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Exploring Students' Critical Thinking and Problem Solving in Two Variable Linear Equations Using Batik Context

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ABSTRACT

The objective of this study is to assess the mathematical problem-solving and critical thinking skills of students in the subject of Two-Variable Linear Equation Systems (SPLDV) within the context of batik culture. The research employed a descriptive qualitative approach, supplemented by rudimentary quantitative data, in a study of 36 eighth-grade students at a junior high school in Karawang Regency. The research instruments employed included a culture-based SPLDV written test, interviews, observations, and documentation. The analysis of mathematical problem-solving skills is referred to as Polya's stages, while mathematical critical thinking skills are analyzed based on Ennis' indicators. The findings indicate that students' mathematical critical thinking skills remain deficient, particularly in the domains of making conjectures, developing and evaluating arguments, and verifying solutions through substitution and graphical representation. Concurrently, mathematical problem-solving aptitudes indicated that the capacity to comprehend problems was in the adequate range, the aptitude to formulate strategies was in the satisfactory range, the aptitude to execute strategies was suboptimal, and the aptitude to verify was the least proficient aspect. These findings suggest a necessity for educational approaches that prioritize the cultivation of procedural, evaluative, and reflective skills by leveraging meaningful cultural contexts.

ABSTRAK

Penelitian ini bertujuan untuk mengkaji kemampuan pemecahan masalah matematis dan berpikir kritis matematis siswa pada materi Sistem Persamaan Linear Dua Variabel (SPLDV) dalam konteks kebudayaan batik. Penelitian menggunakan pendekatan kualitatif deskriptif dengan dukungan data kuantitatif sederhana terhadap 36 siswa kelas VIII SMP di Kabupaten Karawang. Instrumen penelitian meliputi tes tertulis SPLDV berbasis budaya, wawancara, observasi, dan dokumentasi. Analisis kemampuan pemecahan masalah matematis mengacu pada tahapan Polya, sedangkan kemampuan berpikir kritis matematis dianalisis berdasarkan indikator Ennis. Hasil penelitian menunjukkan bahwa kemampuan berpikir kritis matematis siswa masih tergolong rendah, khususnya pada indikator membuat konjektur, mengembangkan dan mengevaluasi argumen, serta memeriksa solusi melalui substitusi dan representasi grafik. Sementara

itu, kemampuan pemecahan masalah matematis menunjukkan bahwa kemampuan memahami masalah berada pada kategori baik, kemampuan merencanakan strategi berada pada kategori cukup, kemampuan melaksanakan rencana tergolong rendah, dan kemampuan mengecek kembali menjadi aspek yang paling lemah. Temuan ini menunjukkan perlunya pembelajaran yang menekankan penguatan keterampilan prosedural, evaluatif, dan reflektif melalui pemanfaatan konteks budaya yang bermakna.

INTRODUCTION

One of the materials in mathematics learning that is relevant for developing students' problem-solving and critical thinking skills is the Two-Variable Linear Equation System (SPLDV). SPLDV material demands that students comprehend the interrelation between variables, articulate problem scenarios through mathematical models, and ascertain solutions in a logical and systematic manner. In addition to emphasizing algebraic aspects, SPLDV also requires mathematical connection skills when linked to contextual problems in everyday life, such as sales transactions, resource distribution, and simple budget planning (Sulistiyowati & Wahyuni, 2024; Ministry of Education and Culture, 2018). Contemporary research indicates that students' capacity to formulate mathematical models and apply SPLDV concepts in contextual scenarios persists as a learning challenge that necessitates specialized attention from educators (Sulistiyowati & Wahyuni, 2024; Purnamasari & Setiawan, 2019; Ferdianto & Yesino, 2019.

Recent studies have indicated that students frequently encounter challenges when attempting to solve SPLDV problems that necessitate conceptual understanding, effective solution strategies, and the ability to link the results with real-world contexts (Nursyahidatin & Rahaju, 2025). For instance, empirical analysis demonstrates that while certain students exhibit competence in problem-solving indicators such as problem comprehension and problem-solving strategy formulation, their implementation of strategies and evaluation of results remain deficient, particularly in the context of complex story problems (Kurniawati et al, 2024). This condition underscores the necessity for educational innovations that are not only oriented towards algebraic procedures but also capable of presenting culturally and applicationally meaningful contexts, thereby facilitating the development of higher-order thinking skills in students. These difficulties suggest that students' limitations are not merely procedural in nature but are closely related to their ability to think critically in analyzing problems, selecting appropriate strategies, and justifying the solutions obtained.

In line with this perspective, the pedagogy of mathematics education must deliberately foster students' mathematical critical thinking skills. Mathematical critical thinking encompasses the capacity to analyze information, evaluate solution strategies, draw logical inferences, and provide justifications or explanations for the solutions obtained (Setyawati et al., 2025; Thoyyibah et al., 2024). In the context of mathematics education, this ability is of paramount importance. Students are expected not only to arrive at the correct solution, but also to comprehend the rationale underlying each step of the process (OECD, 2021). Recent studies demonstrate that the cultivation of mathematical critical thinking plays a substantial role in students' capacity to address non-routine and complex contextual problems (Kong et al., 2020).

However, various studies in the last five years reveal that students' mathematical critical thinking skills are still relatively low, especially in terms of analyzing and evaluating solutions. This condition is inseparable from learning practices that are still oriented towards routine procedures, similar exercises, and an emphasis on one correct answer without allowing room for exploration of alternative strategies (Ahdhianto et al., 2020). As a result, students tend to be passive and lack training in expressing mathematical reasoning or reflecting on their thinking processes. Nevertheless, most existing studies primarily focus on identifying students' difficulties or measuring critical thinking outcomes, while relatively few have examined instructional designs that integrate contextual problem situations, particularly SPLDV problems grounded in meaningful real-life or cultural contexts, as a medium to explicitly foster mathematical critical thinking processes. Therefore, a learning approach that encourages students to think reflectively, analytically, and evaluatively is needed so that their mathematical critical thinking skills can develop optimally.

One approach that can be used to address this issue is ethnomathematics, which is an approach that links mathematical concepts to the culture and social practices of a community (Riadi, Turmudi & Juandi, 2025). Through the cultural context in SPLDV questions, students can understand that mathematics is closely related to real life and meaningful (Solihin, Mariana & Rahmawati, 2025). The culture used in this study is limited to batik. This allows batik to feel more real and be depicted in everyday life in relation to mathematical problems.

Although various studies have examined students' problem-solving and critical thinking skills in mathematics, these studies generally still focus on analyzing difficulties or applying certain learning models without systematically integrating the local cultural context, especially in SPLDV material. In addition, most studies still examine these two abilities separately, so they do not provide a comprehensive picture of their simultaneous development in a meaningful learning context. Meanwhile, this study integrates the ethnomathematics approach in SPLDV learning to analyze students' mathematical problem-solving and critical thinking abilities simultaneously.

Therefore, this study aims to analyze and describe students' problem-solving and mathematical critical thinking abilities through ethnomathematics-based learning of Two-Variable Linear Equation Systems (SPLDV), so that it can provide an empirical description of the potential of local cultural contexts in supporting the development of students' critical thinking and problem-solving skills.

METHOD

This study uses a descriptive qualitative approach supported by simple quantitative data. This approach was chosen because it provides an in-depth description of student profiles in terms of problem-solving skills, critical thinking, and mathematical literacy in the context of two-variable linear equation systems (SPLDV) within a cultural context, emphasizing the process, meaning, and holistic understanding of the phenomenon (Safarudin et al, 2023). Mathematical problem-solving skills were analyzed based on Polya's stages, which include understanding the problem, planning a strategy, implementing the plan, checking, and presenting the results, because these stages represent a systematic mathematical thinking process.

Meanwhile, critical thinking indicators refer to the framework proposed by Ennis, which includes the ability to understand and clarify problems, analyze information and

relationships, formulate solution strategies, carry out logical reasoning, evaluate processes and results, and draw conclusions and provide rational justifications (Ennis, 2011).

The research subjects were 13- to 14-year-old eighth-grade students at a junior high school in Karawang Regency, with a total of 36 students selected directly from one class. The selection of subjects was based on the consideration that the students had studied SPLDV material in accordance with the applicable curriculum (Ministry of Education and Culture, 2018) and had initial experience with single-variable linear equations, so they were ready to face contextual SPLDV problems. In terms of cognitive development, students in middle adolescence are in the early formal operational stage, which allows for the development of critical and abstract thinking skills with the support of concrete contexts.

The research stages include (1) a preliminary study through literature review on problem solving, critical thinking, and ethnomathematics, as well as the development and validation of culture-based SPLDV instruments through expert judgment; (2) data collection through written tests, in-depth interviews, observation, and documentation; (3) data analysis using Polya's indicators for problem solving and critical thinking indicators, and (4) compilation of results in the form of tables, graphs, and narrative descriptions to present a comprehensive profile of student abilities.

Data analysis was carried out with reference to the results of the students' tests. The data was then read and reviewed repeatedly to gain a comprehensive understanding of the patterns of solutions demonstrated by the students. Each answer was then analyzed using problem-solving ability indicators based on Polya's stages and critical thinking ability indicators based on Ines. Furthermore, to explore students' understanding of ethnomathematics, which was the object of this study, namely batik, an analysis was conducted on students' perceptions of issues related to batik.

RESULTS AND DISCUSSION

Based on the results of a mathematical critical thinking test given to 36 students, only 23 students (63.8%) attempted to answer questions covering five indicators of critical thinking skills in the Two-Variable Linear Equation System (SPLDV) material. Meanwhile, the other 13 students (36.1%) did not complete the questions properly, with some even leaving the entire answer sheet blank or most of it blank. This condition indicates that the level of student readiness in facing questions that require high-level reasoning is still not optimal. Not all students are able to understand the instructions in the questions that lead to analytical and evaluative processes, so they choose not to answer or simply write down answers without correct mathematical calculations.

Upon closer examination, students who attempted to solve the problems mostly only completed the initial part related to the indicator of recognizing patterns, namely organizing information in the form of an SPLDV mathematical model (Sulistiyowati & Wahyuni, 2024; Nursyahidatin & Rahaju, 2025). This indicator is still within the scope of basic procedures, making it easier for students to understand. However, when the questions begin to require higher-order critical thinking skills, such as making mathematical conjectures and developing and evaluating arguments, the number of students who continue the process of working on the questions decreases significantly (Aini et al, 2019). This indicates that most students do not yet have the intellectual courage and conceptual readiness to logically express mathematical conjectures and provide reasons to support their solution steps.

In addition, on indicators that require the use of logical reasoning, either through their own methods or graphical representations, only a few students attempted to perform these verification steps. Generally, they stop after obtaining the final result, without validating the

solution (OECD, 2021). This condition shows that previous learning tended to focus on procedural completion so that students were not accustomed to reflecting on the results, while alternative representations such as graphs were not well mastered. Overall, the percentage of students' work and the quality of their answers on each indicator show that students' mathematical critical thinking skills are still at a low level and require learning interventions that can encourage students to actively analyze, check, and evaluate their mathematical work (Suryawan et al., 2023).

Although there were 23 students who attempted to answer the questions, not all of them produced answers that could be assessed according to the criteria for mathematical critical thinking skills. The results of the analysis show that only some students were able to complete the steps for solving SPLDV logically and structurally. On the pattern recognition indicator, the majority of the 23 students were able to write down the appropriate equation based on the information in the question, so the percentage of answers that could be assessed at this stage was higher than the other indicators.

Student performance began to decline in the indicator of making mathematical conjectures, because although students were able to recognize initial patterns, many of them were unable to logically draw mathematical conclusions from the relationships between variables. As a result, the percentage of answers that can be assessed on this indicator has declined quite sharply. A more concerning condition is seen in the indicator of developing and evaluating arguments, where most students do not provide reasons for their solution steps. Answers tend to be only the final results without any explanation of the thought process, so that many answers cannot be assessed except in terms of the results, not the expected critical thinking skills.

The same was true for the indicator of using logical reasoning to recheck solutions. Only a few students attempted to validate their answers on their own, such as by substituting values into the equation. The situation worsened for the fifth indicator, checking solutions using graphs, as almost all students were unable to present accurate graphs as proof. Many answers were only rough sketches without accurate scales or intersection points, so they could not be used as a basis for assessment. Overall, of the 23 students who completed the task, only a small portion of the answers could be assessed as meeting the critical thinking ability indicator, indicating that the

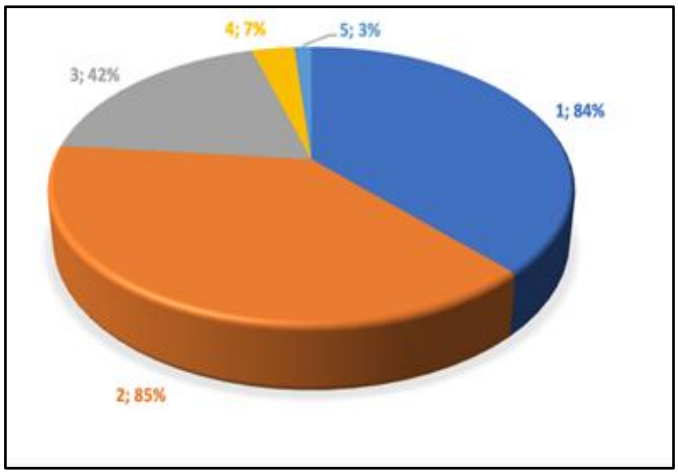
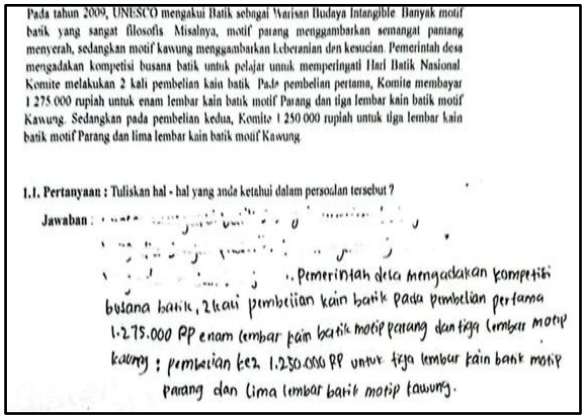


Figure 1. The following diagram illustrates the students' capacity for critical mathematical thinking.

Based on **Figure 1**, this section will delineate the response patterns exhibited by test subjects in response to the SLPDV inquiries. Each question is composed of multiple parts, with each part providing a set of guidelines to assist in the formulation of a solution. In the following section, the results of the survey will be presented. The survey was completed by 27 students, and the responses were then analyzed to identify any patterns or trends. It was observed that several students had similar responses, and these responses will be discussed in the subsequent analysis. As illustrated in **Figure 2**, the responses to Question 1 exhibit a specific pattern.


Pada tahun 2009, UNESCO mengakui Batik sebagai Warisan Budaya Intangible. Banyak motif batik yang sangat filosofis. Misalnya, motif parang menggambarkan semangat pantang menyerah, sedangkan motif kawung menggambarkan keberanian dan kesucian. Pemerintah desa mengadakan kompetisi busana batik untuk pelajar untuk memperingati Hari Batik Nasional. Komite melakukan 2 kali pembelian kain batik. Pada pembelian pertama, Komite membayar 1.275.000 rupiah untuk enam lembar kain batik motif Parang dan tiga lembar kain batik motif Kawung. Sedangkan pada pembelian kedua, Komite 1.250.000 rupiah untuk tiga lembar kain batik motif Parang dan lima lembar kain batik motif Kawung.

1.1. Pertanyaan : Tuliskan hal - hal yang anda ketahui dalam persoalan tersebut ?

Jawaban : Pemerintah desa mengadakan kompetisi busana batik, 2kali pembelian kain batik pada pembelian pertama 1.275.000 RP enam lembar kain batik motif parang dan tiga lembar motif kawung ; pembelian ke2 1.250.000 RP untuk tiga lembar kain batik motif parang dan lima lembar batik motif kawung.

In 2009, UNESCO recognized Batik as an Intangible Cultural Heritage. Many batik motifs are deeply philosophical. For example, the parang motif depicts an unyielding spirit, while the kawung motif symbolizes courage and purity. The village government held a batik fashion competition for students to commemorate National Batik Day. The Committee purchased batik fabric twice. For the first purchase, the Committee paid 1,275,000 rupiah for six pieces of Parang batik and three pieces of Kawung batik. For the second purchase, the Committee paid 1,259,000 rupiah for three pieces of Parang batik and five pieces of Kawung batik.

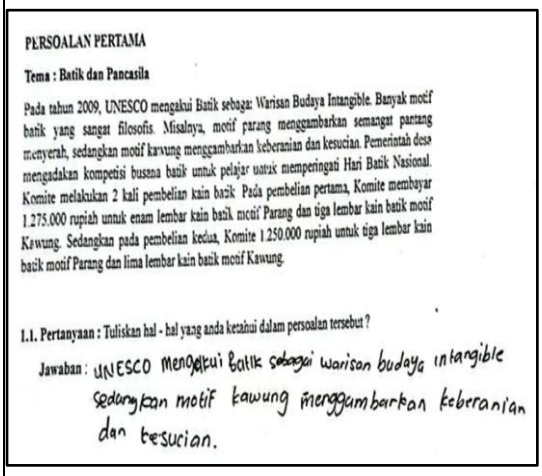
1.1 Question: Write down what you know about this problem.
Answer: The village government held a batik fashion competition and purchased batik fabric twice. The first purchase cost 1,275,000 rupiah for six pieces of Parang batik and three pieces of Kawung batik. The second purchase was 1,250,000 for three pieces of parang motif batik cloth and five pieces of kawung motif batik cloth**.**

Figure 2. The first type of student response is characterized by a particular set of responses

Based on **Figure 2**, the aforementioned issue was addressed by the village administration, which organized a competition to design a batik garment to commemorate the National Batik Day. The committee will purchase two pieces of batik. The initial transaction involved the purchase of six batik fabric pieces, each measuring six square meters, at a cost of Rp1,275,000. The fabric selections included two pieces with the Parang motif and three pieces with the Kawung motif. The second purchase was made at a price of Rp1,250,000 for three pieces of batik fabric, each with a distinct motif, specifically Parang and Kawung. Subsequently, the objective is to administer a demonstration or guidelines to ensure that the students are able to respond to the questions in a manner consistent with the information they have obtained. However, an analysis of the first student's responses reveals

that the student has yet to transform verbal information into mathematical representations, such as defining variables clearly and accurately, and formulating linear equations based on the given information. Despite the student's ability to recite or reproduce numerical values, they are unable to interpret the significance of these values. The response thus far has been limited to a mere reiteration of the information provided, lacking any indication of recognizing patterns within the specified SPLDV. Thirdly, the provided guidelines do not yet direct the students toward the formulation of mathematical models. In accordance with the first indicator, students should be able to write the following:
(1) For instance, x = the cost of one batik with the Parang motif, and (2) For instance, y = the cost of one batik with the Kawung motif. Subsequently, the information can be represented in the form of two equations: (1) 6x + 3y = 1,275,000; (2) 3x + 5y = 1,250,000.

Nevertheless, the student's response does not accurately reflect the mathematical essence of the problem. In the subsequent phase of the study, the second item examined whether the student demonstrated an absence of mathematical aptitude, as indicated by the student's failure to provide a correct response to the question. As illustrated in **Figure 3**, the aforementioned response is indicated as follows.



PERSOALAN PERTAMA

Tema : Batik dan Pancasila

Pada tahun 2009, UNESCO mengakui Batik sebagai Warisan Budaya Intangible. Banyak motif batik yang sangat filosofis. Misalnya, motif parang menggambarkan semangat pantang menyerah, sedangkan motif kawung menggambarkan keberanian dan kesucian. Pemerintah desa mengadakan kompetisi busana batik untuk pelajar untuk memperingati Hari Batik Nasional. Komite melakukan 2 kali pembelian kain batik. Pada pembelian pertama, Komite membayar 1.275.000 rupiah untuk enam lembar kain batik motif Parang dan tiga lembar kain batik motif Kawung. Sedangkan pada pembelian kedua, Komite 1.250.000 rupiah untuk tiga lembar kain batik motif Parang dan lima lembar kain batik motif Kawung.

1.1. Pertanyaan : Tuliskan hal - hal yang anda ketahui dalam persoalan tersebut ?

Jawaban : UNESCO mengakui batik sebagai warisan budaya intangible sedangkan motif kawung menggambarkan keberanian dan kesucian.

English version

Theme : Batik and Pancasila

In 2009, UNESCO recognized Batik as an Intangible Cultural Heritage. Many batik motifs are deeply philosophical. For example, the parang motif depicts an unyielding spirit, while the kawung motif symbolizes courage and purity. The village government held a batik fashion competition for students to commemorate National Batik Day. The Committee purchased batik fabric twice. For the first purchase, the Committee paid 1,275,000 rupiah for six pieces of Parang batik and three pieces of Kawung batik. For the second purchase, the Committee paid 1,259,000 rupiah for three pieces of Parang batik and five pieces of Kawung batik.

1.1 Question :

Write down what you know about this problem.

Answer :

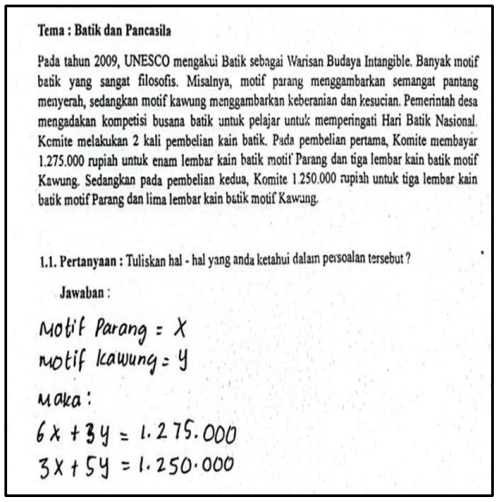
The United Nations Educational, Social and Cultural Organization (UNESCO) has formally recognized batik as a non-material cultural heritage, with the motif of Kawung serving as a representation of both bravery and sanctity.

Figure 3. This is the second type of response exhibited by the students.

Based on **Figure 3**, it is evident from the second response that the student's approach does not demonstrate a clear alignment with the mathematical content pertinent to the specific problem of SPLDV. Students are instructed to provide additional information on the general subject matter presented in the opening paragraph, namely the recognition of batik by UNESCO and the philosophical significance of batik motifs. The aforementioned

response indicates that the individual in question is still operating within the domain of literal comprehension, rather than the domain of quantitative information necessary for the development of mathematical models. It is evident that no effort has been made to identify the variables, quantities, or mathematical relationships that are fundamental to the problem at hand. Therefore, it can be concluded that the response to this question is more indicative of an understanding of language or general literacy than of mathematical aptitude. Consequently, the identification of patterns can be considered as an initial stage of critical mathematical thinking that has yet to be achieved.

This indicates that the students have yet to grasp the fundamental concepts of the problem, specifically the question, "What is known about the problem?" This serves as an initial step in formulating the problem into a linear equation. The capacity to extract mathematical information from contextual texts is indicative of the current state of mathematical reading comprehension skills, which are not yet fully developed. This finding suggests the hypothesis that students perceive mathematics as a procedural activity, devoid of its application to real-world contexts involving processes of interpretation and information categorization. Consequently, the findings indicate that the students' mathematical critical thinking skills at the identification information stage are currently at a low level. As illustrated in **Figure 4**, the third response is nearly correct.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1.1. Pertanyaan : Tuliskan hal - hal yang anda ketahui dalam persoalan tersebut ?

Jawaban :

Motif Parang = X
motif kawung = y
maka :
6x + 3y = 1.275.000
3x + 5y = 1.250.000

English version
In 2009, UNESCO recognized Batik as an Intangible Cultural Heritage. Many batik motifs are deeply philosophical. For example, the parang motif depicts an unyielding spirit, while the kawung motif symbolizes courage and purity. The village government held a batik fashion competition for students to commemorate National Batik Day. The Committee purchased batik fabric twice. For the first purchase, the Committee paid 1,275,000 rupiah for six pieces of Parang batik and three pieces of Kawung batik. For the second purchase, the Committee paid 1,259,000 rupiah for three pieces of Parang batik and five pieces of Kawung batik.

1.1 Question:
Write down what you know about this problem.
Answer:
Parang batik pattern = X
Kawung batik pattern = Y
So, it could be:
6X + 3Y = 1,275,000
3X + 5Y = 1,250,000

Figure 4. Response of the fourth type of student

Based on **Figure 4**, in contrast to the preceding two responses, the third response indicates that the student has successfully identified the essential mathematical information from the problem. The students have accurately determined the variables, specifically identifying xxx as the cost of a batik fabric with the Parang motif and yyy as the cost of a

batik fabric with the Kawung motif. In addition, the student successfully converted the contextual information into two linear equations: 6x + 3y = 1.275.0006x + 3y = 1.275.0006x + 3y = 1.275.000 and 3x + 5y = 1.250.0003x + 5y = 1.250.0003x + 5y = 1.250.000, which serve as mathematical representations of two different surfaces of the cloth as determined by the committee. This step indicates that the student has met the standard of understanding the patterns in mathematical problem-solving, as demonstrated by their ability to comprehend the structure of problems and formulate them accurately in the form of a standard second-order linear differential equation (SPLDV).

This response further underscores the initial comprehension, which is notably proficient, within the context of mathematical modeling that entails the processing of quantitative information derived from textual data. It is imperative to note that the provided solution has not yet been subjected to rigorous mathematical analysis or verification of the solution to the problem. The ability to connect information to algebraic forms is a fundamental skill necessary for more complex problem-solving in the context of SPLDV. It is evident that, within the purview of this category, the works in question are positioned at the nascent stage of critical thinking, exhibiting superiority over other works, though further guidance is necessary to attain the optimal level of refinement and substantiation.

As stated by Polya (2020), the ability to understand problems is the initial and pivotal stage in the process of solving mathematical problems. In absence of a comprehensive understanding of the information provided in the examination, it is implausible that the student will be capable of formulating an appropriate response. Therefore, an analysis of the students' achievements in understanding the issues is a solid foundation for assessing their readiness to progress to the subsequent stage of the strategic plan and the implementation of the action plan.

The data percentage indicates a considerable variation in the level of understanding among the students, suggesting a wide range of comprehension levels. Perbedaaan ini mengindikasi variasi literasi matematika dan konstruksional yang dialami para responden (Sujatha & Vinayakan, 2022). By analyzing the aforementioned percentage patterns, educators can identify students who have demonstrated a strong understanding of the subject matter, as well as those who require more intensive intervention to enhance their fundamental skills in understanding the subject matter.

The data percentage indicates a significant variability in the understanding among the participants. The range of scores, which vary from 18% to 100%, indicates that a proportion of the students have demonstrated an adequate understanding of the material, while others are experiencing significant difficulties. This discrepancy serves as the foundation for assessing the initial proficiency in the process of addressing mathematical problems. The data set includes a considerable number of instances with percentages ranging from 91% to 100%. This finding indicates that the majority of students have demonstrated a comprehensive understanding of the subject matter. The identification of crucial information, comprehension of the problem's context, and determination of the objective of the problem are pivotal for progression to the subsequent stage of problem-solving.

Students who achieve a perfect score of 100% demonstrate a comprehensive understanding of the subject matter and meet all the criteria outlined in the rubric. As stated by Fakhrunisa dan Hasanah (2020), the ability to accurately and precisely identify the information sought is contingent upon the comprehension of the interrelationships among the information presented in the given context. This ability is indicative of their aptitude and proficiency in addressing mathematical problems that are grounded in context. It is evident that students who have attained a score of 91% on their assessments have demonstrated a

high level of proficiency, despite the presence of certain sections that are not fully developed. The aforementioned errors generally manifest as minor oversights, such as the omission of crucial information from the given problem or an incomplete integration of data. Notwithstanding, their comprehension remains at a superior level, exhibiting minimal impediment to the process of resolving the issues at hand.

The percentages of 73%, 82%, and 64%, respectively, are indicative of a satisfactory level of comprehension within the "good" category. At this stage, the student has demonstrated an understanding of the majority of the content, with the exception of certain sections that remain to be fully developed (Sarjana, Hayati & Wahidaturrahmi, 2020). Although they may possess a fundamental understanding of the subject, they occasionally demonstrate a lack of meticulousness in their analysis, potentially omitting crucial information or failing to consider all pertinent aspects, thereby hindering a comprehensive comprehension. A cursory examination reveals that the comprehension of the issue is currently limited to a mere 55%. In most cases, students merely inscribe a portion of the information they are aware of or comprehend in the form of a question without contextualizing it within the broader context of the problem. Despite the efforts to comprehend, the current value falls short of the comprehensive understanding required for a full grasp of the issue (Haryanti, Herman, Prabawanto, 2019).

The absence of significant difficulty in comprehending the issue is indicated by the figures of 36% and 18%. Students with these scores frequently encounter challenges in recognizing crucial information, misinterpreting contextual nuances, and occasionally, failing to comprehend the intended objective of the given task. This indicates that the subjects are still in the initial stages of acquiring reading and comprehension skills, necessitating specialized attention. The presence of several low-scoring items indicates that while a significant proportion of students demonstrate proficiency in the subject matter, a subset of students exhibits a need for intensive support. To facilitate comprehension, it is imperative to employ a systematic approach, such as utilizing keywords, diagrams, or a step-by-step process to interpret the information presented in the narrative (Tambychik & Meerah, 2020).

A significant discrepancy in abilities has been identified as a crucial indicator for educators in designing differentiated instructional strategies. Students who have demonstrated a strong understanding of the subject matter should be presented with more challenging material to assess their analytical abilities. Conversely, students who have received lower grades require more targeted interventions to support their learning and ensure they achieve the minimum proficiency level in the subject. On the whole, the data indicates that the majority of students have already attained a certain level of proficiency in the subject matter, thereby enabling them to progress to subsequent stages of study. However, the presence of a low level of understanding indicates that educators must implement measures to enhance mathematical literacy and provide instruction that is systematically focused on fostering understanding of the subject matter (Hallström & Schönborn, 2019).

The ability to formulate a strategy constitutes a pivotal step in the process of solving mathematical problems, particularly in the context of Systems of Linear Equations in Two Variables (SLETV). At this stage, students are expected not only to comprehend the problem, but also to identify the most appropriate method of solution that aligns with the characteristics of the given equation. The selection of an effective strategy is paramount for achieving optimal efficiency and precision in the completion process. This strategy serves as a crucial metric for evaluating the comprehension of students regarding SPLDV.

The data percentage is indicative of the strategy employed by SPLDV, which is derived from the level of understanding exhibited by the students, indicating a range of comprehension levels. The distinction between these two approaches is evident in the ability to determine an effective method of completion, select a strategy that aligns with the structure of the problem, and provide a rationale that substantiates the selection of the aforementioned method. The analysis of the data presented in percentage form enables the educator to assess the extent to which the students employ strategic and rational strategies in their efforts to solve a system of linear equations, both in the immediate sense and in the broader sense. This assessment facilitates the identification of students who require further instruction or reinforcement.

The proportion of students capable of formulating strategies to solve SPLDV problems indicates a significant variation among them, with values ranging from 0% to 100% across three primary categories: 0% (no solution found), 50% (solution found but not unique), and 100% (solution found and unique). The presence of this variety serves as an indicator of the extent to which the individual possesses the ability to determine an appropriate method of resolution and to comprehend the rational basis for selecting that particular method. The attainment of a perfect score on several tests indicates that the students have demonstrated a high level of proficiency in formulating strategies for the resolution of SPLDV. Students in this category are capable of determining the most effective method, whether it is elimination, substitution, or graphing, by ensuring that the structure of the equation is accurately reflected in the chosen approach.

Students who achieved a perfect score demonstrated a high level of proficiency in explaining the rationale behind their selection of method, exhibiting a logical and coherent argument. For instance, one might posit that the elimination method is selected due to the fact that the coefficient of each variable can be readily standardized, or that the substitution method is more accurate because one of the equations can be converted directly into a variable. This aptitude is indicative of a mature conceptual understanding. The majority of the students were found to be in Category 50%, indicating that while they demonstrated an understanding of the fundamental concepts of SPLDV, they had not yet attained complete mastery of the specific objectives. In this category, students typically demonstrate proficiency in one of the available methods of resolution, yet they often exhibit uncertainty or an apparent lack of consideration for the effectiveness of the methods in relation to the nature of the equations.

The mean value is 50%, and the majority of the time, the rationale provided is insufficient or overly general in nature with respect to the selection method. For instance, the decision to employ a particular method is often influenced by habit rather than by the suitability of the method to the characteristics of the given problem. This indicates that the students require instruction on the correlation between problem structures and optimal problem-solving methodologies. It has been determined that the group of subjects who obtained a percentage of 50% have reached the initial stage of the strategic level. However, further development is necessary to determine the most efficient method of instruction compared to other methods. It must be acknowledged that, at this juncture, their capabilities remain fragmentary and unpolished.

The absence of any correct solutions indicates that the strategy for solving the SPLDV has not yet been formulated. It is possible that they are aware of the general form of a separable linear differential equation (SPLDV). However, they may not be cognizant of the method to solve the system of equations in an effective manner. Students who have not yet demonstrated proficiency in a given method are unlikely to provide a rationale that is

coherent and logical. It is possible that they will attempt to solve the problem without first developing a plan or even without attempting to solve the problem at all. This finding suggests a necessity for fundamental instruction on the characteristics of the elimination method.

The implementation of this stage is of paramount importance in the process of resolving mathematical problems, particularly in the domain of Systems of Linear Equations in Two Variables (SLETV). Following the determination of the problem and the formulation of a solution, it is imperative that the solution be implemented in a logical, systematic, and precise manner. At this stage, the procedural competence of the student is assessed. The assessment includes the identification of variables, the formulation of equations, the simplification of algebraic forms, and the implementation of either elimination or substitution, as appropriate, according to the predetermined design.

An analysis of the percentage of students who successfully complete the SPLDV provides a precise depiction of their level of accuracy and precision in completing the task. The percentage that is obtained is indicative of the degree of success in each indicator, such as the precision in determining the variables, the formulation of linear equations, and the accurate estimation of the variable values. The variation in the percentage indicates the absence of procedural differences among the students, thereby providing a foundation for educators to formulate subsequent learning activities that are more methodical and targeted.

The data indicates that the ability to determine two variables is currently at a very low level, as evidenced by numerous values that are even at 0%. This indicates that the majority of students have yet to grasp the fact that the solution to a system of linear differential equations (SPLDV) is contingent upon the identification of the variables, such as the prices of goods A and B, or the values of x and y. The inability to identify these variables accurately results in difficulties encountered in subsequent steps of the process. The subject's proficiency in formulating two linear equations indicates variability. It is evident that the majority of the participants demonstrated a lack of proficiency in the transformation of information into mathematical models, as evidenced by the prevalence of responses indicating a complete absence of understanding. The establishment of a linear equation constitutes the cornerstone of the resolution of a system of linear differential equations (SLDEs).

The capacity to determine the value of the independent variable (x and y) is only demonstrated by a limited number of cases, as evidenced by the percentage of 25%, 38%, and 50% across several data sets. The final value of the variable is the result of the sequence of steps to solve a system of linear differential equations. Therefore, when the percentage is low, it indicates that many of the steps were not completed correctly from the beginning. A potential underlying factor is the lack of precision in the process of replacing values or conducting final calculations. On the whole, the majority of the indicators show a prevalence of 0%, indicating that the majority of the students are encountering challenges in various aspects of the course. The phenomenon under scrutiny can be attributed to two factors: first, an absence of fundamental understanding of the fundamental principles of SPLDV; and second, an insufficiency of proficiency in the autonomous formulation and resolution of systems of equations. Errors in one step frequently have a direct impact on the subsequent step.

The data indicates that a mere 25% of the respondents demonstrated proficiency in all but a few of the indicators. This finding suggests that only a quarter of the students have achieved the minimum level of proficiency in at least some of the indicators. This finding suggests the presence of a certain degree of proficiency in basic skills, though it does not

necessarily guarantee optimal performance. It is possible that their capabilities are limited to the consistent control of errors or the consistent application of concepts. The data set reveals a 38% occurrence of the phenomenon, suggesting that a proportion of the sample falls within the category of "medium." It is possible to complete the steps in a certain order, but not all of the steps in the sequence of SPLDV. Students in this category typically possess an understanding of the fundamental steps; however, they encounter difficulties when utilizing systematic methods such as elimination or substitution.

The value of 50% signifies that a proportion of the population has demonstrated a capacity to engage in sexual intercourse in its entirety, although this proportion remains minimal. The determination of variables, formulation of equations, simplification, and resolution of equations to obtain the final value are all possible. This group has demonstrated a superior level of preparedness in implementing the prescribed procedures.

The final stage of the mathematical problem-solving process is the verification stage. The purpose of this stage is to ensure that the solution obtained is correct, consistent, and applicable to other contexts. In the course of studying the subject of "System of Linear Equations with Two Variables" (SPLDV), this stage is of paramount importance. Students are expected not only to ascertain the values of the variables, but also to comprehend the manner in which these values are employed to verify the validity of a given problem or to formulate a new equation based on the preceding one. Therefore, the ability to verify the concept in question is indicative of one's comprehensive understanding of the subject matter.

The analysis of the percentage of the indicator of "mengecek" provides insight into the extent to which the student is able to evaluate and transfer knowledge to subsequent contexts, including third-order learning or graphical representations. The presence of a low percentage, or even an absence of it, indicates that the student has not yet developed the habit of reflecting on their work or validating their work in other ways. Through the analysis of the collected data, the educator is able to identify the fundamental deficiencies in the students' evaluative skills and to develop a lesson plan that emphasizes the importance of verification as a component of the problem-solving process.

The data indicates that the majority of the indicators have not yet undergone the verification process, suggesting that the majority of the data has not yet been subjected to the requisite validation. Nevertheless, re-examination constitutes a pivotal step in ascertaining the veracity of an SPLDV prior to its implementation in a novel context. The low percentage indicates that the process of determining the x and y values was terminated without conducting a subsequent verification. The initial indicator is the ability to input the previous price, which is reflected in 0% of the data. This indicates that the subject is experiencing difficulty in establishing a connection between the information obtained from the initial completion and the original context.

The indicator also displays a similar pattern, with a preponderance of 0% values in the new problem. It is evident that the efficacy of the third issue's validation is contingent upon its utilization in the examination of the second issue's validity. This indicates a deficiency in the transfer of knowledge regarding the present state of the art. A segment of the data, constituting 13% of the total, indicates that a limited number of cases have undergone re-examination, despite their incompleteness. It is possible that they are capable of inputting rudimentary information; however, they may still face challenges when it comes to analyzing new contexts. The value of 13% indicates the absence of any potential for enhancement through intensive training.

The absence of any value assigned to any of the indicators indicates that the students have not yet developed the habit of reflecting on the processes they have employed to reach

their goals. It is important to note that the conclusion of the SPLDV is not to be regarded as the final outcome of the process, but rather as a constituent element of a comprehensive problem that necessitates a multifaceted examination. The absence of a repeated review may be indicative of an insufficient emphasis on the importance of verification in the instructional design. It is possible that the student is not provided with guidance on how to review the steps or apply them to the actual problem in the problem statement. Consequently, the self-evaluation process becomes neglected.

It is evident that the capacity to interpret the solution to a system of linear differential equations (SPLDV) within the context of a graph is not yet fully developed. This underscores the need for further refinement of mathematical representations that can offer a more comprehensive and nuanced depiction of the subject matter. The implementation of graphical representation necessitates a comprehensive understanding of the relationship between variables and the ability to interpret algebraic expressions. These competencies are yet to be fully developed among the current generation of data scientists. On the whole, the data reveal that the capacity to verify the accuracy of the data is at a remarkably low level. The majority of students have yet to verify the results or utilize them in subsequent contexts, such as the third test or graphical representations. This phenomenon is referred to as "I."

Cultural literacy is defined as an individual's capability to understand, recognize, and appreciate the diverse cultures in their environment. It is evident that a significant proportion of the respondents, approximately 70%, have been exposed to the concept of cultural diversity as a manifestation of patriotism. One particular manifestation of this capacity is the recognition that each region in Indonesia possesses a distinct array of batik motifs. The aforementioned findings indicate that a considerable proportion of the population is cognizant of the richness of the national culture and the imperative of preserving local identity through traditional heritage, such as batik (Andita et al., 2024; Setiawan & Prasetyo, 2023).

Concomitantly, the capacity to comprehend the cultural heterogeneity inherent within Indonesia stands at approximately 50%. The percentage is characterized by an awareness that the diversity of batik motifs symbolizes unity in diversity. Despite the fact that only a fraction of the respondents have attained this level of comprehension, this development signifies a noteworthy advancement in the realm of cultural literacy, particularly with regard to the understanding of batik. This is not merely regarded as a form of artistic expression, but rather as a symbol of national unity, tolerance, and solidarity.

A general overview of the data indicates that the public has a fundamental understanding of cultural diversity. However, further exploration is necessary to fully comprehend the profound implications of this diversity for national unity (UNESCO, 2022). Nonetheless, the outcomes of this cultural literacy endeavor have yet to be demonstrated in terms of its efficacy in fostering cognitive understanding. There is a conspicuous absence of its integration with mathematical problems.

The findings of this study indicate a discrepancy between the students' comprehension of mathematical problems and their cultural context, despite the presence of a relatively high level of cultural literacy. This suggests a potential gap between understanding cultural context and its application in mathematics. It has been demonstrated that students have the capacity to identify cultural elements, social aspects, and daily practices that are presented in the form of problems. However, they have yet to demonstrate a full ability to transform their understanding of these elements into mathematical models that are precise, formulate strategies for solving problems, and evaluate the results in a logical manner (Fakhrunisa dan Hasanah, 2020). This finding suggests that a high level of

cultural literacy does not inherently lead to the development of critical thinking and problem-solving skills in students, unless it is accompanied by explicit scaffolding that guides students to analyze, evaluate, and reflect on the relationship between cultural context and mathematical concepts (Utami, et al., 2025; OECD, 2021).

In addition, this phenomenon can be interpreted as surface-level contextual understanding, wherein cultural context is perceived as a narrative background, yet it remains underutilized as a source of profound mathematical reasoning. Consequently, students often encounter difficulties in comprehending the contextual nature of the problem, yet they frequently experience challenges in planning effective strategies for problem-solving, executing these strategies, and justifying the outcomes of their efforts. These challenges are pivotal to the process of problem-solving and mathematical thinking. In light of the aforementioned, it can be concluded that the integration of cultural context in mathematics instruction should be directed not solely towards enhancing cultural literacy, but also towards stimulating critical thinking and problem-solving through reflective inquiry, systematic analysis of variable relationships, and systematic evaluation of solutions. (Sari & Lutfi, 2023). These findings imply that the importance of developing culturally grounded SPLDV tasks that explicitly foster students' mathematical critical thinking and problem-solving processes.

CONCLUSIONS

The results of the critical thinking mathematics test on the subject of SPLDV revealed that only a portion of the students attempted the test. The remaining students indicated a lack of readiness to face problems that require high-level thinking skills. The majority of students demonstrate an inability to meet the fundamental indicators, such as recognizing patterns and constructing mathematical models. Additionally, their proficiency is deficient in the domains of formulating conjectures, evaluating arguments, and examining solutions through substitutions and graphical representations. Futhermore, the students' aptitude in resolving mathematical problems exhibited a consistent trend across each stage. Their proficiency in problem-solving was classified as proficient, while their planning, strategy, and evaluation skills were identified as deficient. In summary, the findings indicate that while the subject demonstrated an initial comprehension of the concept, their procedural, evaluative, and reflective abilities require further development through systematic instruction that emphasizes mathematical reasoning.

From an ethnomathematical perspective, the potential of batik as a cultural artifact in the context of mathematics has yet to be fully recognized. Currently, its integration into mathematical thinking is primarily understood in terms of narrative and descriptive explanations, rather than being utilized as a tool for mathematical reasoning. Students have demonstrated proficiency in recognizing cultural elements, such as motifs and symbolic interpretations, yet encounter challenges in translating these elements into mathematical models, effective strategies for problem-solving, and the validation of results. Therefore, the development of SPLDV based on batik culture should be meticulously designed, emphasizing the explicit connection between the cultural context and the mathematical concept. This approach ensures that batik transcends its role as a mere illustrative element, serving as a medium for cultivating critical thinking and addressing mathematical problems.

In this regard, this study contributes by highlighting the need for a systematic design of batik-based SPLDV tasks that explicitly link cultural elements with mathematical reasoning to foster students' critical thinking and problem-solving skills. Nevertheless, this study is limited to a single cultural context and a relatively small sample size, indicating that

further research is needed to explore the effectiveness of ethnomathematical approaches across diverse cultural settings and broader student populations.

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