Journal of Mathematics in Teaching and Learning
Volume 3, No. 2, June 2025, pp. 275-288
P-ISSN: E-ISSN:
DOI: https://doi.org/10.56874/jmtl.2025.v3.i2/2628/5

An Analysis of Mathematics Learning Difficulties among High-Ability Students in Solving Systems of Linear Equations in Two Variables (SLETV)

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Abstract

This study aims to analyze the learning difficulties experienced by high-achieving students in solving problems on the topic of Linear Equations in Two Variables. The research employed a descriptive qualitative approach with one eighth-grade student from SMP Negeri 4 Tasikmalaya as the subject, selected through purposive sampling based on teacher recommendations and daily test scores. Data were collected through a problem-solving test based on NCTM indicators and unstructured interviews, then analyzed using the Miles and Huberman model. The findings revealed that the high-achieving student was able to complete all stages of problem solving (understanding the problem, formulating strategies, applying strategies, and interpreting results). However, difficulties were identified in arithmetic accuracy, limitations in mathematical language, and external factors such as insufficient repetition of material and lack of pedagogical support. The study concludes that learning difficulties may still occur among high-achieving students, thus teachers should provide interventions that strengthen mathematical communication, repeated practice, and reflective learning. Future research is recommended to involve more high-achieving students to obtain a more comprehensive understanding of their learning difficulties.

Keywords: learning difficulties, mathematical problem solving, high-achieving students, linear equations in two variables

Abstrak

Penelitian ini bertujuan untuk menganalisis kesulitan belajar matematika siswa berkemampuan tinggi dalam menyelesaikan masalah pada materi Sistem Persamaan Linier Dua Variabel (SPLDV). Metode penelitian menggunakan pendekatan kualitatif deskriptif dengan subjek satu siswa kelas VIII SMP Negeri 4 Tasikmalaya yang dipilih melalui teknik purposive sampling berdasarkan hasil penilaian guru dan nilai ulangan harian. Data dikumpulkan melalui tes pemecahan masalah berbasis indikator NCTM dan wawancara tidak terstruktur, kemudian dianalisis dengan model Miles dan Huberman. Hasil penelitian menunjukkan bahwa siswa berkemampuan tinggi mampu menyelesaikan seluruh tahapan pemecahan masalah (memahami masalah, menyusun strategi, menerapkan strategi, dan menginterpretasikan hasil). Namun, ditemukan kesulitan pada aspek ketelitian operasi aritmetika, keterbatasan bahasa matematis, serta faktor eksternal berupa kurangnya pengulangan materi dan dukungan pedagogik. Kesimpulan penelitian menegaskan bahwa kesulitan belajar tetap dapat dialami oleh siswa berkemampuan tinggi, sehingga guru perlu memberikan intervensi yang mendorong komunikasi matematis, latihan berulang, dan pembelajaran reflektif. Penelitian selanjutnya disarankan melibatkan lebih banyak subjek berkemampuan tinggi untuk memperoleh gambaran yang lebih komprehensif.

Kata kunci: kesulitan belajar, pemecahan masalah matematis, siswa berkemampuan tinggi, SPLDV

How to Cite: Juliyanti, H. (2025). An Analysis of Mathematics Learning Difficulties among High-Ability Students in Solving Systems of Linear Equations in Two Variables (SLETV). *Journal of Mathematics in Teaching and Learning, 3* (2), 275-288.

INTRODUCTION

Mathematics is one of the subjects often perceived as difficult by the majority of students. This difficulty arises from the abstract nature of mathematics and its demand for higher-order thinking skills (Jupri et al., 2014; Siregar, 2023). Numerous studies have shown that learning difficulties in mathematics contribute to students' low achievement at both national and international levels. For instance, the results of the Programme for International Student Assessment (PISA) consistently place

Received March 27, 2025; Revised April 20, 2025; Accepted June 2, 2025

Indonesia in the lower ranks for mathematical literacy (Guhn et al., 2014; OECD, 2019). Martini (2014) explained that learning difficulties are not always related to students' intelligence levels, but rather to weak learning skills and challenges in carrying out specific tasks required in mathematics. Therefore, examining mathematics learning difficulties remains a relevant and important area of study.

One of the core competencies in mathematics learning is problem-solving ability (Polya, 1973; Weintrop et al., 2016). National Council of Teachers of Mathematics (NCTM, 1989) emphasized that problem solving is the heart of mathematics learning, which involves identifying problems, formulating models, solving them, and interpreting the results. Furthermore, Kilpatrick et al. (2001) argued that problem solving forms the foundation for developing students' conceptual understanding, reasoning, and strategic competence. In Indonesia, the national curriculum also highlights the importance of this competence (Kebudayaan, 2012; Nasional, 2006). Without problem-solving skills, students will struggle to connect mathematics with real-life contexts as well as with other disciplines (Baba, 2023; Hussin et al., 2019). Thus, problem solving serves not only as a learning goal but also as a means to foster critical thinking skills.

The topic of Systems of Linear Equations in Two Variables (SLETV) is one of the essential subjects at the junior high school level, closely related to students' problem-solving abilities. SLETV serves as a foundation for learning more advanced algebraic concepts such as functions, quadratic equations, and higher-order systems of equations (As'ari et al., 2017; Novianti et al., 2020). However, various studies have shown that students often face difficulties in solving SLETV problems, particularly word problems. Stacey & MacGregor (1999) found that students frequently fail to transform everyday language into mathematical models. Similarly, studies by Maryani & Setiawan (2021), Epriyanti (2016), and Slawantya (2024) evealed that students' errors in SLETV are mainly related to model formulation and calculation. This reinforces the idea that SLETV is both a crucial and challenging topic for students.

Mathematics learning difficulties can be classified into several forms. Martini (2014) membagi categorized these difficulties into four types: weaknesses in computation, challenges in transferring knowledge, lack of understanding of mathematical language, and difficulties in visual perception. Sari & Subekti (2023) further added that the causes of these difficulties may stem from general factors such as intellectual, pedagogical, and environmental aspects, as well as specific factors such as insufficient arithmetic skills and challenges in solving word problems. Understanding these variations in learning difficulties allows teachers to design more effective instructional strategies (Swastika et al., 2023). However, in practice, many difficulties remain unidentified, particularly at specific levels of students' abilities.

The study of mathematics learning difficulties also needs to take into account the differences in students' academic ability levels. Krulik & Rudnick (1988) emphasized that students' problem-solving strategies are influenced by their cognitive abilities. Students with high, medium, and low abilities often demonstrate different approaches to solving problems (Pesona & Yunianta, 2018; Yarmayani, 2016).

Polya (1973) further explained that although the steps of problem-solving are generally universal, the implementation of these steps largely depends on students' cognitive capacity. Therefore, analyzing learning difficulties based on students' ability levels is crucial to provide a more detailed understanding.

Focusing on high-achieving students becomes an interesting area of study. High-achieving students are often assumed to understand the material well and, therefore, are rarely the subject of research concerning learning difficulties (Purnamasari & Setiawan, 2019). However, studies by Ulya (2016) and Rosyidah et al. (2021) showed that even high-achieving students still encounter obstacles, particularly in constructing mathematical models and maintaining accuracy in calculations. Stacey & MacGregor (1999) also found that students with higher ability levels may still make errors in interpreting mathematical language. This indicates that learning difficulties are not exclusively experienced by students with low or moderate levels of ability.

In classroom learning practices, teachers often give special attention only to students who experience severe difficulties or have low abilities (Callejo & Zapatera, 2017; Zuhri, 2013). Meanwhile, high-ability students are considered "safe" and therefore rarely receive specific interventions. According to Schoenfeld (2016), the assumption that high-ability students always succeed can lead to problems because it overlooks the hidden difficulties they may encounter. This has implications for the lack of learning strategies that support the development of higher-order thinking skills in this group. Therefore, it is important to examine in more detail the difficulties experienced by high-ability students in problem solving.

Furthermore, the researcher conducted a preliminary observation in the form of an interview with a mathematics teacher at SMP Negeri 4 Tasikmalaya. The results of the observation showed that high-ability students still made mistakes when working on mathematics problems and daily tests. They tended to be less thorough, misinterpreted information, and became trapped in incomplete computational procedures. These findings confirm that high-ability students still face obstacles that need to be identified and analyzed further.

Nevertheless, studies specifically examining the learning difficulties of high-ability students are still rarely conducted. Most previous research has focused more on low- or medium-ability students, as they are considered to require greater attention and scaffolding (Frederick et al., 2014; Lanya, 2016). This condition creates a research gap in understanding the difficulty profiles of high-ability students. In fact, a comprehensive understanding of this group's difficulties is essential to ensure that learning strategies can be fully experienced by all students. Therefore, this study aims to analyze the mathematics learning difficulties of high-ability students in solving problems of Systems of Linear Equations in Two Variables (SLETV).

METHODS

This study employed a qualitative approach with a descriptive study design. The focus of the research was directed at understanding the learning difficulties of high-ability students in solving

Journal of Mathematics in Teaching and Learning
Volume 3, No. 2, June 2025, page. 275-288

mathematical problems on the topic of Systems of Linear Equations in Two Variables (SLETV). The researcher served as the primary instrument in this study. The research subjects were eighth-grade students of SMP Negeri 4 Tasikmalaya who had studied the SLETV material in the odd semester. The selection of research subjects was carried out using purposive sampling, namely selecting subjects based on specific considerations (Sugiyono, 2018). The subjects were focused on students with high mathematical ability as determined by teacher assessments through daily test scores and assignments.

The main instrument consisted of one essay problem designed to measure indicators of mathematical problem-solving ability according to established standards (NCTM, 1989; Polya, 1973). After the students completed the test, the researcher conducted unstructured interviews to explore the sources of students' learning difficulties. Data were collected through written tests and unstructured interviews. The test was used to identify students' problem-solving abilities, including (1) understanding the problem, (2) constructing strategies and mathematical models, (3) applying solution strategies, and (4) interpreting the results. The data obtained were analyzed using the model of Miles et al. (2014), which includes data reduction, data display, and conclusion drawing. The analysis was conducted continuously from the data collection process through to the final stage of the research..

RESULTS AND DISCUSSION

General Description of High-Ability Student Subjects

The subjects of this study were eighth-grade students of SMP Negeri 4 Tasikmalaya who were categorized as high-ability students. The determination of the subjects was based on the average scores of daily tests, assignments, and recommendations from the mathematics teacher. The teacher's recommendation was obtained through an interview conducted by the researcher with the mathematics teacher. Figure 1 presents an excerpt of the interview between the researcher (R) and the mathematics teacher (T) of the eighth grade at SMP Negeri 4 Tasikmalaya.

R:	What is the minimum passing grade for the mathematics subject?
T:	For grades VII, VIII, and IX, it is 75.
R:	How are the students' learning outcomes in mathematics when viewed from their exercises and daily tests?
T:	For the smart students (high-ability), they usually often do the exercises and tend to be capable. But it is different with students who do not like mathematics; they need more guidance from the teacher.
R:	Alright, ma'am. Previously, what difficulties do students often face when you teach the SLETV material?
T:	There are many. Usually, students consider things trivial, so they are not careful in answering. Sometimes there are those who find it difficult to understand the basic concepts. There are also those who struggle to translate word problems into mathematical models. Some can find the answer but do not understand the meaning of the results obtained, and so on.

Figure 1. Excerpt of the researcher's interview with the mathematics teacher

Based on the initial interview with the mathematics teacher, high-achieving students are generally able to understand the basic concepts of systems of linear equations in two variables (SLETV) well.

However, the teacher emphasized that small mistakes still occur, especially in word problems. These mistakes usually appear in calculation accuracy and in clearly interpreting the results. The teacher revealed that although the students he teaches sometimes tend to rush in solving problems, this condition reflects the general picture that high ability is not always identical with being free from learning difficulties.

This finding is in line with Stacey & MacGregor (1999), who revealed that high-achieving students may oversimplify when solving mathematical problems. Research by Arifin et al. (2016) and Purnamasari & Setiawan (2019) also emphasized that high-achieving students still have the potential to make mistakes, especially if they do not evaluate their work. Schoenfeld (2016) explained that teachers who assume high-achieving students always succeed may create a "blind spot," an undetected difficulty.

Identifying the known and asked elements stage

At the stage of identifying the known and asked elements, the high-ability subject (S1) demonstrated good ability. In the answer sheet shown in Figure 2, S1 wrote down what was known and what was asked, and used his own mathematical symbols and sentences. S1 represented the ages of the characters in the problem as variables, then transformed the main information from the text into appropriate mathematical statements. S1 symbolized the elements of the word problem into mathematical symbols. S1 grasped the overall context of the story and was able to connect the pieces of information in the problem. Thus, at the stage of identifying the known/asked elements, S1 demonstrated proficiency in reading the problem and analyzing the information comprehensively.

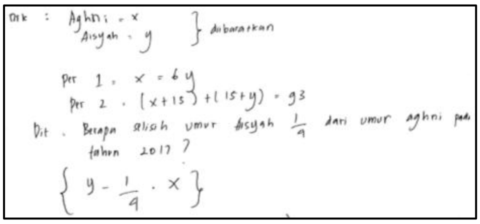

Figure 2. S1's work at the stage of identifying the known and asked elements

The results of S1's work in Figure 2 are reinforced by excerpts from the researcher's interview with S1 as shown in Figure 3.

R:	According to you, what are the known and asked elements in this problem?
S1:	In this problem, I represented Aghni's age as x and Aisyah's age as y.
R:	Okay, then?
S1:	Then I directly wrote equation 1, which is $x = 6y$, and equation 2, which is $(x + 15) + (15 + y) = 93$.
R:	What about the problem being asked?
S1:	The question, ma'am, is how much Aisyah's age differs from ¼ of Aghni's age in 2017? I also directly wrote down the formula.

Figure 3. Excerpt from S1's interview at the stage of identifying the known and asked elements

The alignment between the test results in Figure 2 and the interview excerpt in Figure 3 shows that S1 mastered two crucial aspects of the problem-solving stage, namely understanding the information in the problem in terms of what is known and what is asked. The use of variable representation indicates that S1 was able to translate the word problem into symbolic representation. Marking two different equations also shows that S1 understood the various pieces of information in the word problem, rather than merely copying numbers. Although S1 admitted to experiencing slight confusion, this did not interfere with the clarity of identifying what was known and asked. Thus, in the "understanding the problem" phase, S1 was able to meet the targeted indicators.

This result is consistent with the study of Stacey & MacGregor (1999) who found that high-ability students often skip explicit steps in understanding problems because they feel confident in their comprehension. This is also supported by the findings of Ulya (2016), which stated that high-ability students in Indonesia tend to be concise in writing down information but are still able to proceed to the strategy implementation stage. Nevertheless, the habit of not writing all the information may cause students to miss important details when faced with more complex problems.

Furthermore, Schoenfeld (2016) emphasized that the ability to identify the given and the asked elements is a foundation in problem solving. If this stage is carried out incompletely, it may affect the accuracy of the subsequent steps (Polya, 1973). In line with this, Prismana et al. (2018) asserted that the ability to identify the given and the asked elements is essential in problem solving. The study by Cai & Lester (2010) also showed that students with high mathematical ability still have the potential to experience difficulties in expressing their understanding in written form. Thus, even though high-ability students are able to correctly identify the problem, teachers still need to guide them to develop the habit of systematically writing down information in order to remain thorough.

Stage of Formulating the Problem

Based on the test results, S1 was able to construct a mathematical model from the information obtained in the identification stage. In Figure 4, S1 wrote two equations, namely $x = 6y$, which represents Aghni's age being six times Aisyah's age, and $(x + 15) + (y + 15) = 93$, which represents the sum of their ages 15 years later. The writing of these two equations demonstrates that S1 can accurately translate verbal information into mathematical symbols. This serves as evidence that the student is able to bridge the problem context into a formal mathematical representation.

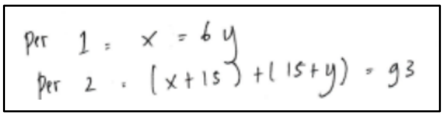

Figure 4. S1's work at the stage of formulating the problem elements

The results of S1's work in Figure 4 are supported by interview data. An excerpt from the researcher's interview with S1 is presented in Figure 5.

R:	Okay, you wrote this next, what does it mean?
S1:	Ummm, how should I say… So I wrote equation 1, $x = 6y$, because Aghni's age is six times Aisyah's age.
R:	Okay, and this one?
S1:	Then I wrote equation 2, $(x + 15) + (15 + y) = 93$. I think this one fits correctly.

Figure 5. Excerpt from S1's interview at the stage of formulating the problem

The results of this interview indicate that S1 was able to explain the reasoning behind the mathematical model created. This confirms that the student's conceptual understanding in connecting the information in the problem to mathematical forms is sufficiently strong. However, it is also evident that S1 needed some time to orally explain the reasoning behind the model. This demonstrates a limitation in verbal mathematical communication fluency. Nevertheless, S1's work remains consistent with the information provided in the problem. Thus, the stage of developing a plan and strategy was successfully completed by S1 accurately and appropriately.

This finding aligns with Blum & Ferri (2009), who emphasized that the ability to construct mathematical models is a key aspect of problem solving because it bridges the real world and the symbolic world. Stacey & MacGregor (1999) stated that high-ability students are generally able to quickly convert information from word problems into equations, even if they hesitate when explaining the process orally. Furthermore, Lewis (2021) found that students' modeling abilities still vary, highlighting the need for teachers to provide intensive practice in linking verbal information to symbolic representations.

Moreover, Schoenfeld (2016) emphasized that formulating problem-solving strategies must include the ability to select appropriate mathematical representations. If the representation is incomplete, subsequent solution steps will be disrupted. Therefore, this study underlines the importance of good mathematical communication for high-ability students so that they are able to write equations and simultaneously explain them accurately and in detail.

Stage of applying the problem-solving strategy

Based on the test results in Figure 6, S1 applied a problem-solving strategy using the substitution method. The first step taken was substituting the equation $x = 6y$ into the second equation $(x + 15) + (y + 15) = 93$. As a result, S1 successfully obtained the value $y = 9$. Next, this value was substituted back into the first equation, yielding $x = 54$. The calculations carried out by S1 demonstrate consistency and accuracy in implementing the chosen problem-solving strategy.

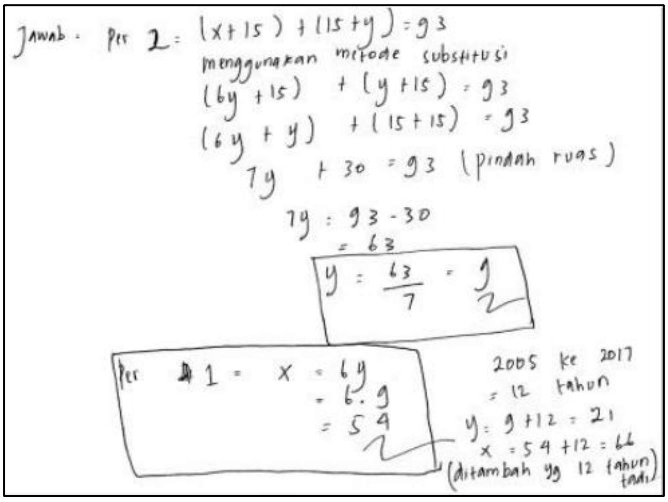

Figure 6. S1's work at the stage of applying the problem-solving strategy

Journal of Mathematics in Teaching and Learning
Volume 3, No. 2, June 2025, page. 275-288

S1's work in Figure 6 is supported by the interview results. The excerpt of the researcher's interview with S1 is shown in Figure 7.

R:	How did you solve this problem?
S1:	So, ma'am, I used the substitution method with the equations $x = 6y$ and $(x + 15) + (15 + y) = 93$. That's how I got $y = 9$
R:	Okay, what did you do next?
S1:	Since I already got $y = 9$, I substituted $y = 9$ ke $x = 6y$ to get $x = 54$.
R:	Good, now that you have the values of x and y nya, what's next?
S1:	Umm… Because the question asks about the year 2017, that means from 2005 to 2017 there are 12 years. So I added 12 to the values of x and y.

Figure 7. Excerpt of S1's interview at the stage of applying the problem-solving strategy

From the test and interview results, it can be concluded that S1 was able to carry out the problem-solving plan using the chosen strategy. Although there was a slight hesitation, the overall process demonstrated strong procedural skills. S1 not only followed the procedure but also attempted to connect the results to the problem's context. Further interpretation shows that the substitution strategy chosen by S1 was both efficient and commonly used in solving SLETV problems. However, a limitation appeared in the reflection aspect, as S1 showed some uncertainty in linking the results to the context of the question. This indicates that even though high-ability students can perform accurate calculations, they still need guidance to consistently review their answers within the context of the given problem.

This finding is consistent with Cai & Lester (2010), who showed that high-ability students are capable of selecting efficient strategies, such as substitution or elimination, and executing them accurately. Purnamasari & Setiawan (2019) emphasized that while students may solve SLETV problems with the correct strategies, their mathematical communication skills are often less developed. Furthermore, Bicer et al. (2015) found that high-ability students tend to be stronger in procedural skills but still require practice in connecting their final answers to contextual situations. Therefore, instruction should not only emphasize selecting the correct strategy but also reflection and verification of answers within the context of real-world problems.

Stage of Interpreting Results and Evaluation

Based on the test results shown in Figure 8, S1 was able to connect the calculation results back to the problem. After obtaining the values $x = 66$ and $y = 21$, S1 proceeded to calculate the difference between Aisyah's age and a quarter of Aghni's age. This step demonstrates that S1 did not stop at the calculation stage but was able to link the results to the question being asked.

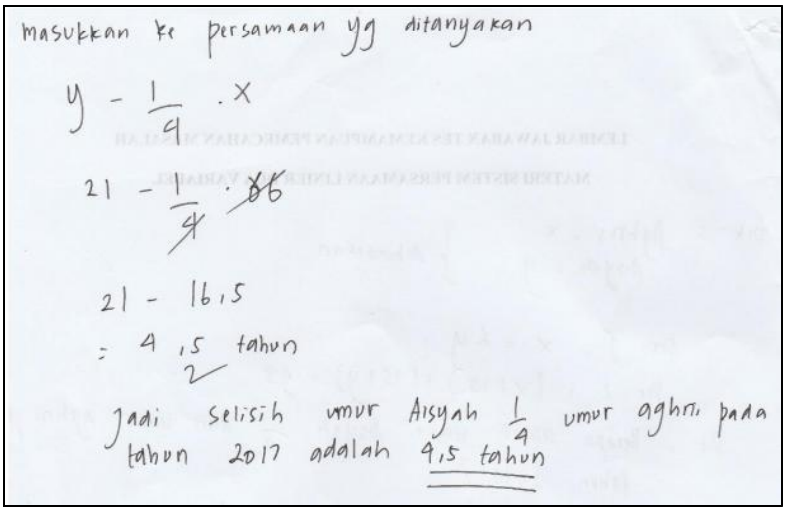

Figure 8. S1’s work at the stage of interpreting results and evaluation

S1’s work in Figure 8 is supported by the interview results. The excerpt of the interview between the researcher and S1 is shown in Figure 9.

R:	After you added 12 to x and y, what did you do?
S1:	Here, ma’am, I substituted them into the equation being asked. Since what’s asked is the difference, I substituted the values $x = 66$ and $y = 21$ into this equation.
R:	What was the result?
S1:	I got 4.5 years as the difference between Aisyah’s age and a quarter of Aghni’s age in 2017.
R:	Are you sure your answer is correct?
S1:	Umm… Yes ma’am, I believe the answer is 4.5 years.

Figure 9. Excerpt of interview with S1 at the stage of interpreting results and evaluation

The interpretation of the test and interview results shows that S1 possesses good evaluative skills. S1 was able to adjust the solution results into the form of the answer required by the problem. This demonstrates that S1 understands verification and interpretation as integral parts of problem solving. Although S1 appeared somewhat hesitant, they were able to provide a correct and contextually appropriate final answer. This process also indicates that high-ability students do not rely solely on procedural skills but also show a tendency to engage in self-evaluation. At the same time, it highlights the need for further reinforcement in mathematical argumentation so that students can be more confident in presenting their answers.

These findings align with Cai & Lester (2010), who assert that the interpretation stage is a crucial aspect of problem solving. Stacey & MacGregor (1999) also point out that although high-ability students can perform calculations well, they often lack confidence in demonstrating the correctness of their answers. Ulya (2016) revealed that high-ability students tend to excel in computation but are less developed in mathematical communication. Furthermore, Suhendra et al. (2016) emphasize the importance of strengthening reflective learning so that students become accustomed to evaluating their work. Thus, mathematics instruction should not only emphasize procedural fluency but also cultivate reflective and evaluative practices.

Overview of Problem-Solving Ability and Difficulties of High-Ability Students

To obtain a comprehensive picture of S1's abilities and learning difficulties, the researcher summarized the findings in the form of a table and additional descriptions. Table 1 presents the stages of problem solving according to NCTM standards that were successfully completed by S1. This is important to systematically show the extent to which high-ability students can meet the indicators of mathematical problem solving.

Table 1. Description of problem-solving stages completed by S1

Subject	Identifying the problem	Formulating strategy and mathematical model	Applying the strategy	Interpreting results
S1	Able to correctly identify the elements, writing them with mathematical symbols and own sentences	Able to formulate the correct mathematical model according to the problem	Able to determine the solution strategy and perform calculations completely and correctly	Able to explain and interpret results according to the problem.

In addition to the test data, interviews were also conducted to explore the difficulties experienced by S1. Figure 10 presents excerpts of the interview that illustrate the kinds of learning difficulties encountered by S1.

R:	Do you think there were any difficulties?
S1:	Not really, but I forgot how to… it was hard to set the variables, and I got a bit confused when making equations 1 and 2, but eventually I managed.
R:	Okay, were there any difficulties from external factors?
S1:	Maybe more on how the teacher explained it, the explanation wasn't focused, so the material didn't stick… also got distracted by other students.
R:	From your side, were there any difficulties or challenges when learning this material?
S1:	Mostly I got sleepy, so some material stuck and some didn't. Also, I was confused when calculating subtractions with decimals.

Figure 10. Excerpt of interview with S1 at the stage of interpreting results and evaluation

From the series of test data, interviews, and summary tables, it can be concluded that S1 was able to complete all stages of mathematical problem solving successfully. However, S1 encountered obstacles related to the understanding of mathematical language and accuracy in arithmetic operations. These difficulties did not significantly affect the final answers but revealed gaps that need to be addressed in mathematics learning. In addition, pedagogical factors also contributed to the learning difficulties. The lack of focus from the teacher in explaining the material and the absence of repetition in learning made high-ability students feel "forgetful" or less confident. This was reinforced by personal factors such as sleepiness and lack of concentration.

These results are consistent with the findings of Liljedahl (2005), who emphasized that high-ability students may face barriers when dealing with problems that require clarity in mathematical symbols. Difficulties in understanding mathematical language indicate a lack of habituation in connecting problem contexts with formal representations (Nugrawati et al., 2018). Furthermore, Polya (1973) also stressed that the success of problem solving is not only determined by algorithmic steps but also influenced by pedagogical support. Meanwhile, the study of Kapur & Rummel (2012) revealed that productive failure may arise in high-ability students when pedagogical support is inadequate. Therefore, the learning difficulties of high-ability students can be addressed through high-quality pedagogical support, repeated problem-solving practice, and the strengthening of students' mathematical communication.

CONCLUSION

Based on the research findings, high-ability students are able to complete the stages of mathematical problem solving on the SLETV material thoroughly. The subject is capable of going through the stages of identifying problem information, formulating a strategy, implementing the strategy, as well as interpreting results and evaluation. The pedagogical limitations experienced by S1 include limited mathematical language, lack of practice, and minimal pedagogical support. Other factors such as insufficient explanations and infrequent material review also hinder the optimal learning experience of high-ability students. Thus, both internal and external factors remain challenges for high-ability students in solving mathematical problems. Future studies are suggested to involve more high-ability students in order to obtain a more comprehensive picture of their learning difficulties.

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