



Analysis of Students' Learning Obstacles in Solving SLETV Problems and the Development of a Hypothetical Didactical Design Based on Contextual Problems

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A B S T R A K	A R T I C L E I N F O
<p><i>Penelitian ini bertujuan mengidentifikasi learning obstacles siswa pada materi Sistem Persamaan Linear Dua Variabel (SPLDV) dan mengembangkan desain didaktis hipotetik berbasis masalah kontekstual. Metode yang digunakan adalah kualitatif deskriptif dalam kerangka Didactical Design Research (DDR) pada tahap analisis prospektif. Subjek penelitian adalah 34 siswa kelas X di salah satu SMA Negeri di Kota Bandung yang dipilih melalui teknik purposive sampling. Data dikumpulkan melalui tes uraian kontekstual dan wawancara semi-terstruktur, kemudian dianalisis menggunakan model Miles dan Huberman. Hasil penelitian menunjukkan bahwa ketiga jenis learning obstacles ditemukan secara bersamaan. Hambatan epistemologis menjadi yang paling dominan, termanifestasi dalam pemahaman variabel yang bersifat nominal, ketidaklengkapan solusi, dan kegagalan transfer antarkonteks. Hambatan didaktis teridentifikasi pada ketidakmampuan siswa memberikan argumentasi matematis, sedangkan hambatan ontogenik tampak pada kesalahan operasi aljabar dan ketidakruntutan langkah penyelesaian. Berdasarkan temuan tersebut, dikembangkan desain didaktis hipotetik berupa LKPD enam tahap berbasis konteks game online, dilengkapi Antisipasi Didaktis Pedagogis (ADP) pada setiap tahapan. Desain ini merespons masing-masing hambatan melalui scaffolding pemisalan variabel, situasi validasi argumentatif, dan institusionalisasi berbasis konteks.</i></p>	<p>Article History: Received: 2026-05-22 Revision: 2026-05-30 Accepted: 2026-05-31 Published: 2026-05-31</p> <p>Kata Kunci: Learning obstacles SPLDV Desain didaktis hipotetik Masalah kontekstual Didactical design research</p>
<p>A B S T R A C T</p> <p><i>This study aims to identify students' learning obstacles in the topic of Systems of Linear Equations in Two Variables (SLETV) and to develop a hypothetical didactical design based on contextual problems. The method used is descriptive qualitative within the framework of Didactical Design Research (DDR) at the</i></p>	<p>Keywords: Learning obstacles SLETV Hypothetical didactical design Contextual problems Didactical design research</p>

prospective analysis stage. The research subjects were 34 tenth-grade students at a public high school in Bandung, selected through purposive sampling. Data were collected via contextual essay tests and semi-structured interviews, then analyzed using the Miles and Huberman model. The results of the study indicate that all three types of learning obstacles were found simultaneously. Epistemological obstacles were the most dominant, manifested in the understanding of nominal variables, incomplete solutions, and failure to transfer knowledge across contexts. Didactical obstacles were identified in students' inability to provide mathematical arguments, while ontogenical obstacles were evident in errors in algebraic operations and the lack of logical sequence in solution steps. Based on these findings, a hypothetical didactical design was developed in the form of a six-stage worksheet based on an online game context, supplemented with Pedagogical Didactical Anticipation (PDA) at each stage. This design addresses each obstacle through variable scaffolding, argumentative validation situations, and context-based institutionalization.

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1. INTRODUCTION

Systems of Linear Equations in Two Variables (SLETV) serve as prerequisite material for advanced algebraic concepts such as linear programming and Systems of Linear Equations in Three Variables (SPLTV), while also being closely linked to the solution of contextual problems in junior high school mathematics (Maryani & Setiawan, 2021). Nevertheless, students' ability to solve story-based SLETV problems remains relatively low (Indah & Hidayati, 2021), indicating a fundamental issue that goes beyond mere procedural weaknesses.

Students' difficulties with SLETV material centered on mathematical modeling skills, specifically, the ability to transform verbal information into solvable equations, encompassing problem comprehension, mathematical modeling, and the selection of appropriate solution operations (Indah & Hidayati, 2021). Significantly, these obstacles are not limited to low-ability students but are also experienced by students of moderate and high ability (Maryani & Setiawan, 2021), suggesting that the source of the problem is more didactical than individual.

To comprehensively map learning obstacles, this study employs Brousseau's (2002) framework of learning obstacles, which categorizes obstacles into three types: ontogenical (students' mental unpreparedness), didactical (the impact of the teaching process), and epistemological (limitations of the students' knowledge context) (Puspita & Fitriani, 2023). These three types of obstacles often appear simultaneously and reinforce one another within a single learning event, making an understanding of their respective characteristics an essential prerequisite before designing interventions.

Epistemological obstacle are the most prevalent obstacle in SLETV content, characterized by a partial and context-specific understanding of concepts, resulting in students' inability to transfer their knowledge when faced with situations different from those they have previously studied (Rizki, Suryadi, & Nurlaelah, 2023). These obstacle manifest in two forms: (1) students struggle to translate verbal narratives into mathematical models, and (2) students are unable to apply the solutions they have derived to the problem context. Both forms indicate that students' understanding relies more on procedures than on concepts.

Didactical obstacle also plays a major role, arising from limited teaching materials, the presentation of formulas without conceptual understanding, and learning patterns that tend to be mechanical (Sadiah, Suhendra & Herman, 2024). Meanwhile, ontogenical obstacle are reflected in the weak mastery of basic algebraic operations as a prerequisite, given that proficiency in algebraic operations and mathematical modeling has been shown to significantly influence the ability to solve SLETV word problems (Antari, Rohman, Erviana & Kusumawati, 2024).

In response to these three types of obstacles, contextual problem-based learning emerges as a relevant approach. In this framework, context does not merely serve a decorative function but must be capable of eliciting authentic mathematization processes and supporting the development of meaningful understanding (Pratamawati, 2020). Thus, the instructional design in this study is oriented toward encouraging students to construct mathematical meaning from real-world situations, rather than merely applying algorithmic procedures.

Suryadi's (2019) Didactical Design Research (DDR) framework serves as an appropriate methodological foundation because it positions the identification of learning obstacles as the starting point for instructional design. Based on the findings regarding these obstacles, a hypothetical didactical design was developed that encompasses the action, formulation, validation, and institutionalization phases (Pratamawati, 2020), supplemented by Pedagogical Didactical Anticipation (PDA) to predict student responses, ensuring that the learning process remains dynamic and responsive.

Although previous researches on learning obstacles in SLETV has been conducted, most studies have not explicitly integrated findings regarding these obstacles with the development of comprehensive, context-based instructional designs (Warsitarumanti, Suryadi, & Dahlan, 2025). This gap forms the basis of this study, which aims to: (1) identify students' learning

obstacles in SLETV material, (2) describe the characteristics of these obstacles based on Brousseau's (2002) three categories, and (3) develop a hypothetical didactical design based on contextual problems in response to the identified obstacles.

2. METHOD

This study employs a descriptive qualitative approach within the framework of Didactical Design Research (DDR) developed by Suryadi (2019). DDR comprises three stages: prospective analysis, which yields a hypothetical didactical design along with Pedagogical Didactical Anticipation (PDA), metapedadidactical analysis, and retrospective analysis (Neshi et al., 2023). In accordance with the research objectives of the prospective analysis stage, the focus of the study is limited to the identification of learning obstacles and the design of a hypothetical didactical design based on contextual problems.

The research subjects were 34 tenth-grade students at a public high school in Bandung who had studied SLETV material during junior high school. The subjects were selected using purposive sampling, based on the consideration that tenth-grade students were deemed to have sufficient experience with SLETV to reveal patterns of learning obstacles that could be identified and analyzed in depth.

Data collection was conducted using two main instruments. First, a learning obstacles test consisting of contextual essay questions comprising three questions, each worth several points was designed to elicit three types of learning obstacles based on Brousseau's (2002) theory: epistemological, didactical, and ontogenical. The test instrument was first validated through expert judgment to ensure alignment between the question indicators and the types of learning obstacles intended to be identified. Second, semi-structured interviews were conducted with six students selected based on response patterns that could not be definitively categorized solely through analysis of written texts. The selection of informants focused on three categories of response patterns: (a) solving only one variable (Question 2b), (b) providing answers without mathematical reasoning (Question 3c), and (c) failing to define variables accurately (Questions 2a and 3a).

Data analysis followed the Miles and Huberman model, which comprises three stages: data reduction, data presentation, and drawing conclusions (Miles et al., 2014). In the data reduction stage, test answers and interview transcripts were categorized based on error patterns and linked to three types of learning obstacles. In the presentation stage, findings were presented in a qualitative descriptive manner, accompanied by excerpts from student responses and interview questions as empirical evidence. In the conclusion-drawing stage, the results of the identification of learning obstacles served as the foundation for developing a hypothetical, context-based instructional design supplemented by PDA to predict student responses to each designed learning situation.

3. RESULT AND DISCUSSION

An analysis of the answer sheets from 34 students identified three types of learning obstacles based on Brousseau's (2002) framework, which were subsequently confirmed and refined through semi-structured interviews with six selected students. A summary of the findings for each test item is presented in Table 1.

Table 1. Summary of findings on learning obstacles by question

Question	Point	Types of Learning Obstacles	Error Pattern	Interview Confirmation
1	a)	Epistemological and Didactical	Does not define variables and does not label equations.	ST5 & ST6: Understand the importance of setting up an example but are in the habit of not doing so; ST6 only mentions people's names, not quantities.
	b)	Ontogenical	Incorrect substitution: only one variable is being substituted.	—
2	a)	Epistemological and Didactical	Does not define variables and does not label equations.	ST6: Simply defines $a = \text{Alya}$ and $b = \text{Bima}$ without understanding the meaning of the variables.
	b)	Epistemological	Only searches for the value of one variable and does not continue searching for the values of the other variables.	ST3: Lack of understanding of the meaning of the SLETV solution; ST4: Time constraints (not learning obstacles).
	c)	Didactical	Provided only a “yes, correct” response without any justification to validate the statement.	ST1 and ST2: Unaccustomed to providing explanations; classroom instruction did not foster reflective reasoning.
3	a)	Epistemological and Didactical	Does not define variables and does not label equations.	ST6: Context-specific understanding that has not yet been generalized.
	b)	Ontogenical	Response was not logical and coherent.	—
	c)	Didactical	Provided only a “yes, correct” response without any justification to validate the statement.	Consistent with the findings in Question 2c; confirmed by ST1 and ST2.

Table 1 shows that epistemological obstacles are the most prevalent and systemic obstacles, appearing in nearly all test items. Didactical obstacles were consistently identified in items requiring mathematical reasoning, while ontogenical obstacles manifested as weaknesses in algebraic operations and the irrelevance of solution procedures.

Question 1

Question 1 was designed to assess students' ability to translate verbal information into a mathematical model and solve it. The analysis results show that most students were able to write equations based on the story context, but they did not define the variables or label the equations. Interviews with ST5 and ST6 confirmed that this difficulty stemmed from learning habits in junior high school that did not emphasize proper problem-solving procedures.

ST5 stated:

"It is hard yet easy because finding the equation is the hard part, but once you know the equation, it is easy. The improvement is to be more careful in finding the equation, and to provide an explanation of the equation and the variables."

This statement indicates ST5's metacognitive awareness of the importance of writing out variable substitutions, even though the habit of not doing so persists from previous learning experiences. This is a characteristic feature of didactical obstacles, that is obstacles stemming from the learning process itself, rather than from students' conceptual inability (Brousseau, 2002).

Meanwhile, the interview with ST6 revealed the accompanying epistemological dimension. Regarding the limitations of the learning experience context, ST6 stated:

"For question number 1, because the context has never been studied, it usually only relates to the prices of goods."

This statement confirms the characteristic of epistemological obstacles in the form of context-bound understanding, as proposed by Puspita and Fitriani (2023). When defining the variables, ST6 was only able to refer to them as people's names ($a = \text{Alya}$, $b = \text{Bima}$) without understanding that the variables represent mathematical quantities, indicating that the understanding of variables is still nominal rather than relational. Thus, this pattern is categorized as a combination of didactical and epistemological obstacles.

In addition, errors were found in the substitution stage, along with an inability to fully determine the values of both variables. This pattern reflects ontogenical obstacles, specifically cognitive unpreparedness in algebraic operations as a prerequisite for SLETV. Mastery of algebraic operations has been shown to significantly influence the ability to solve SLETV problems (Antari et al., 2024), so weaknesses in this aspect directly hinder the smooth completion of the problems.

Question 2

Question 2 was designed to be more complex, requiring students to identify variable coefficients, solve systems of equations, and verify statements mathematically. Patterns of obstacles were identified in three parts. In part (a), epistemological and didactical obstacles reappeared consistently, as confirmed by Student 6, who defined variables merely as labels without understanding the meaning of their quantities. The consistent emergence of this pattern across the three distinct question items confirms that these obstacles are systemic, not incidental, and reflect a deficit in understanding that has not been addressed through previous learning processes.

In part (b), interviews with ST3 and ST4 yielded substantially different categorizations. S4 stated:

"Yeah, it should have been solved. Time was tight, so I did not do it."

This statement indicates that the incompleteness of ST4's answer stems from external factors, thus failing to meet the criteria for learning obstacles within Brousseau's (2002) framework. Conversely, ST3 stated:

"I do not know, I forgot... honestly, I do not really understand SLETV that well, Mrs. So I am confused about how to calculate it."

Unlike ST4, ST3's response indicates a substantive epistemological obstacles: the concept of an SLETV solution as a pair of values (x, y) has not yet been formed, so the student cannot complete the solution procedure. This aligns with findings that students' difficulties lie not only in modeling but also in fully completing the algorithm (Indah & Hidayati, 2021).

In point (c), most students simply answered "yes, correct" without providing an argument. Interviews with ST1 and ST2 confirmed a strong didactical obstacles. ST1 admitted to working on the problem while discussing with a friend, so they could not explain it independently, while ST2 explicitly stated:

"We need to get used to answering questions that require an explanation."

ST2's statement confirms that this obstacles stems from learning habits that do not explicitly train reflective reasoning. This finding aligns with research showing that didactical obstacles arise from learning that does not build mathematical argumentation skills (Sadiah et al., 2024).

Question 3

Question 3 is the question with the highest cognitive demands and is open-ended. The pattern of not defining the variable in part (a) appears for the third consecutive time across all questions, confirming the dominance of epistemological obstacles. Interviews with S6 revealed that in Question 3a, students were already more accurate in defining the variable as the product sum; however, this understanding is context-specific and has not yet been generalized. This finding is a characteristic feature of epistemological obstacles, involving understanding limited to a specific context and failing to transfer to different situations (Puspita & Fitriani, 2023).

In point (c), the pattern of answering without argumentation reappeared and was confirmed as a consistent didactical obstacles. ST1 could not even provide any response because the answer was the result of a discussion with a friend, not independent thinking. Additionally, a pattern of incoherent responses was found among some students, reflecting an ontogenical obstacles in the form of cognitive unpreparedness to construct systematic reasoning, as stated by ST3:

"I do not understand the context because I already do not understand the material."

Conclusions on Learning Obstacles

Based on the results of test analysis and interview confirmation, all three types of learning obstacles were found to coexist, each with distinct characteristics. Epistemological obstacles were the most dominant: they appeared across all questions in the form of partial understanding of the meaning of variables, incomplete solutions, and understanding limited to specific contexts. Didactical obstacles were strongly identified in the inability to provide mathematical arguments stemming from learning patterns that do not train reflective reasoning. Ontogenical obstacles were evident in algebraic operation errors and the inability to organize answers systematically.

Triangulation between test data and interviews revealed that not all error patterns identified from answer sheets can be classified as learning obstacles in Brousseau's (2002) sense. In ST4, the incompleteness of the solution to question 2b was caused by an external factor (time), not a conceptual obstacle. This underscores the importance of data triangulation in research on learning obstacles to ensure that the resulting categorization is more accurate and scientifically justifiable. These three identified types of obstacles subsequently serve as the foundation for designing a hypothetical, context-based instructional design that explicitly addresses each obstacle.

Hypothetical Didactical Design: Based on Contextual

Based on the findings regarding learning obstacles presented above, the next step within the DDR framework is to develop a hypothetical didactical design in response to these obstacles. The hypothetical didactical design in this study takes the form of Student Worksheets based on contextual problems, systematically designed to address epistemological, didactical, and ontogenical obstacles simultaneously. This design aligns with the DDR principle that learning interventions must stem from the identification of concrete learning obstacles, not from general assumptions about students' difficulties (Suryadi, 2019).

The selection of contextual problems as the design foundation is based on the principle that an effective context is not merely decorative but must be capable of eliciting authentic mathematization processes and supporting the formation of meaningful understanding (Pratamawati, 2020). The selected context is a point system in an online game, a situation relevant to the daily lives of junior high school students and one that has the potential to increase cognitive engagement compared to conventional contexts. This choice of context also addresses findings from interviews, in which ST6 reported difficulties stemming from unfamiliarity with the context of the problems presented.

This hypothetical didactical design comprises six learning stages, each designed to address specific learning obstacles, supplemented by PDA as a prediction of student responses in each situation. The six stages are: (1) identifying unknowns, (2) setting up variables, (3) formulating a system of equations, (4) solving the system of linear equations with variables, (5) verifying the solution, and (6) interpreting the solution within the problem context, concluding with a learning reflection.

In the first stage, the learning situation begins with a trigger question that encourages students to identify two unknowns in the problem narrative. This initial identification stage is shown in Figure 1, which displays the design of Step 1 of the worksheet, where students are required to describe the unknown quantities using complete sentences, rather than simply writing abstract mathematical symbols. This stage specifically addresses an epistemological obstacle: students' tendency to perceive variables as names or labels rather than as mathematical quantities. By asking students to write in their own words, this design fosters meaning-making before formalization. The PDA at this stage predicts that some students will write the character's name as the unknown quantity; therefore, a prompt question is prepared to direct students' attention to something derived from the play activity, rather than the player's identity.

LANGKAH 1: Mengenali apa yang belum dikenali

Pemantik: Dalam cerita di atas, terdapat dua besaran yang nilainya belum diketahui tetapi perlu dicari. Baca ulang cerita dengan saksama dan identifikasi dua besaran tersebut. Tuliskan dalam kalimat lengkap, bukan sekadar simbol.

1. Besaran pertama yang belum diketahui?

Tuliskan dalam kalimat lengkap, contoh: 'banyaknya poin yang diperoleh dari setiap ...'

2. Besaran kedua yang belum diketahui:

Tuliskan dalam kalimat lengkap

Figure 1. Step 1 of The Worksheet

The second stage focuses on the formulation of variables to strengthen students' cognitive transition from verbal descriptions to symbolic modeling. A visual representation of the complete instructions for writing variable examples is shown in Figure 2, which includes Step 2 of the worksheet along with columns of correct and incomplete examples to assess students' independent understanding. This stage addresses two obstacles simultaneously: an epistemological obstacle namely, a nominal understanding of variables, and a didactical obstacle namely, the habit of not writing out variable assignments because previous instruction did not require it. This layered scaffolding structure is reinforced by concrete examples in the introductory text: "x = points earned from each daily mission" versus "x = mission," so that students have a quality reference without being told directly. The PDA predicts that some students will proceed with still-incomplete variable definitions; in this situation, guiding questions can ask students to compare their definitions with the available examples.

LANGKAH 2: Membuat permisalan variabel.

<p>Pemantik: Dalam matematika, variabel adalah simbol yang mewakili suatu besaran. Permisalan yang baik harus menyebutkan: (1) apa yang diwakili variabel, dan (2) satuannya. Contoh yang lengkap: $x = \text{banyaknya poin yang diperoleh dari setiap satu misi harian (poin)}$. Contoh yang kurang lengkap: $x = \text{misi}$.</p>

<p>Misalkan:</p> <p>$x =$ _____</p> <p>$y =$ _____</p>

Figure 2. Step 2 of The Worksheet

In the third stage, the formulation process continues with the development of a formal mathematical model. This mathematical translation process is illustrated in Figure 3, which shows Step 3 of the worksheet where students are guided to formulate two separate linear equations based on two characters in the problem context, namely Dimas and Rafi. This separation is not merely procedural scaffolding; conceptually, it reinforces that each equation represents a distinct real-world situation, not an abstract formula. This stage addresses the epistemological obstacles of failing to transform verbal information into a mathematical model, while simultaneously reinforcing the habit of labeling equations as a practice for reinforcement that has been underdeveloped in learning (didactical obstacles).

LANGKAH 3: Menyusun sistem persamaan.

Pemantik (Persamaan 1): Perhatikan informasi tentang Dimas: ia menyelesaikan 3 misi harian dan memenangkan 2 pertandingan, dengan total 340 poin. Jika misi harian = x poin dan pertandingan = y poin, bagaimana cara menuliskan total poin Dimas dalam bentuk persamaan?

Persamaan 1 (data Dimas) :

Pemantik (Persamaan 2): Lakukan hal yang sama untuk Rafi: ia menyelesaikan 1 misi harian dan memenangkan 4 pertandingan, total 380 poin. Gunakan variabel x dan y yang sama!

Persamaan 2 (data Rafi) :

Figure 3. Step 3 of The Worksheet

The fourth stage constitutes both the procedural core and the primary area where ontogenical obstacles arise. The numbering and selection of the flowchart for these mechanical solution methods are shown in Figure 4, which illustrates Step 4 of the worksheet, providing a structured workspace for the elimination, substitution, or combined methods, complete with a column for justifying the choice of method. This design allows for method flexibility (elimination, substitution, or a combination), while requiring students to explicitly write down the rationale for their method choice and all solution steps. The structured workspace functions as procedural scaffolding that prevents students from skipping steps. The PDA at this stage identifies three response predictions: (a) students solve one variable and then stop, (b) students make algebraic operation errors during the elimination stage, and (c) students choose the correct method but lose the sequence of steps. Each prediction is accompanied by guiding questions that teachers can use responsively during the learning process.

LANGKAH 4: Mencari nilai variabel

Pemantik: Tugasmu adalah mencari nilai x dan y yang memenuhi KEDUA persamaan sekaligus. Pilih salah satu metode di bawah ini, kemudian tuliskan seluruh langkah penyelesaian secara runtut — jangan hanya menuliskan hasil akhir.

Eliminasi	Substitusi	Gabungan (Eliminasi + Substitusi)
Samakan koefisien salah satu variabel, kemudian kurangkan atau jumlahkan kedua persamaan untuk menghilangkan variabel tersebut.	Nyatakan salah satu variabel dalam variabel lain dari satu persamaan, kemudian substitusikan ke persamaan yang lain.	Gunakan eliminasi untuk mencari nilai satu variabel, kemudian substitusikan hasilnya untuk mencari variabel lainnya.

Metode yang aku pilih: _____

Alasan memilih metode tersebut:

Langkah-langkah penyelesaian:

Figure 4. Step 4 of The Worksheet

The fifth stage is a validation phase designed to explicitly foster the habit of reflective thinking. The component of the worksheet that requires students to verify the values of the variables is shown in Figure 5, which displays Step 5 of the worksheet, which requires students to substitute the obtained values back into both equations simultaneously. This stage directly addresses the most prominent didactical obstacle: the habit of answering without justification. The reflective question “Why is it necessary to verify both equations, not just one?” demands explicit mathematical reasoning, a skill that needs to be practiced repeatedly in the learning process (Sadiah et al., 2024). PDA predicts that some students will assume verification is sufficient for just one equation; guiding questions are prepared to remind them that the solution to the SLETV must satisfy both equations simultaneously.

LANGKAH 5: Memeriksa kebenaran soal.

<p>Pemantik: Apakah kamu yakin nilai x dan y yang kamu temukan sudah benar? Cara terbaik untuk memastikannya adalah dengan mensubstitusikan kembali nilai x dan y ke dalam KEDUA persamaan. Jika kedua persamaan terpenuhi (ruas kiri = ruas kanan), solusimu benar!</p>
<p>Substitusi ke Persamaan 1:</p> <p>Masukkan nilai $x = \underline{\quad}$ dan $y = \underline{\quad}$ ke Persamaan 1: $3(\underline{\quad}) + 2(\underline{\quad}) = \underline{\quad} \rightarrow$ apakah hasilnya = 340?</p> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div>
<p>Substitusi ke Persamaan 2:</p> <p>Masukkan nilai $x = \underline{\quad}$ dan $y = \underline{\quad}$ ke Persamaan 2: $1(\underline{\quad}) + 4(\underline{\quad}) = \underline{\quad} \rightarrow$ apakah hasilnya = 380?</p> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div>

Figure 5. Step 5 of The Worksheet

The sixth stage involves institutionalization, in which students are asked to reconnect the mathematical concepts they have learned with the original contextual situation. This final process of interpretation and testing of logical reasoning is illustrated in Figure 6, which presents Step 6 of the worksheet in the form of contextual interpretation of the solution and further problem-solving based on questions posed by the character Kirana. This stage addresses an epistemological obstacle, the inability to interpret solutions within the context of the original problem, which is a gap often overlooked when learning focuses solely on solution procedures. The argumentative statement inserted as a final challenge requires students to validate or refute the claim based on calculation results, not merely intuition, thereby simultaneously serving to reinforce mathematical reasoning.

LANGKAH 6: Menginterpretasikan Solusi.

<p>Pemantik: Kamu sudah menemukan nilai x dan y. Ingat — x dan y mewakili sesuatu dalam konteks cerita. Sebelum menjawab pertanyaan Kirana, hubungkan kembali nilai matematismu ke dalam situasi nyata.</p>
<p>Berdasarkan nilai x dan y yang ditemukan:</p> <p>Setiap misi harian memberikan _____ poin, dan setiap pertandingan memberikan _____ poin.</p>
<p>Pertanyaan Kirana: Jika Kirana menyelesaikan 2 misi harian dan memenangkan 3 pertandingan, berapa total poin yang akan ia dapatkan? Tunjukkan perhitungannya.</p> <p><i>Tunjukkan perhitungannya secara lengkap</i></p> <div style="border: 1px solid black; height: 60px; margin-top: 5px;"></div>

Figure 6. Step 6 of The Worksheet

The six stages outlined above form a coherent and hierarchical design framework, in which each stage does not stand alone but rather reinforces the others in building a comprehensive understanding of SLETV. Each design element is explicitly tailored to the identified characteristics of learning obstacles, ranging from context selection, the structure of prompt questions, variable scaffolding, to validation and institutionalization scenarios. Epistemological obstacles are addressed through situations that gradually construct the meaning of variables and encourage cross-context transfer; didactical obstacles are addressed through the institutionalization of reflective reasoning procedures as a mandatory part of every solution; while ontogenical obstacles are overcome through procedural scaffolding that prevents skipping steps. Table 2 briefly presents the relationship between each type of learning obstacle, its manifestations, and the corresponding hypothetical didactical design responses developed.

Table 2. Relationship Between Learning Obstacles and Hypothetical Didactical Design Responses

Type of Learning Obstacles	Manifestation of the obstacle	Worksheet Stages Addressing the Obstacle	Didactical and Pedagogical Anticipation (PDA)
Epistemological	Variables were interpreted as names or labels rather than mathematical quantities; understanding remained context-specific; SLETV solutions were understood only partially.	Step 1 (identifying the unknown quantities), Step 2 (defining variables), and Step 6 (interpreting the solution).	Reflective prompts encourage students to explain the meaning of variables in their own words; explicit questions distinguish between labels and mathematical quantities; solution interpretation is required before answering Kirana's question.
Didactical	Not accustomed to writing variable definitions and equation labels; provided answers without justification; prior instruction was overly procedural.	Step 2 (verification of variable definitions), Step 3 (construction of labeled equations), and Step 5 (substitution and verification in both equations).	The "Cek Pemahamanmu" section requires students to correct variable definitions; each step elicits reasoning rather than answers alone; verification reflections require justification for checking both equations.
Ontogenical	Errors in algebraic operations; incoherent solution procedures; difficulty completing the solution process.	Step 4 (solving the SLETV with scaffolding for method selection).	Students are required to choose a solution method and explicitly record all steps; a structured workspace minimizes procedural jumps; the PDA anticipates substitution errors and includes guiding questions.

The final section of the worksheet includes a learning reflection component that asks students to identify the most challenging parts, articulate their new understanding of the concept of variables, and simulate how they would explain the concept to a classmate who is struggling. This reflection component is not merely a procedural formality but an integral part of the design aimed at developing students' metacognitive awareness of their own thinking processes a dimension often overlooked in procedurally oriented SLETV learning (Sadiah et al., 2024).

As a methodological note, the resulting didactical design is hypothetical and remains at the prospective analysis stage within the DDR framework; thus, empirical validation of its effectiveness requires the implementation of metapedagogical analysis and retrospective analysis in subsequent research.

The hypothetical didactical design developed in this study constitutes a structured, evidence-based response to the learning obstacles identified in students' problem-solving of SLETV questions. Every design element from context selection, the structure of trigger questions, variable scaffolding, to the validation and institutionalization scenarios is explicitly grounded in findings regarding epistemological, didactical, and ontogenical obstacles. This makes this didactical design not merely new instructional material, but a pedagogical response that comprehensively accounts for the characteristics of students' learning obstacles, as mandated by the Didactical Design Research approach (Suryadi, 2019).

4. CONCLUSION

This study yielded two interrelated main findings. First, an analysis of the answer sheets of 34 tenth-grade students, confirmed through semi-structured interviews, identified three types of learning obstacles in the SLETV material according to Brousseau's (2002) framework. Epistemological obstacles were the most dominant and systemic, manifesting in three forms: understanding variables as nominal rather than relational, incomplete solutions due to the lack of a formed concept of value pairs (x, y) , and understanding limited to specific contexts, thus failing to transfer to different situations. Didactical obstacles were consistently identified in students' inability to provide mathematical arguments, stemming from learning patterns that do not explicitly train reflective reasoning. Ontogenical obstacles were evident in errors in algebraic operations and the inability to systematically organize solution steps.

Second, based on the three types of obstacles identified, a hypothetical instructional design was developed in the form of a contextual problem-based worksheet using the point system in online games as a context. This design includes six learning stages that explicitly address each obstacle: action situations to construct the meaning of variables, the formulation of required and reflected assumptions, the formation of labeled mathematical models, solving linear equations with method selection scaffolding, verification of solutions accompanied by mathematical arguments, and institutionalization through the interpretation of solutions within the context of the original problem. Each stage is equipped with an PDA as a prediction of student responses, allowing teachers to respond adaptively during the learning process.

The findings of data triangulation underscore the importance of interview confirmation in research on learning obstacles, given that not all error patterns on answer sheets constitute learning obstacles as defined by Brousseau (2002). This reinforces the validity of the resulting categorization of obstacles and establishes this hypothetical didactical design as an empirically grounded pedagogical response.

Based on the findings and limitations of this study, several suggestions are put forward for further development. First, future research should conduct a metadidactical and retrospective analysis within the DDR framework to validate the effectiveness of the hypothetical didactical design through actual classroom implementation. Second, the effectiveness of the online game context as a foundation for contextual problems needs to be empirically tested and compared with conventional contexts. Third, similar studies can be expanded to advanced algebra topics such as linear programming or SPLTV with a more diverse range of subjects. Fourth,

professional development research for teachers based on findings regarding learning obstacles needs to be conducted so that teachers have an adequate understanding of the characteristics of students' learning obstacles before implementing the developed designs.

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