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ORIGINAL RESEARCH PAPER

Describing students' conceptual understanding in a deep learning approach from their learning style

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Abstract
This research aims to describe the students' conceptual understanding of the linear equation system in two variables under the setting of deep learning approach. In this research, we involved 27 Grade IX-A students of a junior high school in Yogyakarta. We categorized them into a diverse of learning styles which include visual, auditory, and kinesthetic. It was a qualitative research using descriptive method. The data collection technique was carried out through a mathematical concept understanding test and a semi-structured interview. The data were then analyzed based on indicators of conceptual understanding ability, then categorized based on the criteria of conceptual understanding level by grouping them based on their learning styles. The results show that the application of the deep learning approach supports the students' conceptual understanding of linear equation system in two variables through activities of preparing assistant point tables, graph representation, and determining cut-off points as solutions. Students with visual learning styles show good ability in graphic representation, auditory students are able to model problems sequentially, while kinesthetic students are able to follow systematic solution procedures. Overall, the deep learning approach helps students understand the concept of linear equation system in two variables more meaningfully based on the characteristics of their respective learning styles.

Keywords: conceptual understanding, deep learning, learning style, linear equation system in two variables

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INTRODUCTION

In the education system, each subject has the goal of developing students' intellectual potential, one of which is through mathematics learning. According to Siregar (2024), mathematics lessons are one of the crucial areas in human daily life because they play a role in providing significant changes to develop science and technology, and the human way of life. This makes mathematics have a crucial role in Indonesian education and is used as a field of study that must be taught at the elementary level until higher education. Nevertheless, mathematics is often rated as one of the most difficult fields of study. This is due to the abstract nature of mathematical concepts that are difficult to find in real life, requiring teachers to connect mathematical concepts with concrete experiences so that students can understand their meaning (Meidianti et al., 2022).

One of the mathematics materials that is very important to understand and has a connection with real world life is the linear equation system in two variables (LESTV) material. According to Batubara et al. (2024), LESTV is a mathematical concept that involves two linear equations with two unknown variables and has direct application in various daily life situations. However, the results of Auliya et al. (2024) research show that LESTV learning in schools is still not effective because most students are used to memorizing formulas and completion steps without understanding the conceptual meaning of each process carried out. This is in line with the findings of Indah and Hidayati (2021) which shows that the level of students' understanding of concepts in LESTV material is in the low group, with an average achievement of only 58%, due to lack of understanding of what is being questioned in the question, difficulties in turning the problem into a mathematical model, the lack of ability to classify the data given in the question, and the difficulty of applying the concept of solving algorithmically and choosing appropriate algebraic operations.

The condition of students' low conceptual understanding in the LESTV material shows the need for innovation in the mathematics learning approach not only to be centered on procedural aspects, but also to develop the ability to think deeply and reflectively. In line with this, Natsir (2025) emphasized that the application of deep learning is in line with the spirit of the Independent Curriculum which focuses on freedom of learning and project-based learning to build students' meaningful understanding. Furthermore, the results of the research of Mutmainah et al. (2025) reveal that the deep learning approach in mathematics learning is able to increase students' active involvement and deepen their conceptual understanding, because it requires students to relate mathematical concepts to real experiences.

A literature review by Rahayu et al. (2025) revealed that the application of deep learning in the context of Indonesian mathematics education is based on three main elements, namely meaningful learning, mindful learning, and joyful Learning, each of which plays a role in building concept connectedness, learning awareness, and student motivation. Deep learning emphasizes a learning process that is oriented towards understanding concepts, reflection, and application in a real context (Dewi et al., 2025). This approach is not only centered on procedural mastery, but also emphasizes how students build meaning from the concepts learned through active engagement and contextual experiences. In this context, the implementation of deep learning in LESTV can activate three main aspects: meaningful learning when students relate the concept of LESTV to real situations, mindful learning when they review the process and solution strategies, and joyful learning when they find meaning and satisfaction in the problem-solving process. Thus, the application of deep learning to LESTV materials is relevant because both emphasize the importance of high-level thinking processes, logical reasoning, and the ability to connect mathematical concepts with real-life contexts to achieve deep conceptual understanding.

The understanding of mathematical concepts is a foundation for students, because through this process students can relate abstract ideas with contextual meanings. As stated by Wahyuni et al. (2023), understanding basic mathematical concepts is one of the important keys to learning mathematical material that has a more abstract nature. In line with that, Naifio et al. (2023) emphasized that the understanding of mathematical concepts is reviewed through the way students think about solving mathematical problems. In this regard, a number of experts have put forward indicators of understanding mathematical concepts that are used as a basis for assessing students' conceptual abilities. According to Gusmania and Agustyaningrum (2020), there are four indicators of concept understanding, namely: (1) restating a concept; (2) presenting concepts into various forms of mathematical representation; (3) use and select certain procedures or operations; and (4) applying concepts or algorithms in problem solving. Meanwhile, Apriliyana et al. (2023) explain seven indicators in more detail, including: (1) restating a concept; (2) classify objects according to certain properties; (3) provide examples and non-examples; (4) presenting concepts in various forms of mathematical representation; (5) develop the necessary conditions for a concept; (6) use or select certain procedures; and (7) applying concepts in problem solving. On the other hand, Lubis and Rahmadhani (2023) used five indicators of concept understanding, namely: (1) restating concepts; (2) provide examples and non-examples; (3) classify objects according to their properties; (4) presenting concepts in various forms of mathematical representation; and (5) applying concepts in problem solving. Based on the results of the study of these three views, although there are differences in the number and emphasis of indicators, all experts have an alignment of meaning in describing students' conceptual abilities. The similarities lie in three main aspects, namely the ability to restate a concept, present concepts in various forms of mathematical representations, and apply concepts in problem solving. These three indicators represent the essence of conceptual understanding because they measure students' ability to remember, represent, and apply knowledge meaningfully. Thus, in this research, the concept understanding indicators are focused on indicators that have a harmony of meaning between the three expert views, so as to be able to describe conceptual understanding comprehensively and relevant to the context of mathematics learning in schools.

Differences in students' learning styles are also an important factor that affects the effectiveness of the application of deep learning in mathematics learning. According to Budi et al. (2021), each student has a tendency to have a variety of learning styles, some visual, auditorial, and kinesthetic, which determine how they receive and process information throughout learning activities. In line with this, research show that teachers need to understand and accommodate various learning styles so that each student can learn effectively in harmony with their preferences and needs (Azizah & Widyartono, 2024; Sofhiya et al., 2023). In the context of deep learning-based mathematics learning, the introduction of learning styles is important to support students' active engagement, as each learning style requires different strategies in building conceptual understanding. According to Wulandari and Windiani (2025), visual learning styles are more inclined to children who learn through pictures, graphics, or other visuals, while auditory learning styles tend to be more effective by listening to oral explanations. Meanwhile, the kinesthetic learning style prioritizes physical experience or practicum in understanding the material. By understanding the characteristics of students' learning styles, teachers can optimize the application of deep learning so that mathematics learning is not only procedural, but also builds a deep and contextual understanding.

Based on the studies that have been presented, research related to LESTV learning still focuses a lot on the final results, while students' conceptual understanding in learning that emphasizes the deep thinking process has not been widely studied. In addition, the relationship between the deep learning approach and the difference in students' learning styles in understanding concepts is also still limited. Therefore, this study aims to describe students' conceptual understanding of LESTV material through the application of a deep learning approach by reviewing the differences in students' learning styles. The results of this study are expected to provide a deeper picture of students' understanding of concepts and be a consideration in designing learning that is more in accordance with student learning characteristics.

Based on this explanation, the researcher aims to describe students' conceptual understanding of the Two-Variable Linear Equation System (LESTV) material through the implementation of a deep learning approach in one of the junior high schools in Yogyakarta. With this research, it is hoped that students will be able to understand the concept of LESTV after participating in a learning process that emphasizes the process of deep and meaningful thinking by reviewing the differences in students' learning styles.

RESEARCH METHOD

This study uses a qualitative descriptive approach. The location of the research was conducted at one of the junior high schools in the city of Yogyakarta. The selection of research subjects was carried out by referring to student learning style data obtained from the school. Based on this data, class IX A students totaling 27 students have been grouped into visual, auditory, and kinesthetic learning styles in the odd semester of the 2025/2026 academic year.

In this qualitative research, the researcher plays the role of the main instrument that is directly involved in the entire research process, from planning, implementation, to data analysis. Learning is carried out using a deep learning approach that emphasizes the active involvement of students in understanding the concept of LESTV through activities relating problems to contextual situations, compiling tables of help points, drawing graphs, and determining cut-off points as solutions. Learning activities were carried out in two meetings. The first meeting focused on understanding the concept of LESTV through the graph method, while in the second meeting students solved contextual problems by stating the problem in the form of LESTV and determining the solution of the equation system. During the learning process, students are encouraged to re-explain the completion steps used and re-examine the results obtained. To support data collection, instruments were used in the form of mathematical concept understanding tests and semi-structured interviews.

The mathematical concept comprehension test is used to find out the extent to which students understand the material of the Two-Variable Linear Equation System (LESTV) after participating in learning based on the deep learning approach. This test is prepared based on three indicators of concept understanding, including the ability to restate concepts, present concepts in various forms of mathematical representations, and apply concepts in problem solving.

The mathematical concept understanding test instrument is validated first by the teacher and supervisor to ensure the suitability of the questions with the indicators, the level of difficulty, and the relevance of the context. Validation includes simplifying easy questions, as well as adjusting contextual questions to be more logical and relevant to real situations, so that instruments can be used validly to measure students' understanding of LESTV concepts.

In addition, semi-structured interviews are not conducted on all students, but only on a few subjects that are purposively selected based on test results and students who represent each learning style, namely visual, auditory, and kinesthetic. Semi-structured interviews are used to dig deeper into students' conceptual understanding. Through this interview, the researcher traces how students interpret the concept of LESTV, explain the solution steps used, and apply the concept in the context of real problems after participating in the deep learning-based learning process.

To ensure the validity of the data, the researcher checks the data through member checking, which is by comparing the results of the mathematical concept understanding test with the results of semi-structured interviews. The collected data is then analyzed using the stages of qualitative data analysis according to Miles and Huberman (1994), which includes the process of data reduction, data presentation, and conclusion drawn.

Furthermore, the criteria for the level of understanding that shows how high the percentage of students' ability to understand mathematical concepts refers to Setiani et al. (2025) in Table 1. The score category is only used as a tool to see the trend of students' concept understanding levels, while the analysis in this study is still carried out qualitatively through the review of student work results and interviews. The procedure of this study is described in the form of a flowchart in Figure 1.

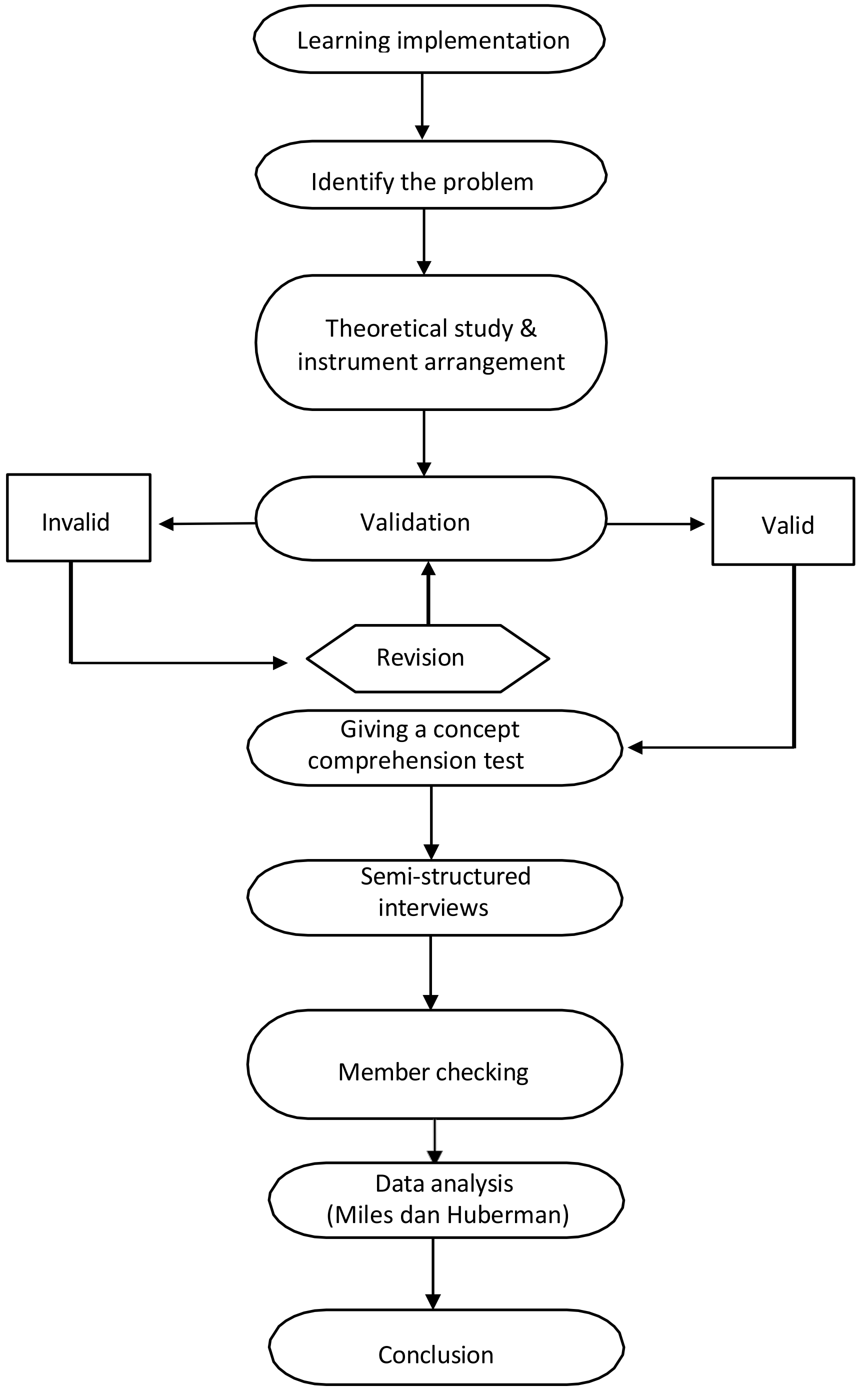


Figure 1. Research flowchart

Table 1. Category of concept understanding level

Value range	Level of Comprehension
$85 \leq X \leq 100$	Very high
$70 \leq X < 85$	High
$55 \leq X < 70$	Fair
$40 \leq X < 55$	Low
$0 \leq X < 40$	Very low

RESULTS AND DISCUSSION

The learning process in this study uses a deep learning approach that emphasizes three main elements, namely meaningful learning, mindful learning, and joyful learning. At the meaningful learning stage, students are first invited to relate the material of the Two-Variable Linear Equation System (LESTV) with contextual problems that are close to daily life, such as determining the prices of two types of goods from the transaction information provided so that students can build an initial understanding of the concept of LESTV. Furthermore, in the mindful learning stage, students solve problems gradually by compiling a table of help points, drawing graphs from two equations, and determining the cut-off point as an LESTV solution while explaining the steps and reasons for the strategy used. And at the joyful learning stage, students are actively involved by working on problems and then moving forward to complete and explain the results of their work, so that the learning atmosphere becomes more lively, encourages students' courage to participate, and makes the learning process feel more fun.

The grouping of students based on learning styles in this study uses secondary data obtained from the school. The data is sourced from internal school documents documented in the form of spreadsheets. Based on these data, grade IX A students are grouped into visual, auditory, and kinesthetic learning styles. The results of the grouping showed that as many as 14 students had a visual learning style, 9 students had an auditory learning style, and 4 students had a kinesthetic learning style. The distribution of students' learning styles is presented in Figure 2.

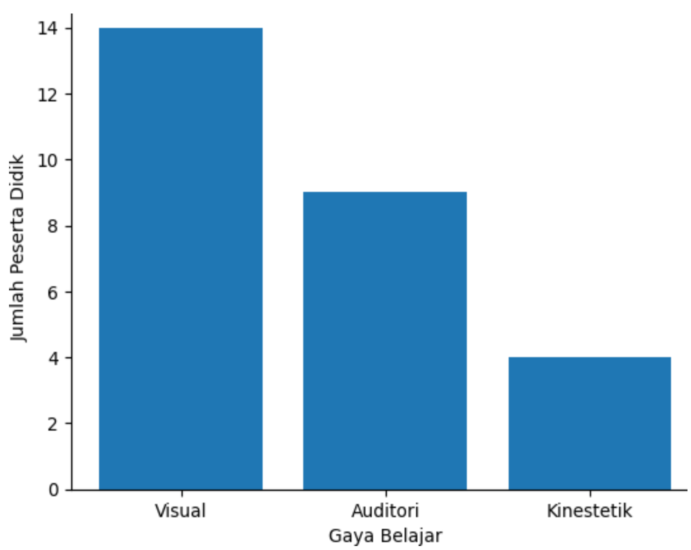


Figure 2. Distribution of learning styles of students in class XI A

The ability to understand mathematical concepts of students in each learning style is explained as follows.

Visual learning style learners

The results of the assessment showed that students with visual learning styles obtained an average concept understanding score of 75.8 which was in the high category. These achievements were then analyzed in more detail through three indicators of concept understanding, namely restating concepts, presenting concepts in various forms of mathematical representation, and applying concepts in problem solving.

In the indicator restating the concept of question number 1, students with visual learning styles are able to determine the help points through the substitution of the values x = 0 and y = 0, but still make mistakes in writing the pair of points (x,y) because the constant is written directly as a coordinate, as seen in Figure 3. This shows that students have not fully understood the symbolic meaning of coordinate pairs. The results of the interviews support these findings, as V1 student stated that "the table at the help point helped me find other points, but I think the LESTV result number is the pair table (x,y)." This finding has been confirmed through the member checking process, and the student stated that the error occurred because of a lack of thoroughness in interpreting the coordinate pair, not because they did not understand the completion steps.

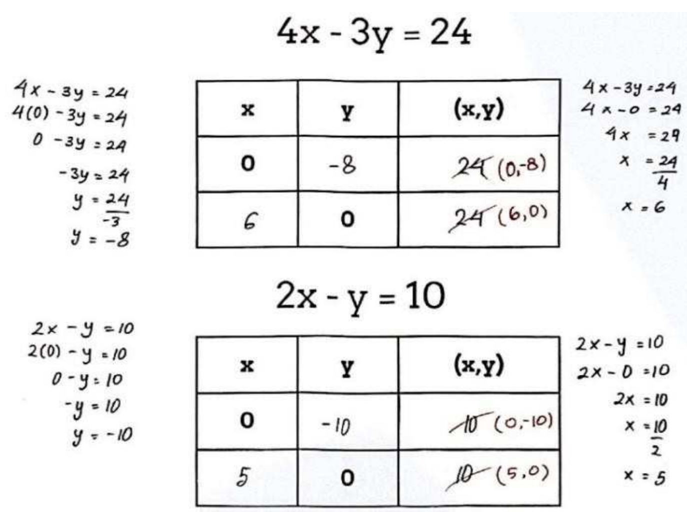
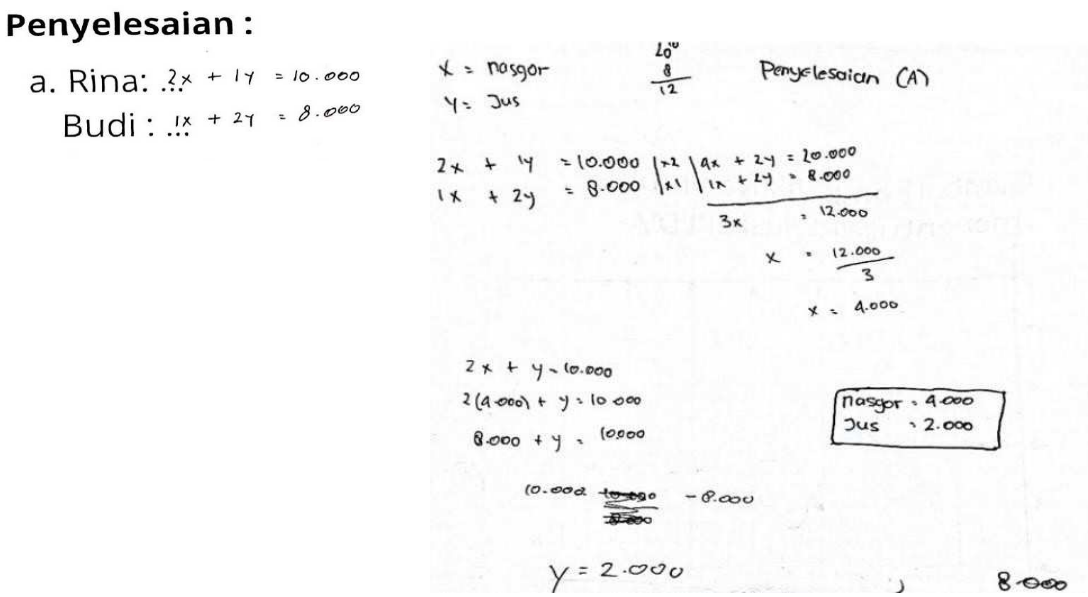


Figure 3. Number 1 indicator restates the concept of visual students

In question number 2, students were able to change the contextual problem into the form of LESTV by taking a variable and forming two equations according to the information in the story question, as seen in Figure 4. This shows that students have understood the initial steps of mathematical modeling, even though the number of constants is still written in units of thousands as listed in the problem. The results of the interview reinforced the findings, as stated by V2 students that "if the problem is in the form of a story with thousands of numbers, I prefer to use the substitution or elimination method. But if you use the graph method, I simplify the numbers first by eliminating the number of thousands so that it is easy." The member checking process shows that students are aware of the strategies used and admit that the simplification of numbers is done to make it easier to calculate, so that the errors that arise are more in the aspects of representation and symbolic accuracy.



(a) (b)

Figure 4. Number 2 indicator restates the concept (a) and re-enactments (b) of visual learners

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Furthermore, in the indicator presenting concepts in various forms of mathematical representation, students are able to draw graphs of both equations precisely. In question number 1, each point is correctly placed and equipped with coordinate information as seen in Figure 5.

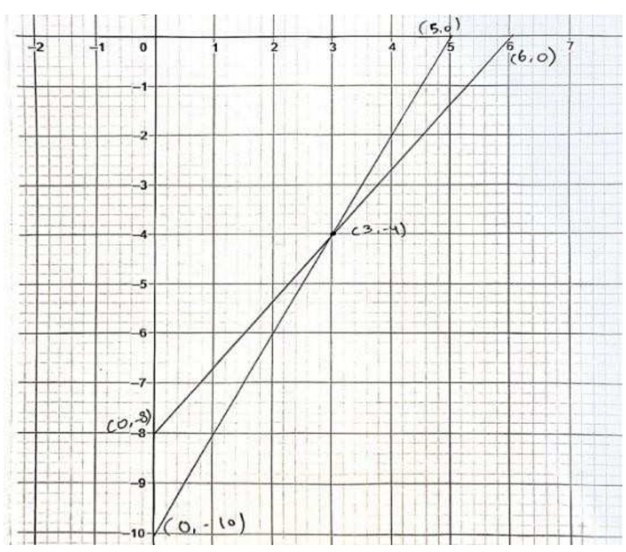


Figure 5. Number 1 indicator presents concepts in various forms of visual student mathematical representation

In question number 2, students were also able to describe the graph from the contextual equation given, but did not write the description of the coordinate pair (x,y) on the points of the graph as seen in Figure 6. The results of the interview showed that in the first question students wrote down the coordinates because there was a table of help points, while in the second question students felt that they understood the position of the points so that there was no need to rewrite the coordinate pairs. This is in accordance with the statement of student V1 that "in the first question, there is a pair (x,y) so on the graph I also write all the description of the pair (x,y), while in the second question I have understood each pair (x,y) so I don't need to write in each description of the point (x,y)." This finding was then confirmed through the member checking process, and the student confirmed that the omission of the coordinate information in the second question was done because they felt that they understood the position of the point, not because they were unable to determine the pair (x,y).

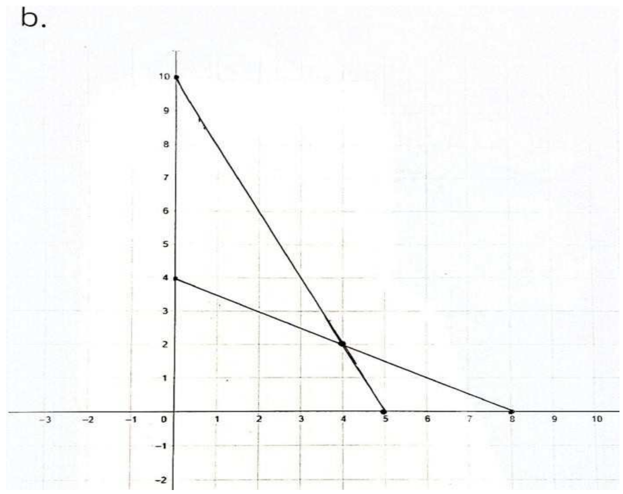


Figure 6. Number 2 indicators present concepts in various forms of visual mathematical representations of students

In the indicator of applying the concept in problem solving, students are able to determine the LESTV solution through the graph cut-off point and identify it as the solution of the equation system, as shown in Figure 7. The results of the interviews showed that the understanding was obtained because the students remembered the previous explanation that the LESTV solution lies at the intersection of two lines. This is in accordance with the statement of V1 students that "when learning has been explained if the cutoff point is the solution of the LESTV, then to find the cut-off point, namely from the meeting point between the two lines of the equation which is the solution." The results have been confirmed through member checking, and students state that the understanding of the cut-off point as a solution does come from the explanations obtained during learning.

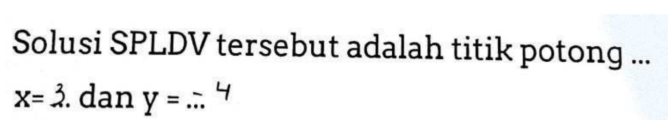


Figure 7. Number 1 indicator of applying the concept in solving visual student problems

In contextual question number 2, students are able to determine the solution through the graph cut-off point and readjust it to the context of the story problem, as shown in Figure 8. This is in accordance with the statement of V2 students that "The cut-off point is a solution from LESTV, if you have found the solution, it just needs to be adjusted from the story problem." The findings show that students have been able to apply the concept of LESTV through graphs to both equations and contextual problems.

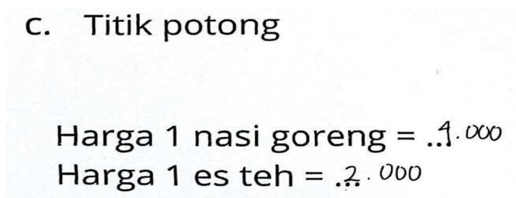


Figure 8. Number 2 indicators apply concepts in visual student problem solving

Students with visual learning styles show good ability to understand LESTV concepts, especially when learning emphasizes graphic exploration and visualization of relationships between equations. They find it easier to understand solutions through cut-off points that are visible directly on a graph than through written symbols, as shown in a study by Fauziah and Kusnandi (2025) which found that visual students are more dominant in visual reasoning and representation, so that concept understanding is more through graphs than symbolic. Although there is still a lack of precision in the writing of coordinate and constant pairs. A deep learning-based learning approach that gives students the opportunity to actively draw, observe, and explore charts

Auditory learning style learners

The results of the assessment showed that students with auditory learning styles obtained an average concept understanding score of 81.4 which was in the high category. These achievements were then analyzed in more detail through three indicators of concept understanding, namely restating concepts, presenting concepts in various forms of mathematical representation, and applying concepts in problem solving.

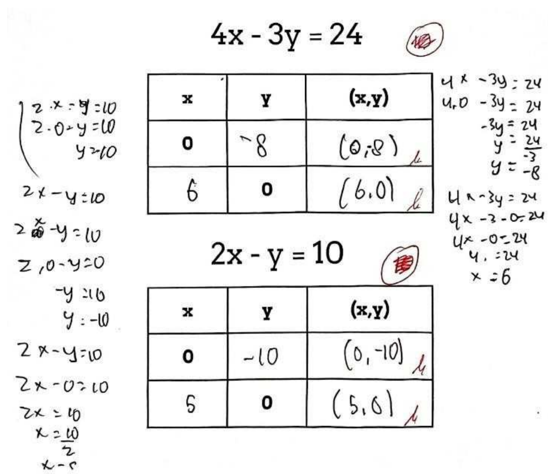


Figure 9. Number 1 indicator restates the concept of auditory students

In the indicator restating the concept, students with auditory learning style determine the value of the variable through the substitution of x = 0 and y = 0 and fill in the pairs (x,y) on the table of help points, as seen in Figure 9. The results of the interview showed that students understood the steps because they followed the explanation presented during the lesson, according to the statement of A1 students, "if there is a table, it is easier to follow the steps because it has been explained beforehand." Thus, member checking that auditory students rely on oral information as the main strategy in solving LESTV questions.

In question number 2, students with auditory learning style first describe the problem in sequence before converting it into LESTV, although the constant is still written in units of thousands as in the question, as seen in Figure 10. The results of the interviews showed that the elaboration helped students remember the completion steps and the use of variables x and y was carried out because they were used to learning. This is in accordance with the statement of A2 students that "to change to the LESTV equation I describe it first so that it is easy to remember and because when learning at school is used to using x and y examples, it can be done by modeling it." These findings show that auditory students understand concepts through systematic explanations and the habit of symbols that are often used in learning.

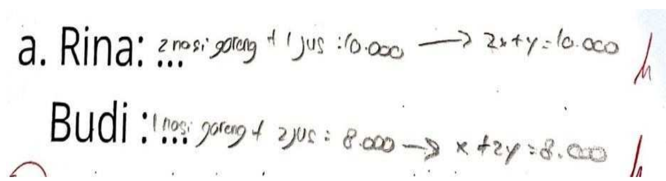


Figure 10. Number 2 indicator restates the concept of auditory students

Furthermore, in the indicator presenting concepts in various forms of mathematical representation, students with auditory learning styles still have difficulty in drawing graphs on question number 1, so the position of points and lines is not completely correct (See Figure 11).

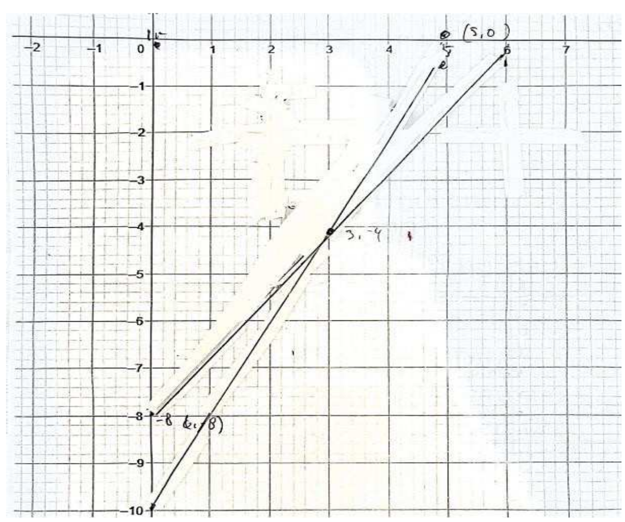
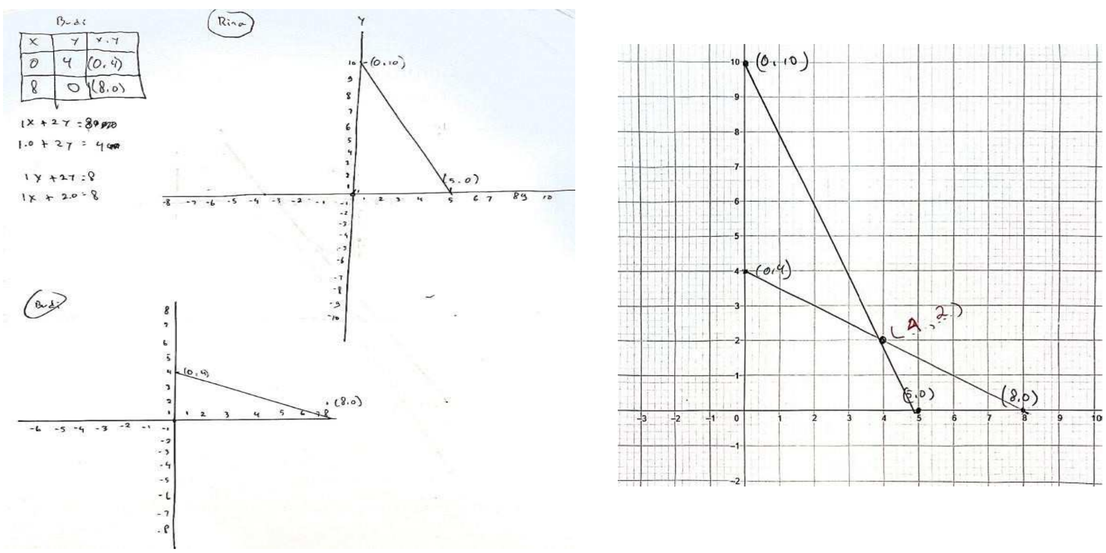


Figure 11. Number 1 indicator presents concepts in various forms of mathematical representation of auditory students

The results of the interview showed that the imprecision of the cut-off point occurred because the lines were drawn without a ruler. This is in accordance with the statement of student A1 that "I think with the origin of the line we can find the cut point correctly, but it turns out that it can cause an error in the result of the cut point." Students also explain that the accuracy of the cutpoint can be double-checked by substituting the values of x and y to each equation to ensure their conformity to the constant. The results have been confirmed through member checking, and students state that cut-off point errors do occur because the line is drawn without a ruler, and the substitution step again helps to ensure the accuracy of the cut-off point.

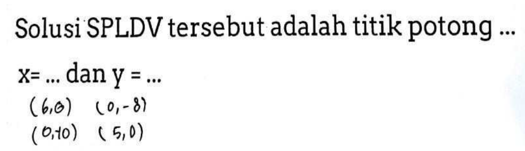
In question number 2, students initially draw each equation on a different graph because they think the two names in the story question represent separate situations (See Figure 12). After realizing that the method did not produce a cut-off point as a solution, students then redrew both equations in a single coordinate field. The results of the interview supported the findings, as stated by A2 students that "because the problem is in the form of a story, I thought that one name is a graph but I didn't find the cut-off point, so finally I joined the two lines into one coordinate field in order to find the cut-off point of the solution." This shows that students are able to recognize and correct errors in chart representation.



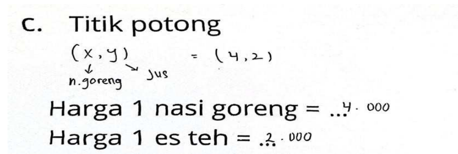
(a) (b)

Figure 12. Number 2 indicator present concepts in various forms of mathematical representations of auditory students

In the indicator of applying the concept in problem solving, some students with auditory learning styles still experience errors in determining the cut-off point as an LESTV solution because they mistakenly interpret the x and y value pairs, as seen in Figure 13. The results of the interviews show that students understand the cut-off point as a solution, but are still confused in determining the right coordinate pair. This is in accordance with student A1's statement that "as described the cut-off point is the solution of the LESTV, but I still mistook the correct x and y pairs for the cut-off point." The results have been confirmed through member checking, and students state that confusion in determining coordinate pairs does occur even though they understand the cut-off point as an LESTV solution.



(a)



(b)

Figure 13. Number 2 indicator 1 indicator applies the concept in solving problems of auditory students

Similar findings are also seen in question number 2 as shown in Figure 16. Students have understood that the cut-off point is the LESTV solution, but it is still necessary to re-describe the variables that represent the objects in the story problem so that the solution is appropriate. This is in accordance with the statement of A2 students that "I understand that the cut-off point is an LESTV solution so in the story question I need to describe the cut-off points of the x and y values and then match it with the exemplary object in the story question." The member checking process shows that students really understand that the cut-off point is the LESTV solution, but they still need to elaborate the variables according to the context of the story question so that the results are correct.

Students with auditory learning styles have been able to understand the concept of LESTV through detailed explanations and systematic steps. Students tend to rely on memory for verbal explanations when determining points of help, modeling story problems, and finding cut-off points as solutions, as shown in a study by Fauziah & Kusnandi (2025) which states that auditory students often use verbal reasoning and verbal explanations of teachers to understand mathematical steps. However, there is still confusion in interpreting the x and y value pairs, especially in story-shaped problems that require the re-elaboration of variables. In the context of deep learning-based learning, an approach that provides room for discussion, verbal explanation, and reflection on the completion steps is very helpful for auditory students to understand concepts more deeply and strengthen the accuracy in interpreting solutions.

Kinesthetic learning style learners

The results of the assessment showed that students with kinesthetic learning styles obtained an average concept understanding score of 73.9 which was in the high category. These achievements were then analyzed in more detail through three indicators of concept understanding, namely restating concepts, presenting concepts in various forms of mathematical representation, and applying concepts in problem solving.

In the indicator restating the concept, students with kinesthetic learning styles still make mistakes in writing point pairs (x,y), where the coordinates are written upside down on the table of assistive points as seen in Figure 14. This shows a lack of precision in the writing of variable pairs. The results of the interviews showed that students understood the use of the help point table, but were not careful in writing the sequence of coordinates, according to the statement of K1 students "the help point table makes it easier to find other points, so I understand how to find each point. But there is confusion between pairs (x,y) due to lack of precision." The member checking process shows that students are aware of errors in writing coordinate pairs and states that the understanding of the use of the help point table is indeed obtained from the teacher's explanation and practical experience, although the accuracy still needs to be improved.

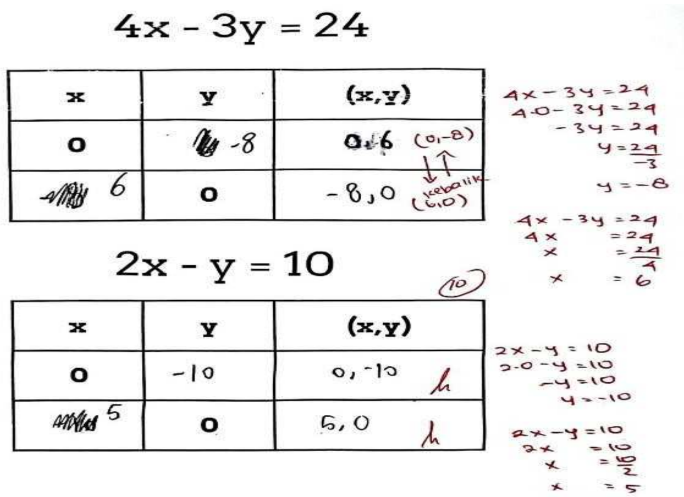


Figure 14. Number 1 indicator restates the concept of kinesthetic students

The same thing can also be seen in question number 2 as shown in Figure 15, where an error occurs in the filling of the table so that the values of x and y are changed, not in the calculation. The results of the interview showed that students used the same steps as question number 1, but were less careful in writing coordinate pairs. This is in accordance with the statement of K2 students that "to work on number 2 the method is the same as number 1, but because of the lack of precision in filling in the table so that the x and y niali are confused." The member checking process shows that students are aware of errors in filling in the table and confirms that the understanding of the completion steps is correct, but the accuracy in writing the coordinate pairs still needs to be considered.

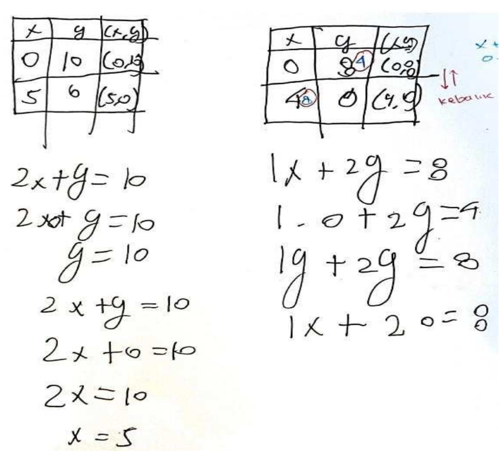
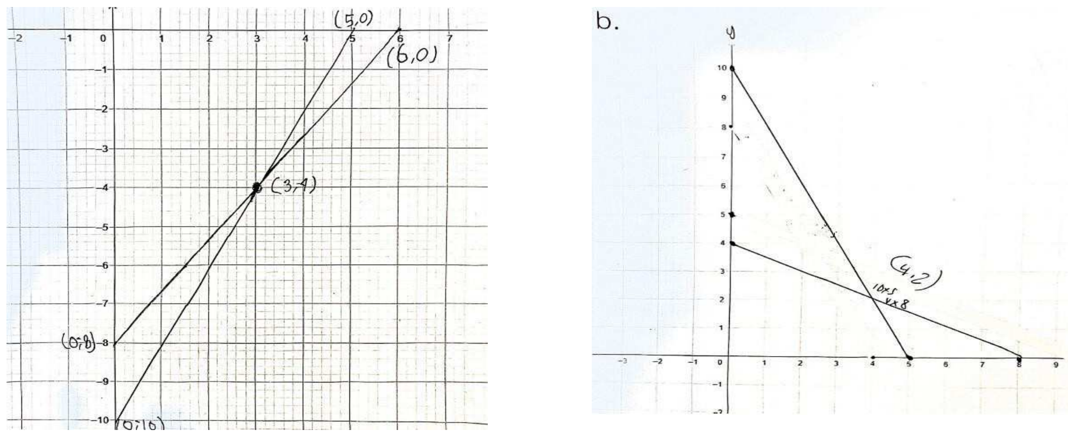


Figure 15. Indicator number 2 restates the concept of kinesthetic students

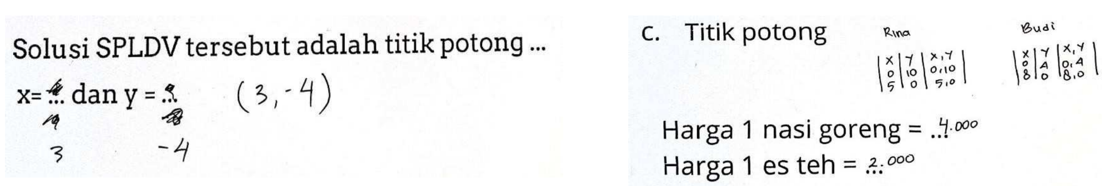
Furthermore, in the indicator presenting concepts in various forms of mathematical representation, students with kinesthetic learning styles are able to draw graphs on questions number 1 and 2 correctly if the table of help points is arranged correctly, as seen in Figure 16 and Figure 20. The results of the interview showed that the drawing of the graph was carried out based on the table of the points of the help, in accordance with the statement of the K1 students that "to determine each point on the graph from the help point table earlier, then each point of the equation is underlined so that the meeting of the two lines will get the point of the cut." This statement shows that students understand the steps of drawing a graph in sequence.



(a) (b)

Figure 16. Number 1 indicator presents concepts in various forms of mathematical representation of kinesthetic students

In the indicator of applying concepts in problem solving, students with kinesthetic learning styles were able to determine the LESTV solution through the graph cut-off point, but still seemed hesitant when writing down the x and y value pairs, as shown in Figure 17. The results of the interviews showed that students understood the cut-off point as a solution, but were confused in determining the right coordinate pair. This is in accordance with the statement of K1 students that "the LESTV solution is from the cutting point, but in the writing of x and y, there is still doubt as to which number x and number y are stated." The member checking process showed that students were aware of their doubts in writing coordinate pairs, and stated that the understanding of the cut-off point as an LESTV solution was indeed obtained from practice and explanation during learning, although the accuracy in determining the sequence of x and y still needed to be improved.



(a) (b)

Figure 17. Number 1 indicator applying the concept in problem solving of kinesthetic students

In question number 2, students find the cut-off point as a solution and adjust the values x and y to the context of the story, as shown in Figure 17. The results of the interviews showed that after determining the cut-off point through a graph, students matched it back to the context of the question. This is in accordance with the statement of K2 students that "To determine the solution, you will first find the cutting point through the graph method, after finding the cutting point, it will be adjusted again to which story represents x and y." The statement shows that kinesthetic students are able to find LESTV solutions through a series of steps.

In general, students with kinesthetic learning styles have been able to understand and complete LESTV through a series of steps, starting from compiling a table of help points, drawing graphs, to determining cut-off points as a solution. They understand the procedure well, but are still not thorough in writing the pairs of values x and y, so that there are several mistakes in the sequence of coordinates. The ability to draw graphs also depends heavily on the accuracy of the preparation of the previous tables. In deep learning-based learning, activities that involve hands-on practice such as compiling tables, drawing graphs, and double-checking solutions help kinesthetic students understand concepts more meaningfully, although it still takes habituation to be more thorough in the final stages of writing answers. These findings are in line with the results of research by Azizah & Widyartono (2024) who explain that students with kinesthetic learning styles tend to understand learning concepts through direct involvement in learning activities.

CONCLUSION

The application of the deep learning learning approach is able to support the conceptual understanding of junior high school students in the Two-Variable Linear Equation System (LESTV) material by considering differences in learning styles. Students with visual learning styles show expertise in graphic representation, auditory students are able to follow the flow of completion sequentially through explanations, while kinesthetic students tend to understand concepts through hands-on activities.

Deep learning approaches that emphasize meaningful, mindful, and fun learning help students restate concepts, present concepts in various forms of mathematical representation, and apply concepts in contextual problem solving. Through the learning process, students not only follow the steps of procedural completion, but also understand the meaning of the solutions obtained. Thus, the application of a deep learning approach that pays attention to differences in learning styles can be an effective learning strategy to improve conceptual understanding of mathematics.

This study still has several limitations, including subjects that are limited to one class with a relatively small number of students so that the results cannot be generalized widely, as well as learning style data obtained from the school without direct measurement using special instruments. In addition, the implementation of learning that only takes place in two meetings has not fully described the development of students' conceptual understanding in depth. Therefore, further research is recommended to involve more diverse subjects, use more structured learning style identification instruments, and carry out learning over a longer period of time in order to obtain a more comprehensive picture of deep learning-based learning processes and outcomes.

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DECLARATION

Author contribution

All authors contribute in the research and/or writing the paper, and approved the final manuscript.

Amanda Dwi Nopiyanti Retno Putri	Conceptualizing the research idea, leading the investigation, setting up the methodology, analyzing the data, and writing the first draft.
Harina Fitriyani	Assisting the investigation, reviewing the validity of the methodology, enriching the data analysis, and approving the final manuscript.

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All authors declare that they have no competing interests.

Ethics declaration
We as authors acknowledge that this work has been written based on ethical research that conforms with the regulations of our institutions and that we have obtained the permission from the relevant institutes when collecting data. We support the International Journal on Education Insight (IJEI) in maintaining the high standards of personal conduct, practicing honesty in all our professional practices and endeavors.

The use of artificial intelligence
We do not use any generative AI tools to write any part of this paper.

Additional information
Not available.

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