by their individual learning styles (Dermawan, Siagian, & Sinaga, 2020). This is in line with the view that learning style is one of the determining factors in a person's problem solving ability (Firmaningtyas, Handayani, Katminingsih, & Widodo, 2024; Harmila, Nurhasanah, Tahir, & Oktavianty, 2022; Inastuti, Subarinah, Kurniawan, & Amrullah, 2021). Each individual's learning style is different and unique. There are visual, auditory, and kinesthetic styles (DePorter & Hernacki, 2015). These learning styles can influence how they process information. Visual learners tend to prefer learning that involves pictures, diagrams, or demonstrations. Meanwhile, auditory learners prefer to learn by listening to explanations or discussing. On the other hand, learners with a kinesthetic learning style are usually more active and require physical involvement in the learning process.

Several previous studies have examined students' problem-solving skills in relation to learning styles and John Dewey's problem-solving theory. Research on differentiated learning based on learning styles shows that students who receive instruction aligned with their preferred learning styles

tend to be more active, enthusiastic, and capable of understanding mathematical concepts, which supports critical and systematic thinking in problem solving (Rahmawati & Suryadi, 2024). Similar findings indicate that learning styles significantly influence students' mathematical problem-solving abilities, particularly in topics such as systems of linear equations, where visual and auditory learners consistently demonstrate stronger problem-solving performance than kinesthetic learners when instruction is not adapted to experiential learning needs (Putri et al., 2024; Hidayat & Arifin, 2023).

Other studies further confirm that visual learners generally show the highest level of mathematical problem-solving ability, followed by auditory learners, while kinesthetic learners often experience difficulties in completing all stages of problem solving. These differences are especially evident in understanding problem representations, planning solution strategies, and executing systematic procedures (Hidayat & Arifin, 2023). This evidence suggests that instructional strategies which ignore learning style diversity may limit students' potential in developing optimal problem-solving skills.

In addition, research grounded in John Dewey's problem-solving approach demonstrates its effectiveness in strengthening students' conceptual understanding and critical thinking skills. Dewey's structured steps—identifying problems, formulating hypotheses, testing solutions, and drawing conclusions—help students organize their reasoning processes when solving mathematical word problems (Sari & Nugroho, 2020). However, studies also report that students still encounter difficulties in interpreting problem statements and performing algebraic operations, indicating that Dewey's approach requires reinforcement through instructional adaptations based on students' learning styles (Wahyuni et al., 2019).

Overall, previous studies indicate that the integration of learning styles with John Dewey's problem-solving framework provides a strong pedagogical foundation for enhancing students' mathematical problem-solving abilities. Learning approaches that combine systematic problem-solving stages with sensitivity to individual learning styles are more effective in facilitating meaningful understanding and improving students' performance in mathematics problem solving.

Several previous studies have found that mathematical problem solving ability can be improved through learning that takes into account learning styles and the reflective problem solving theory proposed by John Dewey. Research by Ishartono, Faiziyah, Sutarni, Putri, Fatmasari, Sayuti,

Rahmaniati, and Yunus (2021), as well as other similar studies, confirms that students with visual and auditory learning styles tend to have better problem solving skills than those with kinesthetic learning styles. Meanwhile, a study by Suryanti, Solikhah, Suliana, Pramesti, and Sari (2024) proves that the steps proposed by John Dewey are effective in helping students understand the concept of and think critically, even though learning style differences have not been considered. Previous research by Fadillah (2025) began to link John Dewey's theory with learning styles, but it was still limited to descriptive analysis. Unlike these studies, this research presents a novelty by integrating John Dewey's theory and learning styles simultaneously in contextual problem- based learning on matrix multiplication, thus providing a more comprehensive perspective on how different learning styles influence students' reflective thinking processes in solving mathematical problems.

The facts on the ground, based on interviews with teachers and student scores at SMAN 1 Sukakarya, show that only a small percentage of students achieved optimal scores in the matrix material. Based on teacher records at the school, where only 25% of the 32 students in class XI F 3 (8 students) achieved a Criteria for Learning Objective Achievement score of 77 in the matrix material. Without a deep understanding, indicating a lack of mastery of problem solving concepts. Therefore, this study aims to analyze and describe students' mathematical problem-solving abilities with different learning styles (visual, audio, and kinesthetic) based on John Dewey's theory, as well as to analyze which learning style shows the highest effectiveness in solving contextual problems in matrix material.

METHOD

The method used in this study was a qualitative research approach. The type of research was descriptive. This method was chosen to describe and analyze students' mathematical problem-solving abilities on matrix material presented in contextual questions based on John Dewey's problem-solving approach. In addition, this study also considers students' learning styles (visual, auditory, and kinesthetic) as factors that influence how they solve problems. The indicators of mathematical problem-solving abilities include several main stages, starting from understanding the problem by identifying what is known and what is being asked. Next, students must define the problem to understand its core. After that, they formulate solutions by finding

several alternative solutions. This process is followed by testing ideas to evaluate the advantages and disadvantages of each method. Finally, students will formulate recommendations by choosing the best method and making a conclusion.

This study collected data in three main ways. First, non-academic diagnostic tests were given to 32 eleventh-grade students at SMAN 1 Sukakarya to identify their learning styles, which resulted in students with three learning styles. The following is the data from the students' non-cognitive diagnostic tests.

Table 1. Results of Non-Cognitive Diagnostic Tests

Learning Style	Number of Students
Visual	10
Auditory	7
Kinesthetic	15
Total	32

Second, a mathematical problem solving test consisting of three contextual questions on matrices in essay form was given to all students. These questions had been validated by experts to measure students' abilities based on John Dewey's theory. The test results were then analyzed according to the stages of the theory. Third, unstructured interviews were conducted with 9 selected subjects through purposive sampling, with 3 students representing each learning style: visual (S1), auditory (S2), and kinesthetic (S3). The selection of subjects was based on different problem-solving ability test scores, consisting of high, medium, and low scores, with good communication skills, to obtain in-depth information about their problem-solving processes. The data obtained was then analyzed. The test indicators used can be seen in table 2.

Table 2. Problem-Solving Ability Indicators According to John Dewey

Steps Problem Solving	Reproduction of Mathematical Concept Understanding	Score
Understanding the Problem	Understanding that the given problem is related to matrix material and identifying the difficulties that arise in solving it.	4

Steps Problem Solving	Reproduction of Mathematical Concept Understanding	Score
	Understanding that the given problem is related to matrix material, but identifying the difficulties that arise in solving it is still not quite right.	3
	Understanding that the given problem is related to matrix material, and being unable to identify the difficulties that arise in solving it.	2
	Not realizing that the question asked was a matrix question, and not knowing the level of difficulty of the question	1
	Write down what is already known and what is being asked by the subject accurately	4
Defining the Problem	Write down what is known and what is asked by the question, but the answer written is not correct	3
	Write down what is known or what is asked by the question, but the answer written is incorrect	2
	Not writing down what is known or what is asked	1
	Able to formulate assumptions based on existing facts and able to relate them to problem-solving appropriately.	4
Formulating Solutions (Resolution)	Able to make assumptions based on existing facts, but unable to connect them to problem-solving accurately	3
	Able to formulate hypotheses based on existing facts, but unable to connect them to problem-solving accurately	2
	Lacks understanding and therefore does not know what to use in solving the problem	1
	Accurately and correctly applies problem-solving steps to matrix problems.	5
	Applies problem-solving steps to matrix problems, but only writes down part of the answer accurately and correctly	4

Steps Problem Solving	Reproduction of Mathematical Concept Understanding	Score
Testing Hypotheses	Applying problem-solving steps to matrix problems, but the written answers are still not quite right.	3
	Applying problem-solving steps to matrix problems, although the steps are not yet accurate, and only a small portion of the answers are correct	2
	Unable to apply problem-solving steps to the matrix problems, and also unable to write down answers accurately and correctly	1
Reviewing Answers and Formulating the Best Hypothesis	Using the formulated hypothesis and concluding it accurately and correctly	3
	Using the formulated hypothesis and drawing conclusions, but incorrectly	2
	Not using the formulated hypothesis and not writing conclusions	1

The data analysis technique in this study refers to the Miles and Huberman model Sugiyono (2018), which includes four main stages. The first stage is data collection, which is done by giving written tests to students. Next, in the data reduction stage, the researcher selects three students who represent high, medium, and low abilities as research subjects in each learning style. The next stage is data presentation, which involves compiling a summary of the three students' work based on John Dewey's problem-solving steps. The final stage is drawing conclusions or verification, which is done by examining the reinforcement of mathematical concepts in each step of problem solving.

The validity of the data in this study was strengthened through triangulation techniques. Researchers collected various types of data from the same subjects, not only through written tests but also through interviews. The application of triangulation aimed to compare the results of problem-solving skills tests with information obtained from in-depth, unstructured interviews after the tests were conducted, so that the data produced was more accurate and reliable. The interview guide used can be seen in table 3.

Table 3. Interview Guide

Stage Dewey	Objective Exploration	Main Questions	Probing Questions	Indicators
1. Facing / Recognizing Problems	Knowing whether students understand the type of problem and the context of the matrix	- "What do you think this problem is about?" - "Which part indicates that this is a matrix problem?" - "What is difficult about this problem?"	- "Using the math you've learned, which chapter can be used to solve this problem?"	- Recognizing the type of problem (matrix) - Recognizing the level of difficulty - Demonstrating initial understanding
2. Defining the Problem	Exploring the ability to write down knowns and unknowns & modeling problems	-	- "Do you understand what you have written?" - "Have you ever encountered a similar problem?"	- Write down what is known/asked accurately - Creating a table correctly - Converting the table into a matrix correctly - Connecting to previous experiences
3. Listing several solutions	Determining whether students are able to create plans and alternative strategies	- "What method can you use?" - "Is there another way?" - "What steps will you take first?"	- "Why did you choose to use matrix multiplicatio n?"	- List the steps for solving using matrix operations - Demonstrate knowledge of alternative solutions - Determine a logical first step
4. Predicting the	Assess students'	- "Are the steps you	- "How did you perform	- Calculate accurately

Stage Dewey	Objective Exploration	Main Questions	Probing Questions	Indicators
Consequences of Solutions	thoroughness in considering the procedure.	took correct?" "How do you know your results make sense?"	the matrix multiplicatio n steps?" - "Why did you choose that step first?"	- Assessing the suitability of steps - Correlating results between equations
5. Testing Consequences (Selecting the Best Hypothesis & Verification)	Exploring the ability to check results and choose the most correct answer	- "How do you ensure your results are correct?" - "Did you try substituting back into the equation?" -"Does the answer fit the context of the story ?"	- "What is your next step after getting the results?" "How do you verify the accuracy of your answer?"	- Ensuring the accuracy of the calculation results. - Drawing conclusions based on the context of the question - Choosing the most logical answer from several hypotheses.

RESULTS AND DISCUSSION

The results obtained from the mathematical problem-solving ability test, consisting of 10 visual learners, 7 auditory learners, and 15 kinesthetic learners, are presented in table 4.

Table 4. Problem-Solving Ability Level Categories

Ability Category Problem Solving	Learning Syle		
	Visual	Auditory	Kinesthetic
High	5	1	7
Medium	3	3	5
Low	2	3	3

The average scores for students' mathematical problem-solving abilities based on learning styles are presented in table 5 below.

Table 5. Average Scores for Students' Mathematical Problem-Solving Abilities Based on Learning Styles

ProblemSolving Stages Problem	**Question 1, 2, & 3**								
	V1	**V2**	**V3**	**A1**	**A2**	**A3**	**K1**	**K2**	**K3**
Understanding the Problem	4	4	4	4	2	2	4	3	2
Defining the Problem	4	4	4	4	3	1	4	4	4
Formulating Solutions	4	3	1	4	4	4	4	4	4
Testing Hypotheses	5	1	1	4	1	1	5	2	2
Double-check and conclude	3	1	1	3	1	1	4	3	3

From the data in table 5 above, the results show that each group has advantages at different stages. (1) Students with Visual Learning Styles: The visual groups (V1, V2) and (V3) excelled in the initial stage, with 4 points, namely when understanding and identifying information from the questions. They were better at writing down what they knew and what was asked compared to other groups; (2) Students with Auditory Learning Styles: The auditory groups (A1), (A2), and (A3) performed best at the stage of formulating solutions with a score of 4. They excelled at creating mathematical models, choosing the right strategies, and utilizing all available information; (3) Students with Kinesthetic Learning Styles: Kinesthetic groups (K1), (K2), and (K3) dominated in two important stages: defining problems and implementing problem-solving strategies. They demonstrated greater ability in accurately applying the steps to solve problems and obtaining the correct results. In addition, they also excelled in the final stage, which was checking the correctness of their answers.

The researchers also analyzed the students' mathematical problem-solving abilities based on the results of interviews and learning style questionnaires. Based on this data, the researchers presented their analysis results. The following are the results of the research on mathematical problem-solving abilities from the results of the problem-solving ability test, learning style questionnaire, and unstructured interview results from the nine subjects randomly selected to represent the three learning styles in table 7 below.

Table 6. Mathematical Problem-Solving Ability of Visual, Auditory, and Kinesthetic Subjects

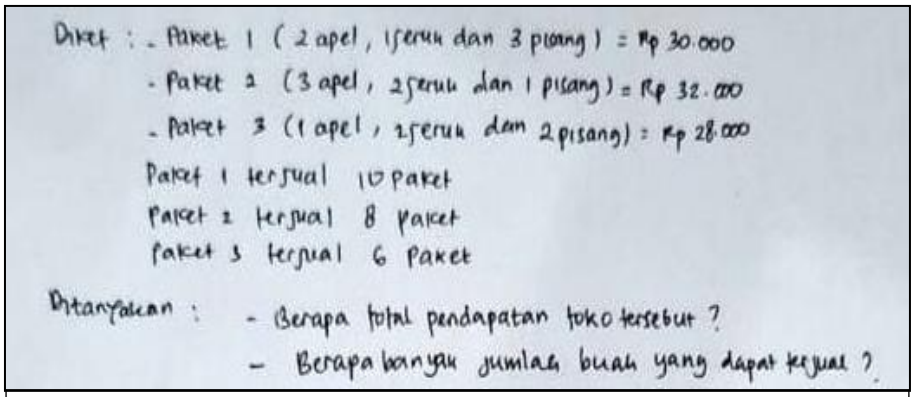
Learning Style Stages	Visual (V-2)	Auditory (A-1)	Kinesthetic (K-1)
Recognizing/ Identifying problems	Able to recognize and write down what is known and asked in one's own style of language clearly.	Able to recognize and write down what is known and asked in their own style, concisely	Able to state and write down existing data, whether known or asked. However, there is a tendency to rewrite mathematical problem-solving test questions exactly as they are written.
Defining the problem (diagnose or define the problem)	Able to define problems	Able to define problems, but the table format is not very clear	Able to define the problem
Developing/ discovering solutions	Able to plan and write down the important steps needed to solve problems. However, even though the planning is good, there are errors in the written calculations.	Able to plan, perform calculations, and write down the important steps that support each other to solve problems. With good planning.	Able to plan, perform calculations, and write down the important steps that support each other to solve problems. However, even though the planning is good, the calculations are written correctly and systematically.
Testing several ideas	Able to plan alternative solutions besides those already obtained.	Able to plan alternative solutions beyond the initial solution obtained previously,	Able to plan alternative solutions other than those already obtained
Take the best hypothesis. (test consequences)	Able to analyze the strengths and weaknesses of the solutions that have been found.	Able to analyze weaknesses and strengths, but the selection of solutions is still not quite right	Able to analyze the strengths and weaknesses of the solutions that have been successfully identified.

From the results of the analysis of students' mathematical problem-solving abilities, interviews, and learning style questionnaires, overall, the mathematical problem-solving abilities of the kinesthetic group were considered superior to those of other learning styles. However, even though each learning style has its own specific strengths, overall problem-solving abilities were more prominent in students with a kinesthetic learning style.

Based on the analysis of the research results, it was concluded that subjects with visual learning styles, as well as auditory and kinesthetic learning styles, were all able to solve mathematical problems through John Dewey's five stages. The following is a description of the research results of the three subjects based on John Dewey's theory on matrix material, reviewed from the three different learning styles.

1. Visual Subject Represented by (V2)

This subject, who has a visual learning style, successfully identified important information in the "confronting the problem" stage. He demonstrated his ability to understand the problem by writing down the known data and questions in the problem.



Translated into English:

Given:

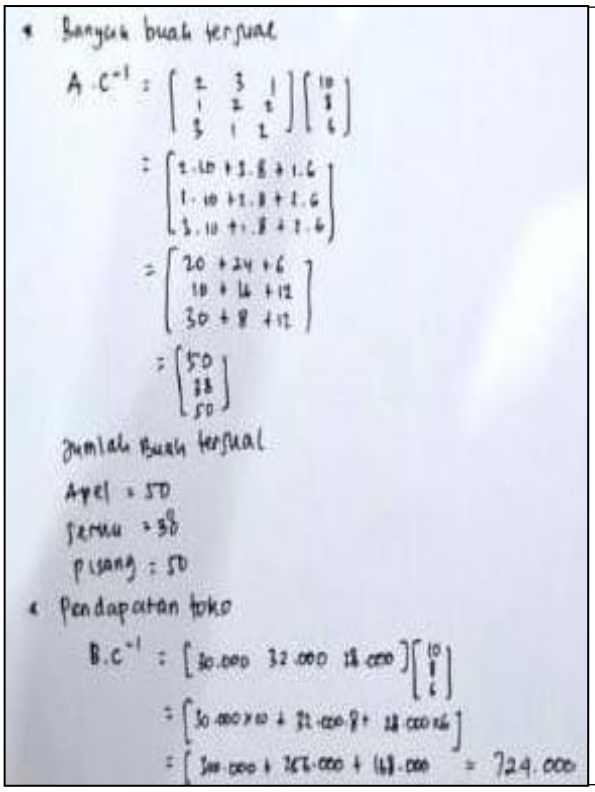
- Package 1 (2 apples, 1 orange, and 3 bananas) = Rp30.000
- Package 2 (3 apples, 2 oranges, and 1 banana) = Rp32.000
- Package 3 (1 apple, 2 oranges, and 2 bananas) = Rp28.000

Package 1 sold: 10 packages
Package 2 sold: 8 packages
Package 3 sold: 6 packages

Questions: - What is the total income of the store?
- How many total fruits were sold?

Figure 1. Subject V-2's Problem Recognition Stage

In the problem definition stage, subject V-2 demonstrated their ability to plan solutions by making sketches or tables. These sketches were the first step in solving the problem.



Translated into English:

- Many fruits were sold

$$A \cdot C^{-1} = \begin{pmatrix} 2 & 3 & 1 \\ 1 & 2 & 2 \\ 3 & 1 & 2 \end{pmatrix} \begin{pmatrix} 10 \\ 8 \\ 6 \end{pmatrix}$$

$$= \begin{pmatrix} 2.10 + 3.8 + 1.6 \\ 1.10 + 2.8 + 2.6 \\ 3.10 + 1.8 + 3.6 \end{pmatrix}$$

$$= \begin{pmatrix} 20 + 24 + 6 \\ 10 + 16 + 12 \\ 30 + 8 + 12 \end{pmatrix}$$

$$= \begin{pmatrix} 50 \\ 38 \\ 50 \end{pmatrix}$$

Number of pieces sold
Apple = 50
Orange = 38
Banana = 50

- Store revenue

$$B \cdot C^{-1} = (30.000 \quad 32.000 \quad 28.000) \begin{pmatrix} 10 \\ 8 \\ 6 \end{pmatrix}$$

$$= (30.000x10 + 32.000x8 + 28.000x6)$$

$$= (300.000 + 256.000 + 168.000)$$

$$= 724.000$$

Figure 2. Solution Discovery Stage, Subject V-2

During the solution discovery stage, Subject V-2, who is a visual learner, demonstrated this ability during the idea testing stage, where he successfully found and planned alternative solutions. At this stage, V-2 was able to perform calculations correctly according to the formula used.

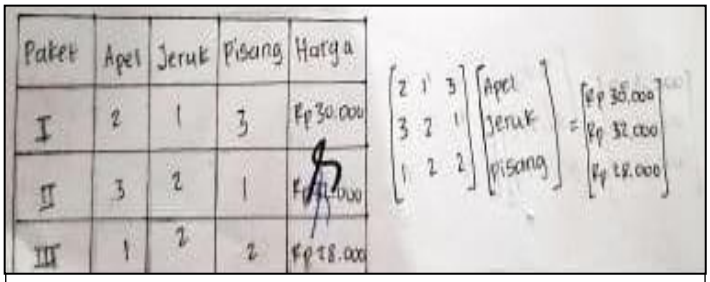
In the stage of selecting the best hypothesis, the student demonstrated his ability to analyze the solutions that had been found. He successfully identified the weaknesses and strengths of these solutions, as seen in the image of his answers. The student was able to find the best solution. During the interview, subject V-2 spoke very quickly. This is in line with the opinion of DePorter and Hernacki (2015); Yuni, Wayoan, and Saputra (2023) that one of the characteristics of a visual learning style is speaking quickly.

2. Subject A-1

Subject A-1, with an auditory learning style, demonstrates good problem-solving skills, particularly in the first stage of John Dewey's problem- solving process, namely recognizing the problem (confronting the problem). This subject can identify and record important information that is known and asked in the question, showing that they have a strong understanding of the core of the problem. His learning style, which relies on hearing, allows him to absorb information effectively and filter out irrelevant things, so that he only focuses on the crucial points needed to solve the problem.

In the next stage, subject A-1, who has an auditory learning style, demonstrated strength in explaining the steps to solve problems verbally. He was able to use his own sentences fluently, which is in line with DePorter and Hernacki (2015); Yuni, Wayoan, and Saputra (2023) opinion that auditory individuals excel at speaking and storytelling even though they may find writing difficult.

At the problem definition stage (diagnose or define problem), subject A-1 can use pictures or tables as aids, but the pictures they create tend to lack detail and are insufficiently complete when viewed by others. This shows their main dependence on verbal explanations rather than detailed visual representations.



Translated into English:

Package	Apple	Orange	Banana	Price
I	2	1	3	Rp30.000
II	3	2	1	Rp32.000
III	1	2	3	Rp28.000

$$\begin{pmatrix} 2 & 1 & 3 \\ 3 & 2 & 1 \\ 1 & 2 & 2 \end{pmatrix} \begin{pmatrix} \text{Apple} \\ \text{Orange} \\ \text{Banana} \end{pmatrix} = \begin{pmatrix} \text{Rp30.000} \\ \text{Rp32.000} \\ \text{Rp28.000} \end{pmatrix}$$

Figure 3. Problem Definition Stage Subject A-1

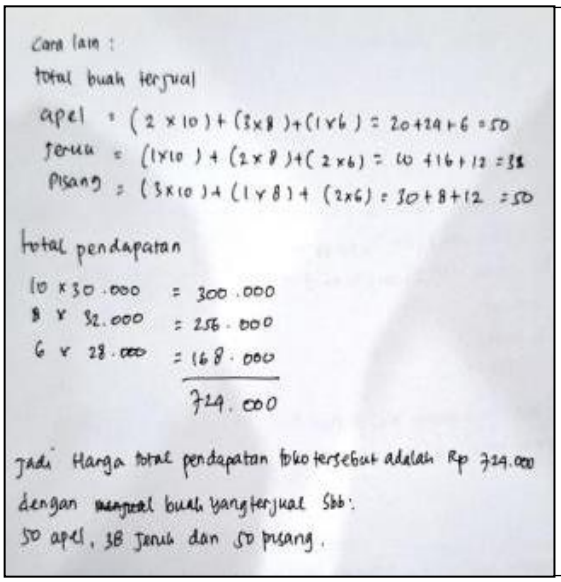
Subject A-2, who has an auditory learning style, faces challenges in tasks that require visualization, as revealed by Boneva & Mihova. This limitation is evident in their tendency to create images that are less detailed and incomplete. However, in the solution discovery stage (inventory several solutions), subject A-1 showed significant strengths. They were able to perform and write down calculations well, confirming that their problem solving abilities were not hampered by visualization difficulties. On the contrary, they excelled in aspects that were more focused on logic and mathematical processes.

In the final stage of problem solving, this stage tests several ideas. He can identify alternative solutions, demonstrating a deep understanding of the problem at hand. Furthermore, at the stage of selecting the best hypothesis, the subject can analytically evaluate the strengths and weaknesses of each solution they have found. This confirms that they are not merely seeking a single answer but are also capable of exploring multiple possibilities, critically analyzing each option, and selecting the most appropriate solution based on careful and rational evaluation. This process reflects higher-order thinking skills, including reasoning, decision-making, and the ability to weigh evidence before drawing conclusions.

3. Subject K-1

Subject K-1, with a kinesthetic learning style, when understanding problems, subject S-3 can identify known and unknown information. However, this subject tends to rewrite questions verbatim. When working on mathematical problem-solving tests, subject K-3 uses his fingers to point while reading the questions. This behavior is in line with the characteristics of learners with a kinesthetic learning style described by DePorter and Hernacki (2015); Yuni, Wayoan, and Saputra (2023), Such learners often exhibit a more physical approach to learning, including speaking slowly, using their fingers as pointers while reading, and engaging in hands-on activities to better understand concepts. These tendencies reflect their preference for movement and tactile experiences as integral components of the learning process.

In the problem definition stage, K-1 subjects were able to present problem definitions through images. The attached answers from students demonstrate this capability.



Translated into English:

Total Fruits Sold

Apples = (2x10) + (3x8) + (1x6) = 20+24+6 = 50

Oranges = (1x10) + (2x8) + (2x6) = 10+16+12 = 38

Bananas = (3x10) + (1x8) + (2x6) = 30+8+12 = 50

Total Revenue

10 x 30.000 = 300.000

8 x 32.000 = 256.000

6 x 28.000 = 168.000

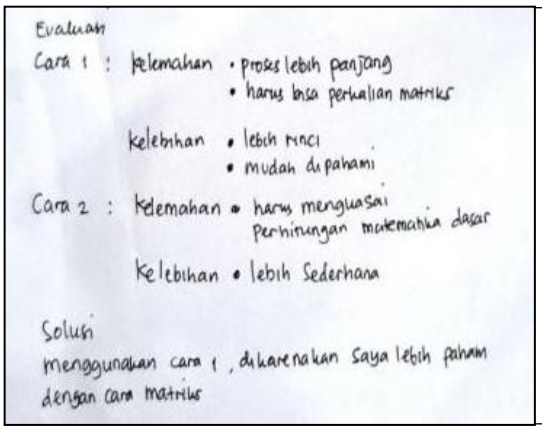
Total = 724.000

Thus, the store's total revenue is Rp724.000 with the total fruits sold as follows:

50 apples, 38 oranges, and 50 bananas.

Figure 4. Testing Several Ideas Stage Subject K-1

In the solution discovery stage, subject K-1 demonstrated the ability to perform calculations in a structured and systematic manner. Furthermore, At the idea testing stage (conjecture consequences of solutions), it can develop alternative solution plans. Finally, when selecting the best hypothesis (test consequences), K-1 can analyze the advantages and disadvantages of the solutions it has found.



Translated into English:

Method 1: Weaknesses: - the process is longer
- must understand matrix operations

Strengths : - more detailed
- easier to understand

Method 2: Weaknesses: - must master basic mathematical calculations

Strengths :- simpler

Solution

Using method 1, because I understand better using the matrix method.

Figure 5. Subject K-1 Selecting The Best Hypothesis

Problem-solving strategies are an effective alternative for teachers to strengthen students' understanding of mathematical concepts. This approach helps contextualize and transfer mathematical knowledge so that

learning becomes more meaningful (Caprioara, 2015). In matrix material, concept reinforcement is carried out through John Dewey's problem solving steps, starting from understanding everyday contexts, simplifying problems through mathematical modeling, and choosing alternative solutions.

CONCLUSION

Based on the results of data analysis, it can be concluded that overall, the mathematical problem-solving abilities of the kinesthetic learning style group are higher than those of the visual and auditory learning styles. Visual learners demonstrate good abilities in presenting arguments, identifying facts, and performing calculations. However, they tend to make minor errors in their calculations. They are also able to compare answers and choose the most effective strategies. Auditory learners can also present arguments and identify facts. However, their visualizations in the form of images are not very detailed, making them less informative for others. They can perform calculations, compare answers, and choose the right strategy. Kinesthetic learners are also skilled at presenting arguments, identifying facts, performing calculations, comparing answers, and choosing effective strategies after trying several approaches. Overall, only kinesthetic learners were able to complete all stages of John Dewey's stages, indicating that, in this study, kinesthetic learners were indeed superior to other learning styles.

Based on the findings of the study, researchers recommend that students be given more variety in the types of questions they encounter, including story problems with different scenarios, so that their problem-solving skills can develop, regardless of whether they are visual, auditory, or kinesthetic learners.

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author and readers in general, and can be used as a reference for further research.

DECLARATIONS

Author Contribution	:	EAD: Conceptualization, Research Design, Data collection, Data analysis, Writing–Original Draft, and Supervision. RMM: Methodology, Formal analysis, Validation, and Writing–Review & Editing. IRDN: Formal analysis, Validation, and Writing–Review & Editing.
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