



## Students' Skills to Solve Linear Equation System in Two Variables: Systematic Literature Review

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### ABSTRACT

The system of linear equations of two variables is contextual material in learning mathematics. Yet, there are facts that show there are still errors and difficulties experienced by students in the problem of the system of linear equations of two variables. The research purpose is to conduct a literature review on the skills, errors, and difficulties of students on the problem of the system of linear equations of two variables. This research uses the SLR (Systematic Literature Review) method. Data collection was carried out by reviewing all articles related to math skills, errors, and difficulties of students on the problem of the system of linear equations of two variables published from 2019 to 2023. Based on the research results, it was found that students' skills to solve the problem of two-variable linear equation system was still low. Students still made many mistakes in understanding the problem and converting it into a mathematical model, carrying out the plan or process, performing calculations, and often ignoring the evaluation of the results obtained.

*Keywords: linear equation system, two variables, math skill*

Submitted	Accepted	Published
06 March 2024	22 May 2024	30 May 2024

<b>Citation</b>	:	Rodiana, I., Hamdiyanti, M., Laelasari., & Subroto, T. (2024). Students' Skills to Solve Linear Equation System in Two Variables: Systematic Literature Review. <i>Jurnal PAJAR (Pendidikan dan Pengajaran)</i> , 8(3), 249-260. DOI: <a href="http://dx.doi.org/10.33578/pjr.v8i3.9853">http://dx.doi.org/10.33578/pjr.v8i3.9853</a> .
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### INTRODUCTION

Mathematical problem solving plays a very important role in everyday life. This is because in various aspects of life, solving mathematical problems can help someone achieve success and improve critical, logical and systematic thinking skills (Cruz-Pichardo, 2021). Apart from that, solving mathematics problems can also show how involved parents are in their children's learning process (Williams & Williams, 2021). Mathematics activities that originate from children's own initiative play an important role in their development and mathematics learning process (McMullen et al., 2020). Arithmetic training has been shown to cause transformations in behavior and brain structure, confirming the significance of mathematics training in cognitive development (Soltanlou et al., 2022).

Problem solving has a significant impact on cognitive development. The importance of mathematics learning abilities in solving different contextual problems for the application of knowledge in real life (Nakakoji & Wilson, 2020). Problem solving skills play an important role in shaping academic abilities and the challenges of daily life so it is necessary to design and implement learning activities that effectively develop these skills, especially in the classroom (Yang & Kim, 2019). It is also very significant in cognitive development, because it involves regular habits in stimulating activities, such as problem solving, maintaining, and strengthening cognitive skills (Alescio-Lautier et al., 2023). In addition, a cognitive approach in dealing with complex problems can improve innovative thinking abilities by changing the way individuals activate and utilize relevant cognitive processes (Li et al., 2020).

Applying problem solving strategies in mathematics learning not only improves students' mathematical problem solving abilities, but also contributes to their overall cognitive development (Harianda & Junedi, 2021). Problem solving practices in digital activities also contribute to improving problem solving abilities in children (Melander Bowden, 2019). Additionally, problem-solving therapy successfully reduces

the burden on caregivers facing cognitive impairment, emphasizing the importance of problem-solving skills in everyday situations (Garand et al., 2019).

Efforts to improve mathematics problem solving achievement face several obstacles. These include students' lack of problem solving abilities (Sukoco et al., 2023), including difficulty understanding mathematical problems and planning correct solving strategies (Supu et al., 2023). Lack of attention and involvement of students in learning activities (Sukoco et al., 2023) (Kusumadewi & Retnawati, 2020). Educators also face difficulties in improving students' mathematical reasoning abilities due to factors such as lack of motivation and students' relaxed attitudes (Nasir et al., 2023). Students may face obstacles in understanding and describing mathematical problems, formulating ideas for solving problems (Pertiwi et al., 2020), as well as identifying keywords and formulating problems into mathematical form (Panthi et al., 2021). Students' low ability to solve mathematical problems can be related to their lack of understanding and lack of skills in numerical operations (Gunawan & Muf seeni, 2022).

A system of linear equations of two variables is a collection of mathematical equations that reflect the relationship between two unknown variables. Each linear equation in the system contains two variables, which can be represented in the form  $ax + by = c$ , with  $a$ ,  $b$ , and  $c$  as constants, and  $x$  and  $y$  as variables. The goal is to find  $x$  and  $y$  values that satisfy all the equations in the system. The solutions of the system can vary, such as unique solutions, no solutions, or infinite solutions, depending on the properties of the equation. The ability to understand and solve systems of linear equations from two variables has broad significance in various fields, including mathematics, physics, engineering, and economics (Awanda Erna & Jamilah, 2022; Saito, 2022; Upu et al., 2022).

Studying systems of linear equations in two variables provides a number of important benefits for high school students. First of all, it helps students hone mathematical problem-solving and communication skills, as these topics have relevance to their daily lives (Waltialan et al., 2022). Second, this learning deepens students' understanding of algebra and systems of linear equations in one variable, which are basic concepts in mathematics (Oktaviani et al., 2021). In addition, students can apply their knowledge to model and solve real-world problems using graph methods, substitution, elimination, and mixed methods (Samurwaru et al., 2022). Not only that, studying two-variable linear equation systems can also improve students' mathematical reasoning abilities (Retnawati et al., 2020).

Students often face various difficulties and obstacles when learning about systems of linear equations with two variables. These challenges include reading errors, comprehension errors, transformation errors, process skills errors, and coding errors (Fimillatika & Haerudin, 2023). Additionally, they may encounter difficulties in relating systems of linear equations to real-world situations, because their logical thinking abilities may not be mature enough to solve such problems (Hidayat & Evendi, 2022). In addition, students can face factual difficulties, conceptual difficulties, and procedural difficulties that affect understanding and solving systems of linear equations (Dalyanti & Sunaryo, 2022).

This research is of course still limited and does not fully describe students' learning difficulties and obstacles. However, it is hoped that this research can provide an illustration for further research. The objectives of this research include describing the mathematical abilities of junior high school students on the topic Systems of Linear Equations in Two Variables based on the year of research, describing the mathematical abilities of junior high school students on the topic Systems of Linear Equations in Two Variables, describing the mistakes of junior high school students on the topic Systems of Linear Equations in Two Variables, and describing the difficulties of junior high school students on the topic Systems of Linear Equations in Two Variables.

## METHOD

This research uses the Systematic Literature Review (SLR) research method. SLR is a research strategy used to obtain evidence from scientific articles stored in digital repositories (Tebes et al., 2020). The article search was carried out in November 2023. Data analysis techniques were carried out by researchers by grouping, analyzing and concluding the data. Research stages include:

**a. Search Process**

At this stage, a search for relevant articles or other terms is carried out using a search process using the Dimensions database. The keywords used are mathematical abilities, students' errors and difficulties in the material on systems of linear equations in two variables. The articles collected in this research are articles published from 2019 to 2023.

**b. Screening Process**

The next process is filtering. At this stage, it is decided whether the articles found are included or eliminated by determining a series of criteria. The inclusion criteria in this SLR are: (1) articles published from 2019 to 2023; (2) The type of article must be in journal form and be research into education and mathematics learning; (3) articles must be openly accessible; (4) Articles were searched using the keywords errors, difficulties and mathematical abilities of junior high school students on the topic of systems of linear equations in two variables.

**c. Eligibility Process**

Eligibility stages follow a screening process. At this stage, the article is checked whether it can be used as a reference or meets the requirements. This is done by reading the title, abstract and contents of the paper.

**d. Inclusion**

Articles are grouped based on year of publication, mathematical ability criteria, error criteria and difficulties for junior high school students on the topic of systems of linear equations in two variables. The population of this research is all research on the mathematical abilities, errors and difficulties of junior high school students in the topic of systems of linear equations in two variables which have been published in various scientific journal publishers. Based on the identification results, researchers obtained 24 relevant articles.

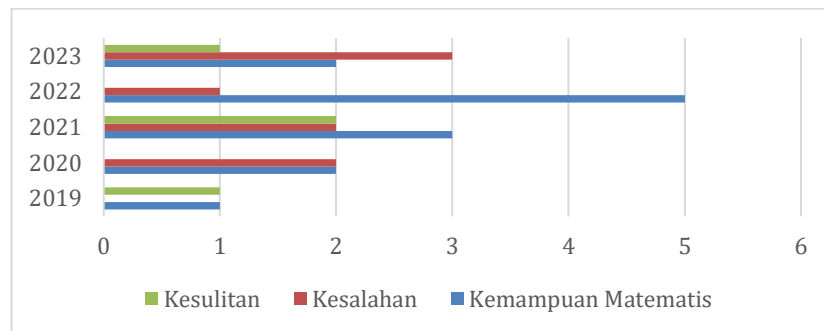
**RESULTS AND DISCUSSION**

From the results of relevant articles, they were then categorized based on year of research, mathematical ability criteria, error criteria, and difficulty criteria.

**Table 1. Based on research year**

No	Year of Research	Criteria		
		Mathematical Ability	Error	Difficulty
1	2019	1		1
2	2020	2	2	
3	2021	3	2	2
4	2022	5	1	
5	2023	1	3	1

Based on Table 1, from 2019 to 2023 there are 13 articles about mathematical abilities. Furthermore, there are 8 articles regarding student errors and 4 articles regarding the difficulties of junior high school students in solving systems of two-variable linear equations that have been published. This indicates that students still have problems in solving problems related to systems of linear equations in two variables.



**Figure 1. Distribution of articles based on research year**

From Figure 1, the most research carried out in 2022 is about mathematical ability, meanwhile, in 2021 and 2023 mathematical ability and errors will be the most research carried out. In 2021 and 2023 research was conducted on the mathematical abilities, errors and difficulties of the three. This illustrates that there are still obstacles in solving problems with systems of linear equations in two variables, which is shown by the large number of studies on this matter. Student errors and difficulties were found based on the results of the article.

### Discussion

From the results of research on junior high school students' mathematical abilities in two-variable linear equation systems, 5 mathematical abilities were found, namely logical thinking, mathematical communication, conceptual understanding, problem solving and representation. The results obtained are displayed in Table 2.

**Table 2. Mathematical Ability**

Writer	Year	Journal	Mathematical Ability	Research result
Mustafa A.H RuhamaNurya YasinKarman La Nani	2020	Journal of Mathematics Education	Think logically	Students with logical thinking abilities are divided into 3 levels, namely levels 2, 1 and 0. At level 0 students can use the steps correctly, but still make mistakes in calculating.
Vidia Amalia Adjis Mustafa A.H R Hasan Hamid	2021	Journal of Mathematics Teacher Education	Think logically	There was still a high number of students when the research was conducted, whose ability to think logically with a metacognitive approach was in the low category.
Marfuah ApriasariSri Rejeki	2020	Journal of Educational Research and Innovation	Mathematical communication	Students' mathematical communication skills with Polya steps still have deficiencies in the calculations carried out to reach answers.
Efira Dwitama Ananda	2021	Scientific Journal of Mathematics Education	Mathematical communication	Written mathematical communication of students with a high level of self-esteem is appropriate for formulating

Ranjaniya Aini	2021	Granada Islamika Journal	Mathematical communication	problem-solving strategies, describing problem-solving steps, and carrying out calculations carefully. From the research results, junior high school students have not fully mastered the material on two-variable linear equation systems and researchers saw that each respondent had difficulty responding to interview questions.
Alvias Noviantika Arnanda Dafik Ervin Oktavianingtyas Harmi Indyah Firmani Vika Oktoviani Wiris Laras Widoyani Ferry Ferdianto	2022	Journal of Mathematics Education and Learning	Mathematical Communication	Students' mathematical abilities have increased by using Geogebra learning media on two-variable linear equation systems.
	2019	Edumatica: Jurnal Pendidikan Matematika	Concept understanding	Students have the ability to apply mathematical concepts to solving problems, are able to form mathematical models, and carry out calculations. However, they still have difficulty interpreting the problem correctly.
Esti Winda Sari Nyoman Sridana Laila Hayati Nurul Hikmah	2022	Griya Journal of Mathematics Education And Application	Concept understanding	Students' ability to understand concepts is good and quite good in solving problems on systems of linear equations in two variables based on independent learning
Megananda Elvaliana Farida Siska Andriani	2023	Circle : Journal of Mathematics Education	Concept understanding	The research results show that the Advance Organizer learning model has an impact on the ability to understand mathematical concepts, and learning style also has an impact on the ability to understand mathematical concepts.
Arnina Dwi Jaya Mukhni	2022	Journal of Mathematics Education and Research	Solution to problem	Students' problem solving abilities using Polya Steps are still low.
Ajeng Siti Rhohmah Euis Eti Rohaeti M. Afrilianto	2022	SOSIOHUMANIORA: Scientific Journal of	Representation capabilities	Students' mathematical representation abilities can be improved through a contextual approach to the material on

Humawida Muthianisa Kiki Nia Sania Effendi	2022	Social Sciences and Humanities Journal of Mathematics Education and Science	Representatio n capabilities	systems of linear equations in two variables.  In the material on two-variable linear equation systems, students' mathematical representation abilities are in the low category.
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From Table 2, critical thinking mathematical abilities are divided into three levels, namely high, medium and low. To measure critical thinking skills using aspects such as problem interpretation, analysis, evaluation, inference and argument evaluation (Agoestanto et al., 2017; Malinda et al., 2022; Nurmayani, 2020; Putri et al., 2022; Rott, 2021). At a high level, students are able to fulfill all aspects of critical thinking skills. At the medium and low levels, students do not write down and say exactly what the question asks. The aspect that is still lacking is the aspect of not providing arguments regarding all the steps to solve the problem of a system of linear equations in two variables, and not drawing appropriate conclusions on the final result of the answer. Through a metacognitive approach, you can improve your ability to think logically in the material on two-variable linear equation systems and interpret them moderately.

Apart from critical thinking skills, research also shows students' mathematical communication skills in solving problems with two-variable linear equation systems. From Table 2, there are still many students who do not understand the material on systems of linear equations in two variables. Students experience difficulties when answering interview questions (Aini, 2021). Students' mathematical communication skills are at a high level, there are still shortcomings, namely when calculating in obtaining answer results. The completeness of written mathematical communication for students with either low or high self-esteem is not complete for all stages of problem solving, but the fluency of written mathematical communication is smooth for all stages of problem solving. Mathematical communication skills can be improved by using Geogebra learning media on two-variable linear equation systems.

The ability to understand concepts is influenced by students' learning styles. Indicators of mathematical understanding ability include the ability to group objects based on characteristics, use certain operations, apply concepts in problem solving, understand mathematical concepts, connect concepts, present mathematically, make problem solving concepts more effective (Jeanita Sengkey et al., 2023; Yusri, et al., 2017). Student errors often occur when carrying out calculations and interpreting problems. Meanwhile, students' problem solving abilities using Polya Steps are still low. Students' representative abilities in the material on two-variable linear equation systems are also still low. However, representative abilities can be improved through a contextual approach.

**Table. 3 Student Mistakes**

Writer	Year	Journal	Research result
Afinda Azimatul Khusna Rizky Esti Utami Farida Nursyahidah	2021	Journal of Tadris Mathematics	The mistake made by the subjects was not making a perfect mathematical model.
Stepania Junita Sari Timbul Yuwono	2020	Journal of Tadris Mathematics	There are three types of errors that are often made by students, namely errors in determining the operations to be used, errors in determining the stages of the problem solving process, and errors in concluding the final results.
Fedi Bandara Halini	2022	AlphaEuclidEdu Journal	Based on the student error indicators, the mistakes made by students were wrong in

Dede Suratman			choosing the solution method, wrong in assigning units to the problem object, wrong in determining what they knew and asked.
Zaskia Ema Nugraha Sri Subarinah Nourma Pramestie W Nani Kurniati	2023	Mandalika Mathematics and Education Journal	The analysis was carried out based on Newman's stages. Mistakes made by students whether they are field independent or field dependent are in process skills.
Rangga Faradisha Hj. Sripatmi Eka Kurniawan Nani Kurniati	2021	Griya Journal of Mathematics Education and Application	The mistake that many students make with the Polya Steps is the stage of implementing the plan.
Sonya Grace Eveline Sianipar	2020	Scientific Journal of Mathematics Education	From the results of this research, it was concluded that many students made mistakes in understanding story questions, converting them into mathematical models during the encoding process.
Deris Ari Saepudin Novi Andri N Pujia Siti Balkis	2023	PEKA Journal (Mathematics Education)	According to the results of the analysis and summary of calculations that have been carried out, procedural errors are more dominant than calculation errors.
Ignasius Nong Mere	2023	Journal of Education, Science and Technology	From the interview results, the factors that cause mistakes made by students are students not understanding the questions as a result of not being able to change the sentences in the questions into mathematical sentences, weak concepts of variables, weakness in calculations, and lack of practice in solving various types of questions on systems of linear equations in two variables. story form.

Based on Table 3, students usually make various mistakes when answering questions related to systems of linear equations in two variables in the polya step. Common mistakes include not understanding story problems (Grace & Sianipar, 2020), changing the problem into a mathematical model (Khusna et al., 2021)(Grace & Sianipar, 2020)(Mere, 2023), making mistakes in the solving process because of using methods and inaccurate mathematical operations (Sari & Yuwono, 2020)(Bandara et al., 2022), and errors in concluding the final results (Sari & Yuwono, 2020). Moreover, students are still trying to understand problems and convert them into mathematical form, find the right solution in answering questions, are less careful in carrying out problem solving steps, and often neglect evaluating the results obtained. These errors emphasize the need for teachers to focus more on increasing student understanding, problem solving solutions, and accuracy regarding small aspects in mathematical problem solving tasks.

**Table 4. Student Difficulties**

Writer	Year	Journal	Research result
Vika Oktoviani Wiris Laras Widoyani Ferry Ferdianto	2019	Edumatika	Errors occur when students cannot interpret the problem given correctly.
Lenny Kharsima Br S Ani Minarni	2023	Education Achievment:	Subjects with either high, medium or low ability experienced difficulty in the calculation process. At medium and low

Sri Hardiyanti A Baharullah Ma'rup	2021	Journal of Science and Research Sigma: Journal of Mathematics Education	abilities, subjects had difficulty converting questions into mathematical sentences Students at the first, second, and third levels of high ability, all three have difficulties in concepts and verbally.
AA Biban Azhimuh Muhammad Turmuzi Wahidaturrahmi	2021	Griya Journal of Mathematics Education and Application	The research results illustrate that students have the most difficulty learning principles, difficulty learning concepts and difficulties in calculations are in the low category.

In studying material on systems of linear equations in two variables, students often face difficulties. Based on Table 4, these difficulties include challenges in factual, conceptual and procedural terms (Dalyanti & Sunaryo, 2022). Students try to understand the concept (Hardiyanti Amaliah A et al., 2021)(Azhimuh et al., 2021), and solve verbal problems related to the material on systems of linear equations in two variables (Hardiyanti Amaliah A et al., 2021). In addition, errors occur at various stages of problem solving, such as reading, understanding, transformation, process skills, and coding which result in errors in mathematical writing (Fimillatika & Haerudin, 2023)(Arifendi et al., 2022). Students also still have difficulty understanding questions and converting them into mathematical form (Br Sembiring & Minarni, 2023). As before, the factors that trigger difficulties in students need to be taken into account so that these incidents can be prevented from recurring.

This research has limitations, one of which is the limitation in collecting data which researchers carried out only through search engines. The number of samples used by researchers certainly cannot describe the actual situation. The results of this research only highlight students' mathematical abilities, errors and difficulties regarding the material on systems of linear equations in two variables. Therefore, it is hoped that the findings that have been obtained can become a basis for consideration for future researchers to find the right solution to reduce these obstacles. Thus, these things might be used as a reference source for future researchers to overcome the weaknesses in this study.

## CONCLUSIONS AND RECOMMENDATION

Over the last 5 years, many studies have been conducted to examine students' mathematical abilities in solving systems of linear equations in two variables, which illustrates that there is still a lack of competence in mathematical abilities in the material, and research into students' errors and difficulties in the material. From the research results, it appears that there are still many mistakes made by students in understanding questions and changing them into mathematical models, carrying out plans or processes, carrying out calculations and often ignoring the evaluation of the results obtained. To overcome this problem, one of the main recommendations is to increase the use of interactive learning media such as Geogebra.

Apart from that, it is necessary to provide training and professional development for teachers so that they can use Geogebra effectively in the learning process. Through workshops and training, teachers can design and implement more interesting and interactive learning, as well as provide better guidance to students. The development of comprehensive, Geogebra-based learning modules is also important. This module can provide students with step-by-step guidance in understanding problems, turning them into mathematical models, implementing a solution plan, and evaluating results.

By giving real-world problems that must be solved using a system of linear equations in two variables, students can more easily understand the application of mathematical concepts in real contexts. Continuous evaluation and reflection on learning outcomes is also important to identify difficulties and errors experienced by students, as well as allowing adjustments to more effective learning strategies. By implementing these strategies, it is hoped that students' mathematical abilities in solving systems of linear equations in two variables can increase significantly.



Next, try to find alternative solutions to deal with and reduce the possibility of errors and students' difficulties in understanding and applying the concept of two-variable linear equations in order to achieve more meaningful learning goals.

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