Architecture
Image Studies

Vol.7, Issue 1, pp.2119-2135, 2026
DOI: https://doi.org/10.62754/ais.v7i1.1183

https://journals.ap2.pt/index.php/ais/index

Mathematical Problem-Solving Ability Based on Learning Style in Core Learning Assisted By E-LKPD

Amidi[1], Kartono[2], Mulyono[3], Emi Pujiastuti[4]

Abstract

Mathematical problem-solving ability is an essential competency in mathematics learning, yet many students still experience difficulties in developing effective problem-solving strategies. This study aims to examine the effectiveness of the CORE (Connecting, Organizing, Reflecting, and Extending) learning model assisted by electronic student worksheets (E-LKPD) in enhancing students' mathematical problem-solving ability, as well as to describe students' problem-solving characteristics based on visual, auditory, and kinesthetic learning styles. Employing a mixed-methods approach with a sequential explanatory design, quantitative data were obtained through a pretest–posttest control group design, while qualitative data were collected through tests, questionnaires, and interviews. The results indicate that the implementation of the CORE learning model supported by E-LKPD contributes positively to students' engagement in understanding problems, organizing solution strategies, and reflecting on mathematical thinking processes. Furthermore, variations in problem-solving characteristics were observed among students with different learning styles, suggesting that learning preferences influence how students construct and apply problem-solving strategies. These findings highlight the importance of integrating constructivist learning models with interactive digital media and adaptive instructional design to support the development of students' mathematical problem-solving ability. Future research is encouraged to explore learning designs that more optimally accommodate diverse student learning characteristics.

Keywords: *Mathematical Problem-Solving, CORE Learning Model, E-LKPD, Learning Style.*

Introduction

Education constitutes a fundamental pillar in enhancing the quality of human resources and determining a nation's capacity to compete in an increasingly globalized world. Amid rapid and complex societal changes, critical thinking, creativity, and problem-solving skills have emerged as essential competencies for the 21st century. Mathematics, as a core subject, plays a pivotal role in fostering these competencies. The National Council of Teachers of Mathematics (NCTM) emphasizes that problem solving is one of the primary standards in mathematics education that must be developed across all educational levels (NCTM, 2000). Mathematical problem solving is not merely a technical skill but a complex cognitive process involving conceptual understanding, strategic planning, execution, and evaluation of solutions. m

However, empirical evidence indicates that mathematical problem-solving ability remains a major challenge for students in many countries. Polya (2004) conceptualizes problem solving as a process consisting of four key stages: understanding the problem, devising a plan, carrying out the plan, and reviewing the solution. In practice, these stages are often not implemented optimally by students. Numerous studies reveal that mathematics instruction still tends to emphasize procedural fluency and rote memorization, resulting in students' limited ability to comprehend problem contexts, select appropriate strategies, and evaluate their solutions critically (Al-Mutawah et al., 2019; Jupri & Drijvers, 2016; Saragih & Napitupulu, 2015; Schoenfeld, 2016; Wijaya et al., 2014).

[1] Doctoral Program of Mathematics Education, Universitas Negeri Semarang,
[2] Mathematics Education, Universitas Negeri Semarang, Email: kartono.mat@mail.unnes.ac.id, (Corresponding Author)
[3] Mathematics Education, Universitas Negeri Semarang
[4] Mathematics Education, Universitas Negeri Semarang

A similar condition was identified through classroom observations conducted at a junior high school in Salam, where students experienced difficulties in identifying relevant information in problem statements, selecting suitable solution strategies, and verifying the correctness of their answers. If such conditions persist without appropriate intervention, students' higher-order thinking skills will be difficult to develop, ultimately leading to weak conceptual understanding and insufficient readiness to solve contextual and complex mathematical problems.

In addition to instructional approaches that remain predominantly teacher-centered, students' mathematical problem-solving abilities are also influenced by individual cognitive characteristics. One commonly used framework to analyze such differences is learning styles, namely visual, auditory, and kinesthetic (Darmin et al., 2021; Hamid, 2024). Although the concept of learning styles remains debated in severals literature, several scholars argue that learning styles should not serve as the primary basis for determining instructional strategies. Instead, they should be employed as an analytical lens to understand variations in students' cognitive processes when solving mathematical problems (Howard-Jones, 2014; Pashler et al., 2009). In this context, differences in learning styles may influence how students represent information, select strategies, and reflect on the solutions they obtain (Cuevas, 2015).

To address these challenges, instructional innovation oriented toward knowledge construction, active participation, and reflective thinking is required. One relevant instructional model is the Connecting, Organizing, Reflecting, and Extending (CORE) learning model, which is grounded in the constructivist theories of Piaget and Vygotsky. Constructivism emphasizes that knowledge is actively constructed through learning experiences and social interaction (Piaget, 1970; Vygotsky, 1978). Consistent with this perspective, problem-based and reflective mathematics instruction has been shown to be effective in enhancing students' conceptual understanding and higher-order thinking skills (Hiebert et al., 1996; Prince & Felder, 2006). The CORE model encourages students to connect prior and new knowledge (connecting), organize information meaningfully (organizing), reflect on their thinking processes (reflecting), and extend their understanding by applying concepts to new contexts (extending). Empirical studies have demonstrated that the CORE model effectively improves various aspects of mathematical thinking, including mathematical connections, conceptual understanding, and problem-solving abilities (Fatimah & Khairunnisyah, 2019a; Ningsih et al., 2019; Ulya et al., 2024a).

In addition to instructional models, the integration of digital media in mathematics learning plays a significant role in enhancing student engagement and problem-solving abilities. Previous research indicates that interactive digital learning media can improve conceptual understanding, critical thinking skills, and mathematical problem-solving performance (Hillmayr et al., 2020; Jensen et al., 2021). In mathematics education, Electronic Student Worksheets (E-LKPD) enable the integration of text, images, animations, and interactive activities that accommodate diverse student learning characteristics. Several studies have reported that E-LKPD is valid, practical, and effective in supporting mathematics learning (Cahyani et al., 2025; Rahayu et al., 2025; Triasari et al., 2022).

A growing body of research has examined the effectiveness of the CORE learning model and the development of E-LKPD in improving students' mathematical problem-solving abilities. Studies by Fatimah & Khairunnisyah, (2019), Ningsih et al. (2019), Ulya et al. (2024) eported that the CORE model significantly enhances students' mathematical problem-solving skills. Meanwhile, research on the development and implementation of E-LKPD indicates that this digital medium is valid, practical, and effective in supporting mathematics learning and improving students' reasoning and problem-solving abilities (Cahyani et al., 2025; Rahayu et al., 2025; Triasari et al., 2022). Nevertheless, most of these studies have examined these aspects separately and have not yet integrated them into a comprehensive instructional design. Furthermore, studies analyzing students' mathematical problem-solving abilities by considering learning style differences remain limited, particularly in the context of digital learning media such as E-LKPD.

Moreover, studies that describe students' mathematical problem-solving abilities based on visual, auditory, and kinesthetic learning styles are still relatively scarce and are generally conducted within conventional instructional settings or specific learning models. Some studies suggest that students exhibit distinct characteristics in their problem-solving abilities and processes depending on their learning styles (Darmin et al., 2021; Hamid, 2024; Ikawati & Kowiyah, 2021). However, research that analyzes students' mathematical problem-solving abilities from a learning style perspective within the implementation of the CORE learning model supported by E-LKPD remains rare. In addition, most previous studies predominantly employ quantitative approaches, which limits their capacity to capture in-depth variations in students' problem-solving abilities and processes. Therefore, research is needed to examine the effectiveness of the CORE learning model assisted by E-LKPD in enhancing mathematical problem-solving abilities while simultaneously describing these abilities from the perspective of students' learning styles using a mixed-methods approach with a sequential explanatory design.

Based on the aforementioned background and research gaps, this study aims to evaluate the effectiveness of the CORE learning model assisted by E-LKPD in enhancing students' mathematical problem-solving abilities. Additionally, this study seeks to describe students' mathematical problem-solving abilities in terms of learning styles of visual, auditory, and kinesthetic in CORE learning assisted by E-LKPD. By employing a mixed-methods approach with a sequential explanatory design, this study is expected to provide a more comprehensive understanding of instructional effectiveness and variations in students' mathematical problem-solving abilities.

Method

Research Design

This study uses a mixed method research type with a sequential explanatory design. The quantitative method uses a true experimental design with a pretest-posttest control group design. In this design, there are two groups, where the first group is the experimental group that is given treatment in the form of a CORE model assisted by E-LKPD (X), and the second group is the control group that is only given treatment with the DL (Discovery Learning) model (Y). The pretest-posttest control group research design (Sugiyono, 2019) used in this study is presented in Table 1.

Table 1. Pretest-Posttest Control Group Research Design

Group	***Pretest***	Treatment	***Posttest***
Experimental	O_1	X	O_2
Control	O_3	Y	O_4

Where:

X : Treatment in the form of a CORE model assisted by E-LKPD

Y : Treatment in the form of a DL model

O_1 : Pretest scores of the experimental group

O_2 : Posttest scores of the experimental group

O_3 : Pretest scores of the control group

O_4 : Posttest scores of the control group

Meanwhile, the use of qualitative methods aims to describe the mathematical problem-solving ability of students in term of learning styles of visual, auditory, and kinesthetic in CORE learning assisted by E-LKPD.

Participants

The sample was selected from the population of all 8th grade students at one of the junior high school in Salam, with a total of 253 students. The sample was determined using the simple random sampling technique, because the sampling carried out included random categories without paying attention to the levels or strata in the population. Through this technique, the sample obtained was students from two 8th classes, namely class VIII B and VIII E, where each class consisted of 32 students. Of the two classes, class VIII B was the experimental class and class VIII E was the control class. The subjects in this study were determined using the purposive sampling technique, namely 3 students with visual learning style, 2 students with auditory learning style, and 1 student with kinaesthetic learning style in the experimental class, based on the results of the learning style questionnaire analysis.

Data Collection

1) Test

The test technique was used to collect data about the level of mathematical problem-solving ability of students in the experimental class before and after receiving the CORE model treatment assisted by

E-LKPD, also in the control class before and after receiving the DL model treatment. The test given was a written test in the form of 3 essay questions, which were arranged based on the indicators of mathematical problem-solving ability in this study, namely: (1) constructing new mathematical knowledge through problem solving (*understanding the problem*); (2) developing and adapting appropriate strategies to solve the problem (*making a plan*); (3) solving problems that arise in mathematics and in other contexts (*executing the plan*); and (4) monitoring and reflecting on the mathematical problem solving process (*re-examining*). The questions given had gone through validity tests, reliability tests, discriminatory power analysis, and level of difficulty analysis.

2) Questionnaire

The questionnaire was used to collect data about the type of learning styles of students in the experimental class. The questionnaire given contained 27 statements and based on the learning style indicators in this study, namely: (1) how to absorb and process information (learning modalities); (2) personality; (3) social interaction; and (4) environmental interaction. The questionnaire given has also gone through a validation test. The compilation of the questionnaire uses a Likert scale.

3) Interview

The interview technique was used to obtain deeper information about the mathematical problem-solving ability of students with learning style of visual, auditory, and kinesthetic in the CORE model assisted by E-LKPD. The type of interview used was a structured interview, in which the interviewer had prepared interview guidelines in the form of several written questions to be asked to the interview source (interviewee) (Sugiyono, 2018). In this study, the researcher acted as the interviewer, and the six students who were the subjects of this research acted as interviewee.

Data Analysis

1) Classical Assumption Test of Initial Data

Before the data is analyzed, the data is first tested for classical assumptions. The initial data to be tested is the mathematical problem-solving ability pretest value data that has been implemented in the experimental class and the control class. Initial data analysis uses normality test, homogeneity test, and two-average equality test.

The normality test of initial data was carried out using the Kolmogorov-Smirnov test assisted by SPSS, with results as in Table 2 below.

Table 2. Normality Test Result of Initial Data

Group	Kolmogorov-Smirnov			a	Description
	Statistic	Df	Sig.		
Experimental	0.143	32	0.094	0.05	Normally distributed
Control	0.147	32	0.078	0.05	Normally distributed

Based on the results of the Kolmogorov-Smirnov normality test output assisted by SPSS, it is known that for experimental class obtained the Sig. = 0.094 > 0.05 and for control class obtained the Sig. = 0.078 > 0.05. It can be decided that H_0 is accepted and H_1 is rejected, which means that both samples come from a normally distributed population.

The homogenity test of initial data was carried out using the Levene test assisted by SPSS, with results as in Table 3 below.

Table 3. Homogenity Test Result of Initial Data

Levene Statistic	df1	df2	Sig.
0.021	1	62	0.886

Based on the results of the Levene homogenity test output assisted by SPSS, it is known that obtained the Sig. = 0.886 > 0.05. It can be decided that H_0 is accepted and H_1 is rejected, which means that both samples come from a homogeneous population.

The two-average equality test of initial data was carried out using the independent sample t-test assisted by SPSS, with results as in Table 4 below.

Table 4. Two-Average Equality Test Result of Initial Data

Data	Levene's Test for Equality of Variances		a	Description
	F	Sig.		
Equal variances assumed	0.021	0.886	0.05	There is no difference in the average initial abilities of students in the experimental and control classes.

Based on the results of the independent sample t-test output assisted by SPSS, obtained the Sig. = 0.886 > 0.5. It can be decided that H_0 is accepted and H_1 is rejected, which means that both samples have the same initial mean.

2) Quantitative and Qualitative Data Analysis

The data of mathematical problem-solving ability pretest and posttest were analyzed quantitatively and qualitatively. Quantitatively, the data were analyzed using the mean completeness test, classical completeness test, two-mean difference test, and N-gain test. Qualitatively, the data were analyzed through three stages as stated by (Sugiyono, 2019), namely data reduction, data display, and conclusion drawing. Data reduction is done by focusing on the important things, looking for patterns and themes, and removing unnecessary things. Data display is done in the form of relationships between various categories, narrative texts, short descriptions, charts, flowcharts, and so on. The conclusions drawn from this research are expected to produce new findings that have never existed before.

To analyze students' mathematical problem-solving ability, a scoring rubric with a 0-3 scale was developed and applied to four indicators of mathematical problem-solving. This rubric was applied to quantify qualitative findings from students' written work to ensure consistent and objective analysis. The criteria for each score presented in Table 5.

Table 5. Scoring Rubric for Mathematical Problem-Solving Indicators

Score	Ability Level	Description
3	Able	Student's answer is complete, correct, and follows the appropriate procedures
2	Quite able	Student provides a mostly correct answer with minor errors
1	Less able	Student's answer shows several conceptual or procedural mistakes
0	Not able	Student is unable to answer or give irrelevant answer

3) Data Validity Techniques

In this study, triangulation was conducted to ensure the accuracy of the research findings, specifically using technique triangulation. Technique triangulation was carried out by comparing the results of the mathematical problem-solving ability test and the learning style questionnaire in the experimental class, also the interview results with the six research subjects. The findings from the test were confirmed through interviews to observe the consistency of students' mathematical problem-solving ability. Additionally, the questionnaire results were used to assess whether students' learning style was aligned with how they answered questions and explained solutions during the interviews. The results from each instrument were used to complement and verify one another in order to obtain a more comprehensive picture of the mathematical problem-solving ability of students with visual, auditory, and kinesthetic learning style.

Results

Effectiveness of CORE Model Assisted by E-LKPD

The first stage of this research was to collect quantitative data on the results of the posttest of students' mathematical problem-solving ability in the experimental class and the control class. The data were then analyzed using the t-statistic test for the mean completeness test and the two-mean difference test, also the z-statistic test for the classical completeness test. Based on the analysis of quantitative data, the results were obtained as in Table 6 below.

Table 6. Statistical Test Results of Learning Effectiveness

Statistical Test	Value of t_{table} or z_{table}	Value of t_{count} or z_{count}	H_1 accepted if	Result
Mean completeness test	$t_{table} = 1{,}69$	$t_{count} = 6{,}60$	$t_{table} < t_{count}$	H_1 accepted
Classical completeness test	$z_{table} = 1{,}64$	$z_{count} = 2{,}04$	$z_{table} < z_{count}$	
Two-mean difference test	$t_{table} = 1{,}69$	$t_{count} = 2{,}301$	$t_{table} < t_{count}$	

From the results of the three analyses, it is known that H_0 is rejected and H_1 is accepted. So it can be concluded that: (1) students' mathematical problem-solving ability in the CORE model assisted by E-LKPD class meets the minimum completion criteria (MCC); (2) students' mathematical problem-solving ability in the CORE model assisted by E-LKPD class achieves classical learning completion, with the proportion of students reaching completion being more than or equal to 75%; and (3) the average mathematical problem-solving ability score of students in the CORE model assisted by E-LKPD class is higher than that in the DL class.

The results of the N-gain analysis showed that the experimental class achieved higher improvements in all mathematical problem-solving ability indicators than the control class. Overall, the average N-gain of the experimental class was better than that of the control class, like presented in Figure 1.

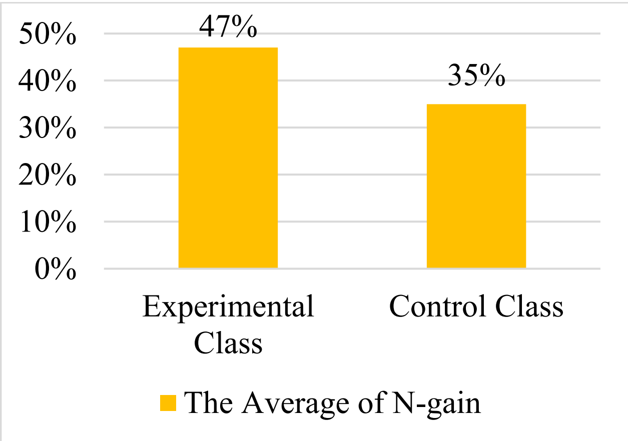


Figure 1. The Average of N-gain of Experimental and Control Class

Students' Mathematical Problem-Solving Ability in Term of Learning Style

The second stage of this study was to collect qualitative data on the description of mathematical problem-solving ability of students who have learning style of visual, auditory, and kinesthetic in the experimental class. The percentage of learning styles possessed by students in the experimental class is presented in Figure 2.

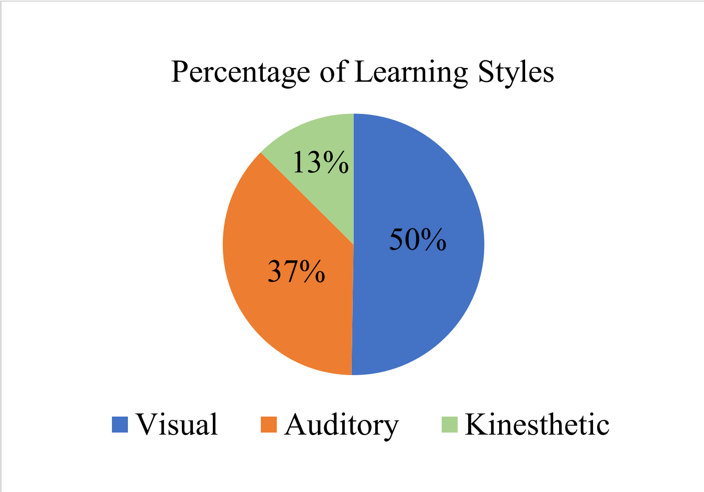


Figure 2. Percentage of Learning Styles in Experimental Class

In this study, there were six research subjects, namely two students with visual learning style, two students with auditory learning style, and two students with kinesthetic learning style, which were determined through purposive sampling techniques by looking at the results of the student learning style questionnaire. These specific subjects were chosen because they represented typical characteristics of each category and demonstrated consistency in their responses, making them suitable to provide in-depth insights into the relationship between learning style and mathematical problem-solving ability within the CORE model assisted by E-LKPD learning framework. The subject codes can be seen in Table 7.

Table 7. Research Subject Codes

Subject's Code	**Learning Style**
V-1	Visual
V-2	Visual
V-3	Visual
A-1	Auditorial
A-2	Auditorial
K-1	Kinesthetic

1) Mathematical Problem-Solving Ability of Subject with Visual Learning Style

Based on the test results of subjects V-1, V-2, and V-3, students with visual learning style have mastery of the following mathematical problem-solving ability indicators: (1) constructing new mathematical knowledge through problem-solving (score 3); (2) developing and adapting appropriate strategies to solve the problem (score 3); (3) solving problems that arise in mathematics and in other contexts (score 3); and (4) monitoring and reflecting on the mathematical problem solving process (score 3). The results of the analysis are an accumulation of the test results of subjects V-1, V-2, and V-3 as in Table 8 below.

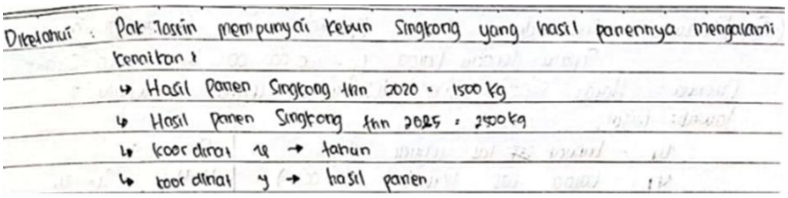
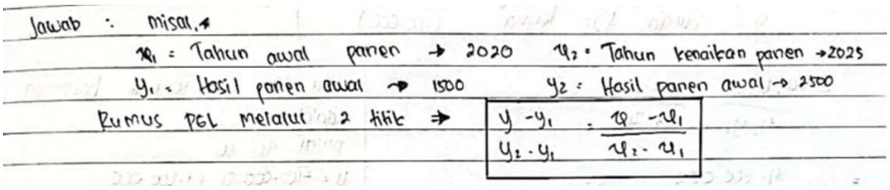
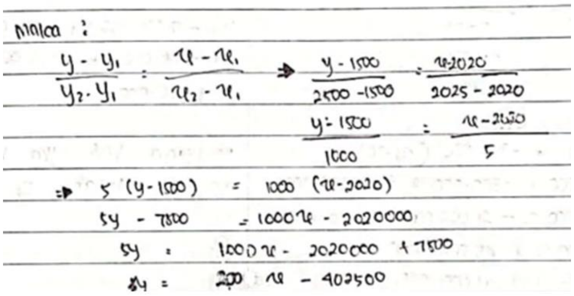
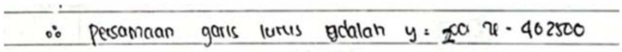
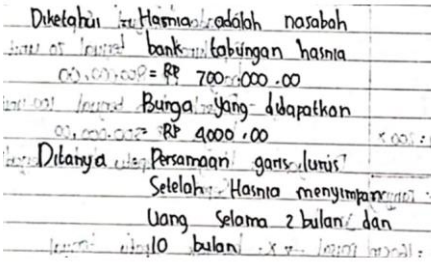
Table 8. Recapitulation of Mathematical Problem-Solving Subject V-1, V-2, and V-3

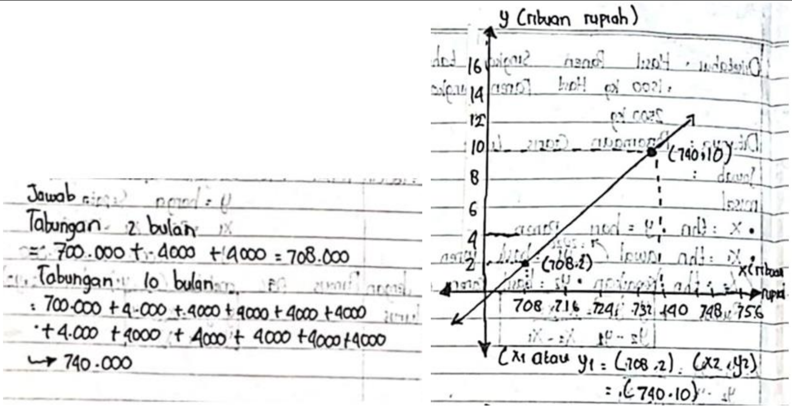
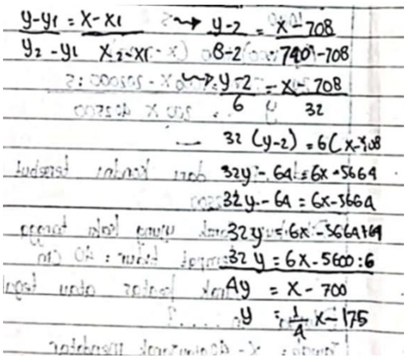
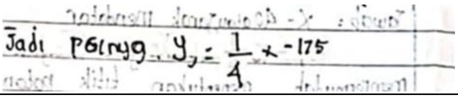
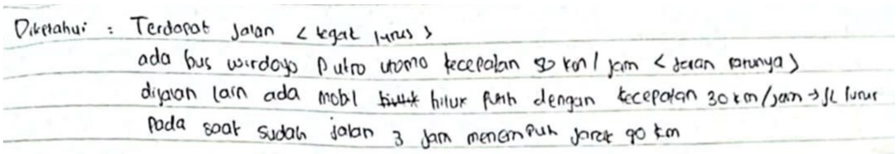
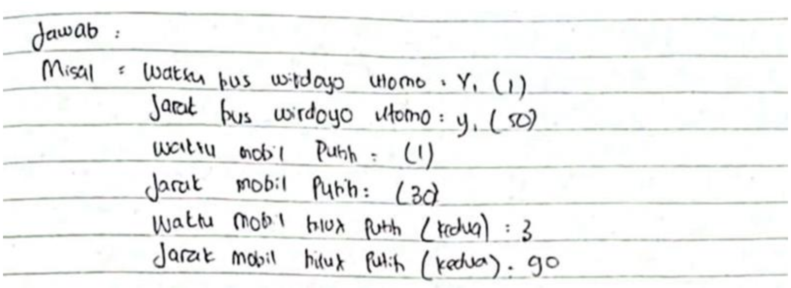
Subject Code	**Mathematical Problem-Solving Indicators**			
	Understanding the Problem	**Making a Plan**	**Executing the Plan**	**Re-examining**
V-1	Able to construct new mathematical knowledge through problem-solving *(Score: 3)*	Able to develop and adapt appropriate strategies to solve the problem *(Score: 3)*	Able to solve problems that arise in mathematics and in other contexts *(Score: 3)*	Able to monitor and reflect on the mathematical problem-solving process *(Score: 3)*

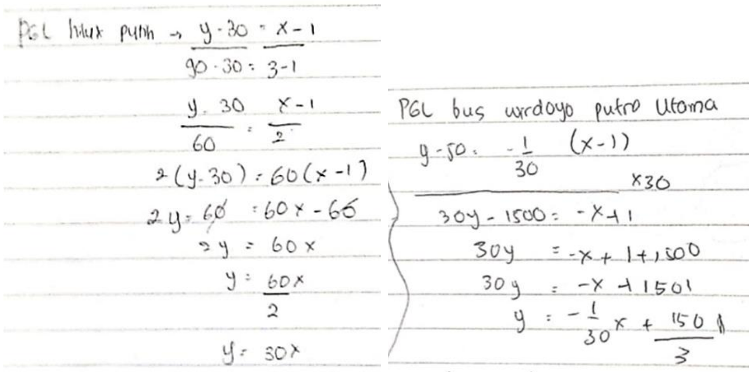
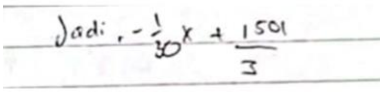
V-2	Able to construct new mathematical knowledge through problem-solving *(Score: 3)*	Able to develop and adapt appropriate strategies to solve the problem *(Score: 3)*	Able to solve problems that arise in mathematics and in other contexts *(Score: 3)*	Able to monitor and reflect on the mathematical problem-solving process *(Score: 3)*
V-3	Able to construct new mathematical knowledge through problem-solving *(Score: 3)*	Able to develop and adapt appropriate strategies to solve the problem *(Score: 3)*	Able to solve problems that arise in mathematics and in other contexts *(Score: 3)*	Able to monitor and reflect on the mathematical problem-solving process *(Score: 3)*

Table 9 is the test results on one number of subjects V-1, V-2, and V-3 to support the data in Table 8.

Table 9. Test Result of Subject V-1, V-2, and V-3

Subject	**Test Result**
V-1	Indicator 1  Indicator 2  Indicator 3  Indicator 4 
V-2	Indicator 1  Indicator 2

	 Jawab Tabungan 2 bulan = 700.000 + 4000 + 4000 = 708.000 Tabungan 10 bulan = 700.000 + 4.000 + 4000 + 4000 + 4000 + 4000 + 4.000 + 4000 + 4000 + 4000 + 4000 + 4000 → 740.000 Indicator 3  y-y1 = x-x1 → y-2 = x-708 y2-y1 x2-x1 8-2 740-708 y-2 = x-708 6 32 32 (y-2) = 6 (x-708 32y - 64 = 6x - 5664 32y - 64 = 6x - 5664 32y = 6x - 5664 + 64 32 y = 6x - 5600 : 6 4y = x - 700 y = 1/4 x - 175 Indicator 4  Jadi PGrsyg y = 1/4 x - 175
V-3	Indicator 1  Diketahui : Terdapat jalan < tegak lurus > ada bus wirdoyo Putro utomo kecepatan 50 km / jam < jarak pertamanya > dijalan lain ada mobil hilux putih dengan kecepatan 30 km/jam → jl lurus pada saat sudah jalan 3 jam menempuh jarak 90 km Indicator 2  Jawab : Misal : Waktu bus wirdoyo utomo : x, (1) Jarak bus wirdoyo utomo : y, (50) waktu mobil putih : (1) Jarak mobil putih : (30) Waktu mobil hilux putih (kedua) : 3 Jarak mobil hilux putih (kedua) : 90 Indicator 3

	 Indicator 4 

Based on the test results, all three subjects were able to fulfil indicators 1, 2, 3, and 4 because able to construct new mathematical knowledge through problem-solving, able to develop and adapt appropriate strategies to solve the problem, able to solve problems that arise in mathematics and in other contexts, and able to monitor and reflect on the mathematical problem-solving process.

During the interview, subject V-1, V-2, and V-3 showed good understanding and were able to explain the information known and what was asked in the questions in a coherent manner. They looked confident and did not hesitate when answering questions. They were also able to explain the concept of material and the steps used to solve the problem. Below is an interview excerpt with subject V-1, V-2, and V-3.

Interview excerpt of subject V-1 P : Do you understand this question? Please explain what is known in the question. V-1 : Yes, I understand, Sir. It is known that Mr. Tasrin's cassava plantation increased from 1,500 kg to 2,500 kg from 2020 to 2025. Then, he was asked to create a straight-line graph, where x represents the year and y represents the harvest. P : What is asked in the question? V-1 : Straight line equation graph of Mr. Tasrin's harvest increase.
Interview excerpt of subject V-2 P : In this question, can you determine the formula that should be used? V-2 : Yes I can, Sir. P : What strategy do you use to solve this problem? V-2 : First, I created an assumption, assuming the horizontal distance is represented by x and the vertical distance is represented by y. To make it easier, I first graphed the equation of the straight line so I could see the coordinates of the points it passes through. After that, I did calculations using the formula I had determined to solve this problem.
Interview excerpt of subject V-3 P : After getting the results, did you check the answers again? V-3 : Yes, I checked the results I got one by one. P : Okay, what conclusion do you get? V-3 : The conclusion is that the straight line equation of the distance and travel time of the Wirdoyo Putro Utomo bus is $y = -\frac{1}{30}x + \frac{1501}{30}$.

2) Mathematical Problem-Solving Ability of Subject with Auditory Learning Style

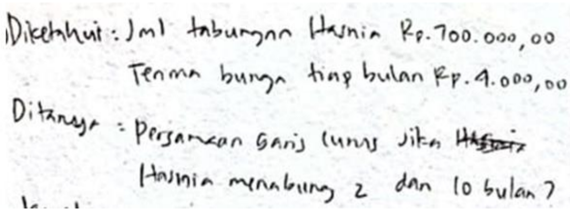
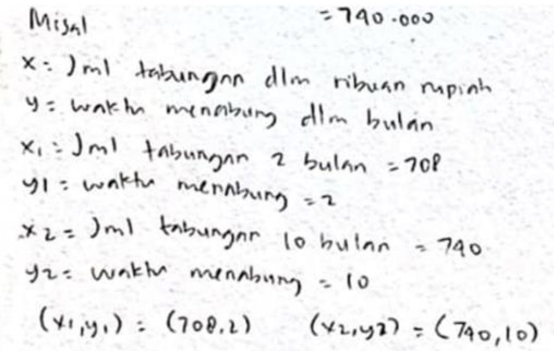
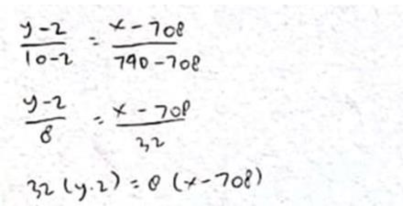
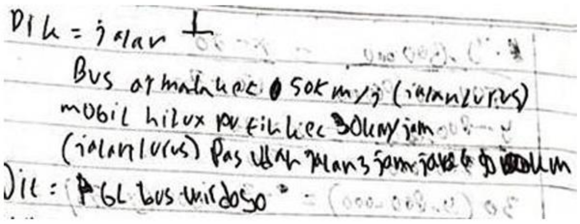
Based on the test results of subjects A-1 and A-2, students with auditory learning style have mastery of the following mathematical problem-solving ability indicators: (1) constructing new mathematical knowledge through problem-solving (score 3); (2) developing and adapting appropriate strategies to solve the problem (score 3); (3) solving problems that arise in mathematics and in other contexts (score 1); and (4) monitoring and reflecting on the mathematical problem solving process (score 1). The results of the analysis are an accumulation of the test results of subjects A-1 and A-2 as in Table 10 below.

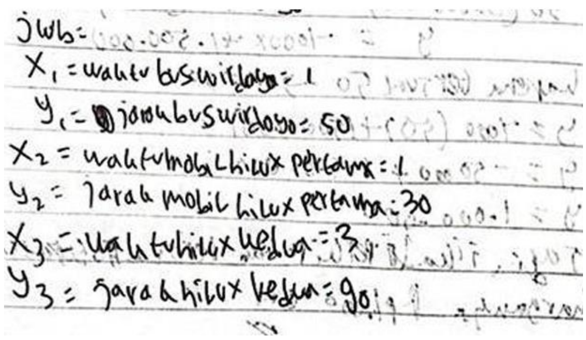
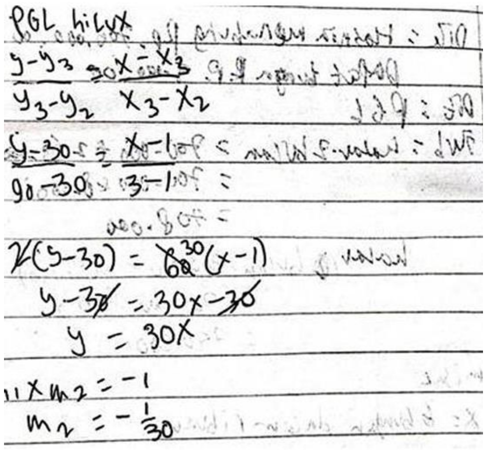
Table 10. Recapitulation of Mathematical Problem-Solving Subject A-1 and A-2

Subject Code	Mathematical Problem-Solving Indicators			
	Understanding the Problem	**Making a Plan**	**Executing the Plan**	**Re-examining**
A-1	Able to construct new mathematical knowledge through problem-solving *(Score: 3)*	Able to develop and adapt appropriate strategies to solve the problem *(Score: 3)*	Less able to solve problems that arise in mathematics and in other contexts *(Score:1)*	Less able to monitor and reflect on the mathematical problem-solving process *(Score: 1)*
A-2	Able to construct new mathematical knowledge through problem-solving *(Score: 3)*	Able to develop and adapt appropriate strategies to solve the problem *(Score: 3)*	Less able to solve problems that arise in mathematics and in other contexts *(Score:1)*	Less able to monitor and reflect on the mathematical problem-solving process *(Score: 1)*

Table 11 is the test results on one number of subjects A-1 and A-2 to support the data in Table 10.

Table 11. Test Result of Subject A-1 and A-2

Subject	**Test Result**
A-1	Indicator 1  Diketahui : Jml tabungan Hasnia Rp.700.000,00 Terima bunga tiap bulan Rp.4.000,00 Ditanya : Persamaan Garis lurus jika Hasnia menabung 2 dan 10 bulan? Indicator 2  Misal =740.000 x : Jml tabungan dlm ribuan rupiah y : waktu menabung dlm bulan x_1 : Jml tabungan 2 bulan = 708 y_1 : waktu menabung = 2 x_2 = Jml tabungan 10 bulan = 740 y_2 = waktu menabung = 10 $(x_1,y_1) = (708,2)$ $(x_2,y_2) = (740,10)$ Indicator 3  $\frac{y-2}{10-2} = \frac{x-708}{740-708}$ $\frac{y-2}{8} = \frac{x-708}{32}$ $32(y-2) = 8(x-708)$ Indicator 4 *Subject A-1 did not write anything.*
A-2	Indicator 1  Dik = jalan [illegible] Bus [illegible] 50 km/j (jalan lurus) mobil hilux [illegible] 30 km/jam (jalan lurus) Pas [illegible] Dit : [illegible] bus [illegible] Indicator 2

	 Indicator 3  Indicator 4 *Subject A-2 did not write anything.*

Based on the test results, all two subjects were able to fulfil indicators 1 and 2 because able to construct new mathematical knowledge through problem-solving, also able to develop and adapt appropriate strategies to solve the problem. But in other hand, they less able to solve problems that arise in mathematics and in other contexts, and less able to monitor and reflect on the mathematical problem-solving process.

During the interview, subjects A-1 and A-2 demonstrated a moderate level of understanding. They were able to identify some of the information provided and what was asked in the questions, although their explanations were not always complete or well-structured. At certain points, they showed hesitation when responding and required additional time to clarify their answers. While they understood the general concept of the material, they had difficulty explaining the problem-solving steps in detail and tended to rely on procedural reasoning rather than conceptual justification. Below is an interview excerpt with subject A-1 and A-2.

Interview excerpt of subject A-1 P : Do you understand this question? Please explain what is known in the question. A-1 : Pretty good, Sir. As far as I know, Mrs. Tarmusi received an order to build a bunk bed. Looking at the diagram in the question, you can see that the distance from the ladder to the top bunk is 40 cm from the bottom and 160 cm from the top. P : What is asked in the question? A-1 : The slope of the stairs, Sir. P : Why didn't you write it down correctly when answering the posttest? A-1 : Yes Sir, I made a mistake yesterday. I wrote that what was being asked was the slope of the bed, when it should have been the slope of the stairs.
Interview excerpt of subject A-2 P : After you have finished working, are you sure and know that the answer you got is correct? A-2 : I'm sure, Sir. P : After getting the results, did you check the answers again?

A-2	: No, Sir.
P	: So, can you draw any conclusions from this question?
A-2	: The conclusion is that the straight line equation of the increase in harvest yield is $y = 200x - 402500$.
P	: But why did you write the result $x = 200y - 402500$ in the posttest?
A-2	: Sorry Sir, I wrote it the wrong way around.

3) Mathematical Problem-Solving Ability of Subject with Kinesthetic Learning Style

Based on the test results of subjects K-1, students with kinaesthetic learning style has mastery of the following mathematical problem-solving ability indicators: (1) constructing new mathematical knowledge through problem-solving (score 3); (2) developing and adapting appropriate strategies to solve the problem (score 1); (3) solving problems that arise in mathematics and in other contexts (score 1); and (4) monitoring and reflecting on the mathematical problem solving process (score 1). The results of the analysis are an accumulation of the test results of subjects K-1 as in Table 12 below.

Table 12. Recapitulation of Mathematical Problem-Solving Subject K-1

Subject Code	Mathematical Problem-Solving Indicators			
	Understanding the Problem	**Making a Plan**	**Executing the Plan**	**Re-examining**
K-1	Able to construct new mathematical knowledge through problem-solving *(Score: 3)*	Less able to develop and adapt appropriate strategies to solve the problem *(Score: 1)*	Less able to solve problems that arise in mathematics and in other contexts *(Score: 1)*	Less able to monitor and reflect on the mathematical problem-solving process *(Score: 1)*

Table 13 the test results on one number of subjects K-1 to support the data in Table 12.

Table 13. Test Result of Subject K-1

Subject	Test Result
K-1	Indicator 1 Dik = Tabungan Hasnia = 700.000 Bunga = 4000 / bulan Dit = PGL setelah menabung 2 dan 10 bulan Indicator 2 Tabungan 2 bulan = 708 Tabungan 10 bulan = 740 Indicator 3 $\frac{y-2}{10-2} = \frac{x-708}{740-708}$ $\frac{y-2}{8} = \frac{x-708}{32}$ $32(y-2) = 8(x-708)$ Indicator 4 *Subject K-1 did not write anything.*

Based on the test results, subject K-1 was only able to fulfil indicator 1, where the subject able to construct new mathematical knowledge through problem-solving, but not able to develop and adapt appropriate strategies to solve the problem, not able to solve problems that arise in mathematics and in other contexts, and not able to monitor and reflect on the mathematical problem-solving process.

During the interview, subject K-1 showed a low level of understanding of the problem. The subject had difficulty identifying the information given and what was being asked in the questions, which led to incomplete or incorrect explanations. During the interview, the subject appeared unsure and frequently hesitated when answering, often providing short or fragmented responses. The subject was unable to clearly explain the underlying concepts of the material and experienced difficulties in describing the steps used to solve the problem, relying mainly on trial-and-error rather than a systematic problem-solving approach. Below is an interview excerpt with subject K-1.

Interview excerpt of subject K-1	
P	: In your opinion, is there another way to solve the problem in this question?
K-1	: I don't know, Sir.
P	: Are you sure about the results obtained?
K-1	: I'm still in doubt.
P	: Did you check the answer again?
K-1	: No Sir, because the time is out.
P	: Can you now draw a conclusion for this question?
A-1	: No Sir, because I haven't finished working on it yet.

Discussion

Effectiveness of CORE Model Assisted by E-LKPD

The quantitative results of the study indicate that the implementation of the CORE learning model assisted by E-LKPD is proven effective in improving students' mathematical problem-solving ability, as indicated by a significant increase in post-test scores and N-gain values that meet the effectiveness criteria. This finding is consistent with the statement of (Herman et al., 2017) who revealed that the CORE learning model has characteristics that are in line with the development of mathematical problem-solving ability, because each stage requires active involvement of students in the thinking process. The connecting stage encourages students to link prior knowledge to new problems, while the organizing stage helps students organize information and problem-solving strategies systematically. Furthermore, the reflecting stage provides space for students to evaluate their thinking processes and results, while the extending stage emphasizes the application of concepts to broader situations. Recent research shows that the CORE model significantly improves mathematical problem-solving ability compared to conventional learning, because this model facilitates reflective thinking processes and in-depth reinforcement of concepts. This finding is also in line with the results of other studies that report that reflection-based learning and knowledge organization can improve higher-order thinking skills, including mathematical problem solving, more consistently (Anriani, 2018; Son & Ditasona, 2020).

In addition to learning models, the use of E-LKPD also plays an important role in supporting the improvement of students' mathematical problem-solving ability. E-LKPD allows for interactive, contextual, and systematic problem presentation, allowing students to explore problem-solving steps independently and collaboratively. The results of this study are in line with the findings of Harini et al. (2023) who stated that the use of E-LKPD significantly improves mathematical problem-solving ability and encourages students' learning independence. Other studies also show that digital worksheets provide faster feedback and clearer visualizations, thus helping students understand the problem structure and choose the right solution strategy (Widodo, 2023). Thus, E-LKPD functions not only as a supporting medium but also as a means of strengthening students' cognitive processes in solving mathematical problems.

The combination of the CORE learning model with E-LKPD has been proven to have a more optimal impact on improving students' mathematical problem-solving ability. The results showed that classes implementing the CORE model assisted by E-LKPD achieved individual and class-based learning mastery and had higher N-gain scores than control classes. These findings demonstrate a synergy between the pedagogical approach and learning technology support. Recent international research confirms that integrating active learning models with digital media can significantly improve the quality of mathematical problem-solving compared to implementing either component separately (Harini et al., 2023; Widodo, 2023). In other words, the CORE model provides a systematic framework and learning flow, while E-LKPD enriches the learning experience through structured and interactive digital activities. Therefore, implementing the CORE model assisted by E-LKPD can be seen as an effective and relevant learning strategy to improve students' mathematical problem-solving ability in the digital learning era.

Students' Mathematical Problem-Solving Ability in Term of Learning Style

The results of the qualitative analysis indicate differences in the characteristics of students' mathematical problem-solving ability, based on their visual, auditory, and kinesthetic learning styles, when implementing the CORE model with the help of E-LKPD. Students with a visual learning style demonstrated good mastery of all indicators of mathematical problem-solving ability, from understanding the problem, planning a strategy, implementing the solution, to reflecting on the process. This finding aligns with international research, which states that visual learners tend to be better able to organize information and represent problems systematically, especially when learning is supported by digital media that provide clear and structured visual displays (Bearneza, 2023; Chetty et al., 2019). In the context of CORE learning with the help of E-LKPD, visual support in the form of problem-solving steps, illustrations, and gradual presentation of information helps visual learners build deeper conceptual understanding and enhance their reflective abilities.

In contrast to visual learners, students with an auditory learning style demonstrated good abilities at the problem-understanding and planning stages, but still experienced difficulties at the implementation and reflection stages. These findings align with previous research, which revealed that auditory learners tend to understand concepts through verbal explanations but often encounter obstacles when having to translate this understanding into written or procedural representations independently (Chetty et al., 2019; Jamaluddin et al., 2023). In CORE-based learning, these limitations are evident in the Reflecting and Extending stages, where auditory learners require additional support to systematically reconnect their thinking processes. Although the E-LKPD has helped guide the steps for completion, auditory learners still show a tendency to use procedural reasoning without strong conceptual justification.

Meanwhile, students with a kinesthetic learning style demonstrated relatively lower mathematical problem-solving ability compared to the other two learning styles. Kinesthetic learners were only able to meet the indicator of understanding the problem, but experienced difficulties in the planning, implementation, and reflection stages. This finding is consistent with international research reporting that kinesthetic learners require physical activities, concrete manipulatives, or hands-on simulations to optimize their mathematical thinking processes (Bardia & Sharahi, 2023; Sheromova et al., 2020). In the context of digital E-LKPD that emphasize visual and cognitive interaction, limited opportunities for physical exploration result in kinesthetic learners being less than optimal in developing strategies and evaluating the problem-solving process. This suggests that although the CORE model, supported by e-LKPD, is generally effective, adjustments to learning activities are needed to better accommodate the characteristics of kinesthetic learning styles.

Overall, the qualitative results of this study reinforce previous research findings that learning styles influence how students develop and apply mathematical problem-solving strategies in technology-based learning (Autida, 2024; Bardia & Sharahi, 2023; Bearneza, 2023). The integration of the CORE model with E-LKPD has been shown to provide strong support for visual and auditory learners, but requires enrichment of learning strategies for kinesthetic learners. Thus, these findings emphasize the importance of learning differentiation in the application of technology-assisted learning models to optimize mathematical problem-solving ability across various student characteristics.

Conclusion

This study concludes that the implementation of the CORE (Connecting, Organizing, Reflecting, and Extending) learning model supported by electronic student worksheets (E-LKPD) represents a relevant instructional approach for developing students’ mathematical problem-solving ability. The integration of constructivist learning principles with interactive digital media encourages active student engagement in understanding problems, organizing solution strategies, and systematically reflecting on mathematical thinking processes.

Furthermore, students’ learning styles influence the way they construct and apply mathematical problem-solving strategies within CORE-based learning assisted by E-LKPD. Differences in cognitive tendencies among visual, auditory, and kinesthetic learners indicate the importance of adaptive and differentiated instructional practices. Therefore, technology-based mathematics learning should be designed with careful consideration of students’ learning characteristics in order to support the development of mathematical problem-solving ability in a more inclusive and sustainable manner.

References

[1] Al-Mutawah, M. A., Thomas, R., Eid, A., Mahmoud, E. Y., & Fateel, M. J. (2019). Conceptual Understanding , Procedural Knowledge and Problem- Solving Skills in Mathematics : High School Graduates Work Analysis and Standpoints. International Journal of Education and Practice, 7(3), 258–273. https://doi.org/10.18488/journal.61.2019.73.258.273

[2] Anriani, N. (2018). Influence of CORE Model with Scientific Approach to Students' Mathematical Problem Solving Ability. Proceedings of International Conference on Issues in Social and Education Research (ICISER 2017), 112–115.

[3] Autida, N. (2024). The Influence of Learning Styles on Mathematical Performance among Junior High School Students. Journal of Educational Issues, 10(2), 18–28. https://doi.org/10.5296/jei.v10i2.22029

[4] Bardia, N., & Sharahi, B. Y. (2023). The effect of learning mathematics using the VAK (Visual Auditory Kinesthetic) method on the attitudes and academic performance of primary school students in virtual education during the Corona period. Technology of Education Journal (TEJ), 17(2), 421–432.

[5] Bearneza, F. J. D. (2023). Students ' Learning Styles and Performance in Mathematics : Basis for the Development of Teaching Materials. International Journal of Innovative Science and Research Technology, 11(3), 987–998.

[6] Cahyani, I., Fitrianti, Y., & Nizar, H. (2025). Development of Student Worksheets (E-LKPD) to Strengthen Numeracy Literacy on Relations and Functions Material. Absis: Mathematics Education Journal, 7(1), 40–56.

[7] Chetty, N. D. S., Handayani, L., Sahabudin, N. A., Ali, Z., Hamzah, N., Rahman, N. S. A., & Kasim, S. (2019). Learning styles and teaching styles determine students ' academic performances. International Journal of Evaluation and Research in Education (IJERE), 8(3), 610–615. https://doi.org/10.11591/ijere.v8i3.

[8] Cuevas, J. (2015). Is Learning Styles-Based Instruction Effective? A Comprehensive Analysis of Recent Research on Learning Styles. Theory and Research in Education, 13(3), 308–333. https://doi.org/10.1177/1477878515606621

[9] Darmin, S., Arsyad, N., & Upu, H. (2021). The Effectiveness of Application Visualization , Auditory , Kinesthetic Learning Models in Mathematical Problem-Solving Abilities. 611(ICoESM), 348–352.

[10] Fatimah, A. E., & Khairunnisyah. (2019a). Peningkatan Kemampuan Koneksi Matematis melalui Pembelajaran Model Connecting- Organizing-Reflecting-Extending (CORE). Journal of Mathematics Education and Science, 5(1), 51–58.

[11] Fatimah, A. E., & Khairunnisyah. (2019b). PENINGKATAN KEMAMPUAN KONEKSI MATEMATIS MELALUI PEMBELAJARAN MODEL CONNECTING- ORGANIZING-REFLECTING-EXTENDING (CORE). Journal of Mathematics Education and Science, 5(1), 51–58.

[12] Hamid, A. (2024). The Descriptions of Students ' Problem Solving Abilities on the Topic of Linear Equation of Two Variables Viewed from Learning Styles. UNM International Proceeding, 1(1), 1–11.

[13] Harini, E., Islamia, A. N., Kusumaningrum, B., & Universitas, K. S. K. (2023). Effectiveness of E-Worksheets on Problem-Solving Skills: A Study of Students' Self-Directed Learning in the Topic of Ratios. International Journal of Mathematics and Mathematics Education (IJMME), 1(2), 150–162. https://doi.org/10.56855/ijmme.v1i02.333 Ciptaan

[14] Herman, T., Usdiyana, D., & Wijayanti, A. (2017). The Implementation of CORE Model to Improve Students ' Mathematical Problem Solving Ability in Secondary School. 1st International Conference of Mathematics and Science Education, 57(ICMSEd 2016), 89–93.

[15] Hiebert, James, Carpenter, Thomas P, Fennema, Elizabeth, Fuson, Karen, Human, Piet, Murray, Hanlie, Olivier, Alwyn, & Wearne, Diana. (1996). Problem Solving as a Basis for Reform in Curriculum and Instruction: The Case of Mathematics. Educational Researcher, 25(4), 12–21. https://doi.org/10.3102/0013189X025004012

[16] Hillmayr, D., Ziernwald, L., Reinhold, F., Hofer, S. I., & Reiss, K. M. (2020). The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis. Computers and Education, 153(April), 103897. https://doi.org/10.1016/j.compedu.2020.103897

[17] Howard-Jones, P. A. (2014). Neuroscience and Education: Myths and Messages. Nature Reviews Neuroscience, 15(12), 817–824. https://doi.org/10.1038/nrn3817

[18] Ikawati, O. N., & Kowiyah. (2021). Visual, auditory, and kinesthetic learning model on the mathematics problem solving ability. Desimal: Journal Matematika, 4(1), 13–20. https://doi.org/10.24042/djm

[19] Jamaluddin, N. Y., Osman, S., & Buchori, A. (2023). Exploring the Interaction Between Learning Styles and Mathematics Anxiety among Secondary School Students: A Correlational Study in Southern Malaysia. Journal of Technology and Science Education, 14(3), 683–700. https://doi.org/10.3926/jotse.2224

[20] Jensen, L. X., Bearman, M., & Boud, D. (2021). Understanding Feedback in Online Learning – A Critical Review and Metaphor Analysis. Computers & Education, 173, 104271. https://doi.org/10.1016/j.compedu.2021.104271

[21] Jupri, A., & Drijvers, P. (2016). Student Difficulties in Mathematizing Word Problems in Algebra. Eurasia Journal of Mathematics, Science & Technology Education, 12(9), 2481–2502. https://doi.org/10.12973/eurasia.2016.1299a

[22] NCTM. (2000). Principles Standards and for School Mathematics.

[23] Ningsih, T. S., Abdurahman, Mardapi, D., & Fayanto, S. (2019). Study on the Effect of CORE (Connecting , Organizing , Reflecting and Extending) Learning Model on Mathematics Learning Outcomes of Cognitive Domain. Universal Journal of Educational Research, 7(11), 2463–2471. https://doi.org/10.13189/ujer.2019.071125

[24] Pashler, H., Mcdaniel, M., Rohrer, D., & Bjork, R. (2009). Learning Styles: Concepts and Evidence: Concepts and Evidence. Psychological Science in the Public Interest, 9(3), 105–119. https://doi.org/10.1111/j.1539-6053.2009.01038.x

[25] Piaget, J. (1970). Science of Education and the Psychology of the Child. Viking Press.

[26] Polya, G. (2004). How to Solve It Mathematical Method. Princeton University Press.

[27] Prince, M. J., & Felder, R. M. (2006). Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases. Journal of Engineering Education, 95(2), 123–138. https://doi.org/https://doi.org/10.1002/j.2168-9830.2006.tb00884.x

[28] Rahayu, S. T., Nurhanurawati, Rohman, F., & Adha, M. M. (2025). Development of an ethnomathematics-based E-LKPD on flat-sided solid geometry to enhance elementary students ' critical thinking skills. Al-Jabar: Jurnal Pendidikan Matematika, 16(01), 293–303. https://doi.org/10.24042/ajpm.v16i1.27378

[29] Saragih, S., & Napitupulu, E. (2015). Developing Student-Centered Learning Model to Improve High Order Mathematical Thinking Ability. International Education Studies, 8(6), 104–112. https://doi.org/10.5539/ies.v8n6p104

[30] Schoenfeld, A. H. (2016). Learning to Think Mathematically : Problem Solving , Metacognition , and Sense Making in Mathematics. Journal of Education, 196(1–38). https://doi.org/10.1177/002205741619600202

[31] Sheromova, T. S., Khuziakhmetov, A. N., Kazinets, V. A., Sizova, Z. M., Buslaev, S. I., & Borodianskaia, E. A. (2020). Learning Styles and Development of Cognitive Skills in Mathematics Learning. EURASIA Journal of Mathematics, Science and Technology Education, 16(11), 1–13. https://doi.org/10.29333/ejmste/8538

[32] Son, A. L., & Ditasona, C. (2020). CORE RME learning model on improving students' mathematical problem-solving ability. Journal of Physics: Conference Series, 1–6. https://doi.org/10.1088/1742-6596/1657/1/012060

[33] Sugiyono. (2018). Metode Penelitian Kombinasi (Mixed Methods). Alfabeta.

[34] Sugiyono. (2019). Metode Penelitian Kuantitatif Kualitatif dan R&D. Alfabeta.

[35] Triasari, I., Susanti, R., & Raharjo, M. (2022). Electronic Development of Student Worksheets (E-LKPD) in Class XI Coordination System Material Using Liveworksheets. Journal of Curriculum Indonesia, 5(2), 123–131.

[36] Ulya, K., Srimuliati, Husna3, R., Zaiyar, M., & Anggreini, R. (2024a). Model CORE (Connecting, Organizing, Reflecting, Extending) pada Pembelajaran Matematika Sekolah. Jurnal Ilmiah Pendidikan Matematika Al Qalasadi, 8(2), 189–195. https://doi.org/10.32505/qalasadi.v8i2.10460

[37] Ulya, K., Srimuliati, Husna3, R., Zaiyar, M., & Anggreini, R. (2024b). MODEL CORE (CONNECTING, ORGANIZING, REFLECTING, EXTENDING) PADA PEMBELAJARAN MATEMATIKA SEKOLAH. Jurnal Ilmiah Pendidikan Matematika Al Qalasadi, 8(2), 189–195. https://doi.org/10.32505/qalasadi.v8i2.10460

[38] Vygotsky, L. (1978). Mind in Society: The Development of Higher Psychological Processes. MA: Harvard University Press.

[39] Widodo, S. A. (2023). Effects of Worksheets on Problem-Solving Skills : Meta-Analytic Studies. International Journal of Educational Methodology, 9(1), 151–167. https://doi.org/10.12973/ijem.9.1.151

[40] Wijaya, A., Robitzsch, A., Heuvel-Panhuizen, M. van den, & Doorman, M. (2014). Difficulties in Solving Context-Based PISA Mathematics Tasks : An Analysis of Students ' Errors. The Mathematics Enthusiast, 11(3). https://doi.org/10.54870/1551-3440.1317.