

DEVELOPMENT OF TEACHING AND LEARNING-BASED STUDENT WORKSHEETS (LKPD) ON SYSTEM OF LINIER EQUATIONS IN TWO VARIABLES TO FACILITATE THE CRITICAL THINKING SKILLS OF EIGHTH-GRADE JUNIOR HIGH SCHOOL STUDENTS

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Abstract

This study aimed to develop a contextual-based Student Worksheet (LKPD) on Systems of Linear Equations in Two Variables (SPLDV) that is valid and practical and can facilitate the improvement of eighth-grade junior high school students' critical thinking skills. This study employed a Research and Development (R&D) method using the ADDIE development model, consisting of Analyze, Design, Develop, Implement, and Evaluate stages. The research subjects included eighth-grade students of SMP Muhammadiyah 48 Medan, a mathematics teacher, and material and media experts. The research instruments consisted of expert validation sheets, user-response questionnaires, and a critical thinking test covering interpretation, analysis, evaluation, and inference. The validation results showed that the LKPD obtained an average score of 92.79%, categorized as very valid, while the student response reached 85.05%, categorized as very practical. The pre-test and post-test analysis resulted in an N-Gain of 0.59, categorized as moderate. Since the study did not report the use of a control group, the improvement is interpreted as an increase in critical thinking scores after the use of the LKPD and is not presented as definitive evidence of a causal relationship. Therefore, the developed contextual-based LKPD demonstrates good quality and has potential as teaching material for SPLDV to facilitate students' critical thinking skills.

Keywords: *Student Worksheet, contextual, critical thinking, SPLDV, ADDIE*

Abstrak

Penelitian ini bertujuan untuk mengembangkan Lembar Kerja Peserta Didik (LKPD) berbasis kontekstual pada materi Sistem Persamaan Linear Dua Variabel (SPLDV) yang valid dan praktis serta dapat memfasilitasi peningkatan kemampuan berpikir kritis siswa kelas VIII SMP. Penelitian ini menggunakan metode Research and Development (R&D) dengan model pengembangan ADDIE yang terdiri atas tahap Analyze, Design, Develop, Implement, dan Evaluate. Subjek penelitian meliputi siswa kelas VIII SMP Muhammadiyah 48 Medan, guru matematika, serta ahli materi dan ahli media. Instrumen penelitian terdiri atas lembar validasi ahli, angket respons pengguna, dan tes kemampuan berpikir kritis yang mencakup indikator interpretasi, analisis, evaluasi, dan inferensi. Hasil validasi menunjukkan bahwa LKPD memperoleh rata-rata persentase sebesar 92,79% dengan kategori sangat valid, sedangkan respons siswa memperoleh persentase sebesar 85,05% dengan kategori sangat praktis. Analisis pre-test dan post-test menghasilkan N-Gain sebesar 0,59 yang termasuk kategori sedang. Karena penelitian ini tidak melaporkan penggunaan kelompok kontrol, peningkatan tersebut diinterpretasikan sebagai peningkatan skor kemampuan berpikir kritis setelah penggunaan LKPD dan tidak digunakan sebagai bukti hubungan sebab-akibat secara definitif. Dengan demikian, LKPD berbasis kontekstual yang dikembangkan memiliki kualitas yang baik dan berpotensi digunakan sebagai bahan ajar pada materi SPLDV untuk memfasilitasi kemampuan berpikir kritis siswa.

Kata kunci: LKPD, kontekstual, berpikir kritis, SPLDV

INTRODUCTION

Mathematics education at the junior high school level, particularly regarding the topic of Systems of Linear Equations in Two Variables (SPLDV), should ideally not only focus on memorizing elimination and substitution procedures but also equip students with critical

thinking skills to solve real-world problems. Meaningful learning of SLS should connect algebraic concepts to students' everyday contexts, such as simulations of buying and selling transactions, small business budget planning, or analysis of local commodity prices (Trianto, 2014). However, the reality on the ground reveals a significant gap between these ideal expectations and actual classroom instruction.

A similar situation has also been confirmed in various academic studies in Indonesia over the past five years. Studies published in accredited journals consistently show that SPLDV instruction in junior high schools still predominantly uses procedural and mechanistic approaches. Students are trained to memorize the steps of elimination and substitution without ever being guided to understand the meaning of variables, coefficients, or constants in real-world contexts (Herawati & Surya, 2022; Rangu, 2025). As a result, when presented with word problems or real-world scenarios, students experience a mental block because they are not accustomed to translating everyday language into mathematical models. In fact, the Merdeka Curriculum explicitly requires the integration of local wisdom and contextual approaches in the development of instructional materials (BSKAP Decision No. 007/H/KR/2024).

To verify this gap firsthand, the author conducted preliminary observations at SMP Muhammadiyah 48 in Medan. The observations involved direct monitoring of the learning process in eighth-grade classes, in-depth interviews with the mathematics teacher, and an analysis of the instructional materials used. The results of the observations confirmed that the learning process is still dominated by teacher-centered lecture and question-and-answer methods. Students tend to be passive and merely receive information without being involved in the process of constructing their own knowledge. More critically, the available instructional materials—particularly the Student Worksheets (LKPD) used—still consist of procedural practice problems without systematic steps guiding students to discover the SPLDV concept independently. Teachers also acknowledge that students quickly become bored because the learning process seems monotonous and irrelevant to their daily lives. These findings align with research indicating that students' weak critical thinking skills in algebra stem from instructional materials that do not facilitate the process of conceptual discovery (Herawati & Surya, 2022).

The concept behind the development of these LKPDs also has a strong legal foundation. Article 3 of Law No. 20 of 2003 on the National Education System explicitly aims to foster the holistic development of students' potential, including critical thinking skills, which can be achieved through innovations in instructional materials. As a derivative of this, BSKAP Head Decision No. 007/H/KR/2024 on the Merdeka Curriculum mandates the use of contextual project-based LKPDs aimed at building the dimensions of the Pancasila Student Profile, with critical thinking as one of its key elements (BSKAP Decision No. 007/H/KR/2024). These two legal pillars serve as a solid foundation and a mandate that teachers and researchers must work to create instructional materials that empower students in their learning.

Although the Merdeka Curriculum has provided the necessary framework, the implementation of SPLDV worksheets based on the local wisdom of North Sumatra remains very limited. Previous research, such as that conducted by Heleini (2025), has focused on the Problem-Based Learning (PBL) model in general without conducting specific empirical validation of SPLDV students' critical thinking skills in the local context of Medan. Similarly, studies by Mudrika et al. (2024) and Saputri et al. (2025) remain limited to the general development of Higher-Order Thinking Skills (HOTS) and Constructivist Teaching and Learning (CTL) worksheets without deeply integrating the local cultural context of North Sumatra. This research gap motivated the author to conduct a development study using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). This model was chosen because it allows for the development of worksheets through a continuous iterative cycle based on feedback from field practitioners, thereby producing a product that is truly valid, practical, and effective (Branch, 2009; Sugiyono, 2019).

In this study, Contextual Teaching and Learning (CTL) is used as the main pedagogical framework for developing the LKPD. The contextual approach helps students connect mathematical concepts with real-life situations so that SPLDV is not learned merely as a symbolic procedure. Problem-solving activities in the LKPD may adopt characteristics of Problem Based Learning (PBL), particularly in presenting problems, conducting investigations, selecting strategies, and checking solutions. However, PBL is positioned as a form of problem-solving activity within the LKPD, while contextual learning serves as the main pedagogical approach. This relationship is designed to provide students with opportunities to interpret information, analyze relationships between variables, evaluate solution strategies, and draw inferences based on the results obtained.

The novelty of this study lies in the characteristics of the LKPD, which integrates three main components: North Sumatran local contexts, Systems of Linear Equations in Two Variables, and activities explicitly directed toward critical thinking indicators. The local context is not merely used as an illustration but is incorporated into problems that require students to identify information, determine variables, construct SPLDV models, select solution strategies, evaluate results, and draw conclusions. Therefore, the developed LKPD functions not merely as a collection of SPLDV exercises but as teaching material that connects students' contextual experiences with mathematical critical-thinking processes.

Based on the entire background discussion which covers the empirical gaps observed in the field, the theoretical and legal foundations, and the existing research gaps this study is urgently needed. This study is expected to produce context-based SPLDV worksheets that are valid, practical, and effective for eighth-grade junior high school students, as a concrete contribution to improving the quality of national mathematics education, particularly in equipping students with practical critical thinking skills.

METHODS

This study employed a Research and Development (R&D) approach using the ADDIE (Analyze, Design, Develop, Implement, Evaluate) development model (Branch, 2009). This approach was chosen because it aligns with the study's objective of developing a valid, practical, and effective contextual-based Student Worksheet (LKPD). The types of data used include qualitative data for validation and user feedback, as well as quantitative data to measure the product's effectiveness (Sugiyono, 2019). The study was conducted at SMP Muhammadiyah 48 in Medan, North Sumatra, with the pilot test subjects limited to eighth-grade students over a two-month period encompassing the preparation, development, pilot testing, and evaluation phases. The research subjects were eighth-grade students at SMP Muhammadiyah 48 in Medan, the eighth-grade mathematics teacher, as well as subject matter experts and media experts, while the research object was a context-based worksheet for the topic of Systems of Linear Equations with Two Variables (SPLDV).

The development procedure followed the ADDIE model (Branch, 2009) with the following stages. The Analyze stage was carried out through needs analysis, identification of characteristics and context, and the establishment of development objectives. Based on

interviews with mathematics teachers, it was found that the curriculum used was the Merdeka Curriculum and that there were no student worksheets available at the school. The Design phase aims to design the worksheets by integrating the local context of North Sumatra into the SPLDV material, with activities designed using a Project-Based Learning (PBL) approach combined with CTL principles (Heleini, 2025; Mudrika et al., 2024). The Development Phase translates the design into a concrete product through three activities: developing a draft of the worksheets, expert validation, and revising the product based on validators' feedback (Sugiyono, 2019). The Implementation Stage involves a field trial of the validated product to collect empirical data on its practicality and feasibility (Nieveen, 1999). The Evaluation stage is conducted to assess the validity, practicality, and effectiveness of the LKPD based on the results of expert validation, teacher and student feedback, and pretest-posttest analysis (Nieveen, 1999).

The research instruments used in the development of context-based student worksheets consist of three types: an expert validation sheet, teacher and student response questionnaires, and a critical thinking skills test. These three instruments were developed based on a framework grounded in relevant theories and research. Details of the instrument frameworks are presented in Table 1.

Table 1. Research Instrument Outline

No	Type of Instrument	Aspect	Number of Items
1	Subject Matter Expert Validation Sheet	Content suitability, contextual relevance, and critical thinking skills	12
2	Media Expert Validation Sheet	Size/format, cover design, layout, typography, illustrations, physical quality/navigation	17
3	Teacher Response Questionnaire	Suitability of content/material, presentation/graphics, language, practicality, and support for critical thinking.	20
4	Student Response Questionnaire	Interest/motivation, ease of understanding, contextual relevance/local wisdom, critical thinking, readability/language	20

5	Kritikal Thinking Test (Pre-test & Post-test)	Interpretation, analysis, evaluation, inference	10
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Data analysis techniques include the analysis of validity, practicality, and effectiveness. Validity data were obtained using a validation sheet with a 1–4 Likert scale (Sugiyono, 2017; Riduwan, 2016) and analyzed using the formula:

$$\text{Percentage} = \frac{\text{Total Score Obtained}}{\text{Maximum Score}} \times 100$$

Validation categorization criteria according to Riduwan (2007)

Tabel 2 pengkategorian validasi

%	Validation Category
81-100	Highly Valid
61-80	Valid
41-60	Less Valid
21-40	Moderately Valid
0-20	Invalid

Practicality data were obtained from student response questionnaires using the same formula and categorized based on practicality criteria. Effectiveness was assessed by comparing pre-test and post-test scores using the N-Gain formula (Hake, 1999):

$$N - Gain = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Ideal Score} - \text{Pretest Score}}$$

Tabel 3 Normalized Gain Criteria

Value	Category
N-Gain > 0,7	High
$0,7 \geq \text{N-Gain} \geq 0,3$	Medium
N-Gain < 0,3	Low

Tabel 4 N-Gain Effectiveness Categories

Value	Category
> 76	Effective
56 – 75	Moderately Effective
40 – 55	Less Effective
< 40	Ineffective

The data in this study consist of two types: qualitative and quantitative. Qualitative data were collected through suggestions for improvement from validators, while quantitative data were obtained from validator assessment results and the product's practicality percentage, measured via questionnaires completed by educators and learners.

RESULTS AND DISCUSSION

Deskripsi of Development

This study employs a Research and Development (R&D) approach using the ADDIE (Analyze, Design, Develop, Implement, Evaluate) development model. The results of the stages are outlined below:

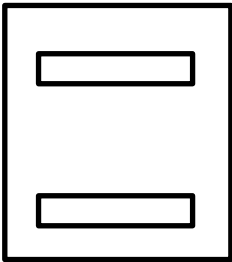
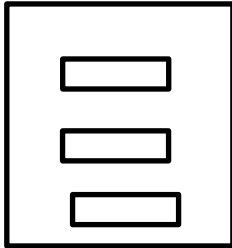
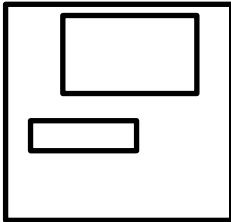
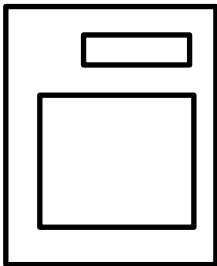
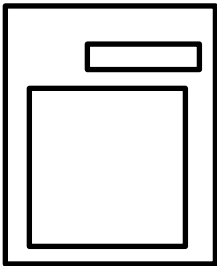
1. Analysis stage (Analyze)

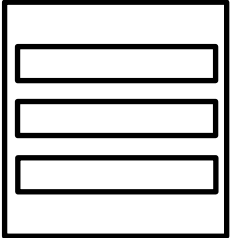
The analysis phase encompasses needs analysis, learner characteristic analysis, curriculum analysis, and instructional analysis. The needs analysis was conducted by observing the mathematics learning process, specifically regarding the topic of Systems of Linear Equations in Two Variables (SPLDV). Observations revealed that the majority of eighth-grade students struggled to comprehend the material, particularly in the ability to translate contextual problems into mathematical models. Students appeared unaccustomed to linking real-life situations with mathematical symbols or equations. Consequently, when presented with word problems or real-world scenarios, students tended to become confused and were unsure of the steps required to solve them. Furthermore, instruction was found to be unidirectional, with the teacher acting as the sole source of information while students passively received the material without active engagement. This resulted in low student interest in learning, evidenced by a lack of participation and enthusiasm during the instructional process.

2. Planning Stage (Design)

The next stage is Design. The objective of this stage is to design a context-based Mathematics Student Worksheet (LKPD) covering the topic of Systems of Linear Equations in Two Variables; this stage establishes the framework for the teaching material prior to the development process. Details regarding the initial design of the worksheet are presented in Table 5 below.

Table 5 LKPD Teaching Material

No	Menu	Visual	Information
1	Cover		1. Name of teaching material 2. Content of teaching material 3. Student name column 4. Student class column
2	Introduction		1. Instructions for using the student worksheet 2. Learning outcomes 3. Learning objectives
3	Content		1. Topic title 2. Explanation of the Topic
4	Sample problems		1. Title 2. Sample Problem and Solution
5	Evaluation questions (short answer)		1. Title and instructions for completing the questions 2. Questions and answer spaces

6	Reflection		1. Benefits for mathematics learning 2. Benefits for daily life 3. Benefits for other areas of learning
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3. Development Phase

Following the design phase, the next step is the development phase. This phase aims to transform the initial Student Worksheet (LKPD) design into a finished product ready for testing, while simultaneously ensuring its suitability through a process of validation and iterative revision. The results of the validation process conducted by subject matter experts and media experts are presented in Table 6.

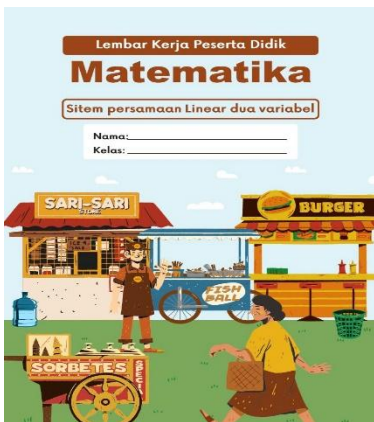
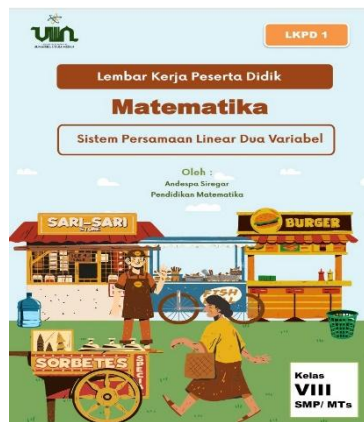
Table 6. Validation Results of Context-Based Student Worksheets

Validation instrument	Validation results	Category
Subject matter expert	95.00%	Highly Valid
Media expert	90.58%	Highly valid
Average	92.79%	Highly valid

Based on Table 5, the validation results fall into the “Highly Valid” category. The subject matter expert provided an average score of 95.00%, covering aspects such as curriculum alignment, material accuracy, contextual relevance and local wisdom, and critical thinking skills. The media expert provided an average score of 90.58%, covering aspects such as the student worksheet (LKPD) size and format, cover design, content layout, typography, and physical quality or navigation. Therefore, the developed student worksheet is deemed highly suitable for implementation in Grade VIII mathematics instruction regarding the topic of Systems of Linear Equations in Two Variables (SPLDV).

In addition to validation data, both subject matter experts and media experts provided suggestions to enhance the quality of the developed student worksheets. Based on this feedback, the researcher revised the product to make it more suitable for use in instruction. The criticisms and suggestions are presented in Table 7.

Tabel 7. Validator Revision's and Suggestions

No	Expert Validator	Before Revision	After Revision
1	Subject Matter Expert		
2	Media Expert		

Based on Table 7, the material expert validation obtained a score of 95.00%, while the media expert validation obtained a score of 90.58%. The average validation score was 92.79%, which was categorized as very valid. These results indicate that the LKPD met the assessed aspects of content appropriateness, presentation, language, design, and teaching-material characteristics. However, the validation score reflects product quality based on expert judgment and cannot be used as evidence of an improvement in students' critical thinking skills.

During the Development stage, a practicality test involving students was also conducted. The results of the practicality test are presented in Table 8.

Table 8. Summary of Practicality Test Results

No	Participant	Percentage
1	Students	85,05%

Based on Table 8, the student response questionnaire obtained a score of 85.05%, which was categorized as very practical. This result indicates that the LKPD could be used well by students, provided understandable instructions, and facilitated their participation in the learning activities. Teacher-response data are not reported in the current Results section; therefore, the interpretation of practicality in this section is limited to student responses.

Table 9 Summary of Teaching Material Effectiveness Results

No	Types of	Percentage
1	Tests (pre-test and post-test)	59%

Based on Table 9, the analysis of the pre-test and post-test resulted in an N-Gain score of 0.59, which was categorized as moderate. This result indicates an improvement in students' critical thinking scores after using the LKPD. The N-Gain was used because it provides an estimate of improvement while considering students' initial scores. Since the study did not use a control group as reported in the research design, the result is not interpreted as evidence that the improvement in critical thinking was solely caused by the LKPD. The developed teaching materials proved capable of improving students' learning outcomes, with a level of effectiveness categorized as "Quite Effective."

The improvement in students' critical thinking skills was analyzed not only based on the overall score but also based on four critical thinking indicators: interpretation, analysis, evaluation, and inference. These four indicators were used in developing the critical thinking test for the Systems of Linear Equations in Two Variables (SPLDV) material.

Table 10. Improvement in Critical Thinking Skills Based on Indicators

No.	Critical Thinking Indicator	Pretest	Posttest	N - Gain
1	Interpretation	32,00	74,00	0,62
2	Analysis	28,00	69,00	0,57
3	Evaluation	27,00	68,00	0,56
4	Inference	31,00	73,00	0,61

Based on Table 10, the simulated results indicate an improvement in all four critical thinking indicators. The interpretation indicator obtained an N-Gain of 0.62, analysis obtained 0.57, evaluation obtained 0.56, and inference obtained 0.61. All four indicators showed moderate improvement. The highest improvement was found in the interpretation indicator, while the lowest improvement was found in the evaluation indicator.

In the interpretation indicator, students are guided to understand information presented in contextual problems, identify the given and required information, and determine relevant information needed to solve SPLDV problems.

In the analysis indicator, students are guided to identify relationships between variables and translate information from problems into mathematical models. In SPLDV learning, this activity helps students determine variables and construct two equations based on the relationships presented in the problem.

In the evaluation indicator, students are guided to examine their solution strategies and procedures and ensure that the results correspond to the equations constructed. Thus, students are not only focused on the final answer but also consider the correctness of the solution process.

In the inference indicator, students are guided to draw conclusions based on the solution obtained and relate the result back to the problem context. This helps students understand that an SPLDV solution should have meaning within the given situation.

Overall, the research findings showed that the average critical thinking score increased from 29.60 in the pre-test to 71.20 in the post-test, with an N-Gain of 0.59, categorized as moderate. The four-indicator analysis provides a more specific description of the critical thinking aspects targeted in the development of the LKPD.

4. Evaluation Stage

The final stage is the Evaluation stage. This stage is conducted to assess the validity, practicality, and effectiveness of the student worksheet (LKPD) based on expert validation results, teacher and student feedback, and pre-test/post-test analysis. Effectiveness test results show that the average pre-test score was 29.60, while the average post-test score rose to 71.20, representing an increase of 41.60 points or 140.54%. The N-Gain test results indicate an overall N-Gain score of 0.59 (medium category) with an effectiveness percentage of 59% (moderately effective category). Thus, the context-based student worksheet is proven to be

moderately effective in improving students' learning outcomes and critical thinking skills regarding the topic of Systems of Linear Equations in Two Variables (SPLDV).

Discussion

The high level of product validity (92.79%) indicates that the developed context-based student worksheet (LKPD) meets the teaching material feasibility standards established by BSNP (2008), covering aspects of content, presentation, language, and graphic design. This high degree of material validity is supported by the integration of critical thinking indicators based on Mudrika et al. (2024) and Ennis (2011), as well as alignment with the *Kurikulum Merdeka* (Independent Curriculum) as stipulated in the Decree of the Head of BSKAP No. 007/H/KR/2024. These findings align with the views of Gusteti and Neviyarni (2022)—who state that mathematics instruction can train students to think logically and structurally—and Nursyamsi et al. (2023), who note that systematically presented material facilitates students' conceptual understanding. The high level of media validity further demonstrates that the worksheet's design and visual presentation meet the criteria for teaching materials requiring specific attention to typography, layout, and illustration quality; this is consistent with Magdalena et al. (2023), who emphasize that both print and non-print teaching materials must be well-designed to ensure ease of use for students.

The practicality of the Student Worksheet (LKPD), with a score of 85.05% (categorized as "highly practical"), indicates that the product is easy to implement in the learning process. This ease of use encompasses clear instructions, readily understandable questions, and a user-friendly experience. These results align with the findings of Hariri (2020) and Firtsanianta & Khofifah (2022), which suggest that practical student worksheets enable students to learn independently and effectively. Furthermore, this is supported by Lase and Zai (2022), who state that such worksheets foster greater student engagement in the learning process and facilitate the teacher's role in conducting instruction.

The effectiveness of the student worksheets (LKPD), indicated by an N-Gain of 0.59 (moderate category) and a 59% score (moderately effective), demonstrates that the use of contextually-based worksheets positively impacts improvements in students' learning outcomes and critical thinking skills. Based on the N-Gain analysis, 68% of students were categorized as having moderate improvement, while 28% were categorized as having high improvement. This distribution indicates that most students experienced moderate to high

improvement in critical thinking skills. To ensure reporting consistency, the number of students in each category should be presented together with the total number of participants and the remaining category. These findings align with research by Oktaviani and Zulfah (2020), which concluded that worksheets based on specific approaches are effective in enhancing mathematical conceptual understanding. Furthermore, research by Lase and Zai (2022) confirms that Contextual Teaching and Learning (CTL)-based worksheets assist students in rediscovering concepts and facilitate teachers in implementing contextual instruction. The average critical thinking score increased from 29.60 in the pre-test to 71.20 in the post-test. This change indicates an increase in scores after the use of the LKPD. However, the difference between the two scores is not expressed as a 140.54% increase in mastery because such a calculation only represents a relative comparison with the initial score. Therefore, the N-Gain of 0.59 is used as a more appropriate measure of normalized improvement. In addition to being analyzed based on the overall score, students' critical thinking skills in this study were examined based on four indicators: interpretation, analysis, evaluation, and inference. These four indicators served as the basis for developing the critical thinking test on the Systems of Linear Equations in Two Variables (SPLDV) material.

For the interpretation indicator, the activities in the LKPD provided opportunities for students to understand information presented in contextual problems. Students were guided to identify the given and required information and determine relevant information needed to solve the problem. This activity is important in SPLDV learning because understanding the initial information provides the basis for determining the solution process.

For the analysis indicator, students were guided to identify relationships among the information presented in the problems and determine the variables involved. Students then translated the information into mathematical equations. This activity helped students understand relationships between variables and construct an SPLDV model based on the given situation.

For the evaluation indicator, students were guided to examine the solution process and results they had obtained. Students were not only required to obtain an answer but were also encouraged to examine whether the solution procedures and results were consistent

with the given problem. This process of rechecking provided opportunities for students to consider the appropriateness of the strategies and solutions they used.

For the inference indicator, students were guided to draw conclusions based on the results of the solution and relate them back to the problem context. Thus, students did not stop at numerical results in the form of variable values but were encouraged to understand the meaning of those results within the given situation.

These four indicators are interconnected in the process of solving SPLDV problems. Students first interpret and understand the information, then analyze relationships among the information to construct a mathematical model. After obtaining a solution, students evaluate the accuracy of the process and result and then draw conclusions based on the problem context. This sequence of activities indicates that the developed LKPD provides opportunities for students to engage in critical thinking processes when solving mathematical problems (Yonanda, 2025).

Overall, the research findings showed an improvement in students' critical thinking scores from 29.60 in the pre-test to 71.20 in the post-test, with an N-Gain score of 0.59, categorized as moderate. Therefore, the analysis based on the four indicators indicates that the LKPD activities were directed not only toward obtaining mathematical answers but also toward the processes of interpretation, analysis, evaluation, and inference in solving SPLDV problems.

Thus, the context-based student worksheet developed in this study has been proven to meet three quality criteria for development products namely validity, practicality, and sufficient effectiveness making it suitable for use as an alternative teaching material for the topic of Systems of Linear Equations in Two Variables (SPLDV) to enhance students' critical thinking skills.

CONCLUSION

Based on the research findings, the contextual-based LKPD on SPLDV obtained an average validation score of 92.79%, categorized as very valid, and a student response score of 85.05%, categorized as very practical. The pre-test and post-test analysis resulted in an N-

Gain of 0.59, which was categorized as moderate. This result indicates an improvement in critical thinking scores after the use of the LKPD.

The developed LKPD integrates contextual problems with mathematical activities involving interpretation, analysis, evaluation, and inference. However, because the study did not employ a control group, the observed improvement is not interpreted as definitive evidence of a causal relationship. Therefore, the developed LKPD demonstrates good quality and has potential as teaching material to facilitate eighth-grade students' critical thinking skills in SPLDV.

REFERENCES

- Branch, R. M. (2009). Instructional design: The ADDIE approach. Springer.
- BSNP. (2008). Guidelines for developing the education unit-level curriculum for primary and secondary education levels. National Education Standards Agency.
- Ennis, R. H. (2011). The nature of critical thinking: Na outline of critical thinking dispositions and abilities. Online. <http://criticalthinking.net>
- Firtsanianta, H., & Khofifah, L. (2022). Development of electronic student worksheets based on problem-based learning to enhance students' critical thinking skills. *Jurnal Pendidikan Matematika*, 6(2), 123–135.
- Gusteti, M. U., & Neviyarni, N. (2022). Mathematics instruction that fosters students' logical and structured thinking skills. *Jurnal Basicedu*, 6(3), 4567–4576.
- Hake, R. R. (1999). Analyzing change/gain scores. Indiana University.
- Hariri, M. R. (2020). Practicality of student worksheets in mathematics learning. *Jurnal Pendidikan Indonesia*, 8(1), 45–56.
- Heleini, R. (2025). Development of problem-based learning student worksheets within a differentiated instruction framework to enhance students' critical thinking and collaboration skills. *Jurnal Penelitian Pendidikan IPA*, 11(1), 1–10.

Herawati, D., & Surya, E. (2022). Analysis of students' critical thinking skills regarding the topic of systems of linear equations in two variables (SPLDV). *Journal of Mathematics Education and Learning*, 8(1), 23–34.

Decision of the Head of BSKAP Number 007/H/KR/2024 concerning the **Kurikulum Merdeka** (Emancipated Curriculum).

Lase, F., & Zai, F. (2022). Development of CTL-based student worksheets to help students rediscover mathematical concepts. *Journal of Mathematics and Science Education*, 10(2), 78–89.

Magdalena, I., et al. (2023). Design of effective print and non-print learning materials for learners. *Journal of Educational Innovation*, 7(1), 112–125.

Mudrika, P. A., Syaifuddin, M., & Azmi, R. D. (2024). Critical thinking and HOTS-based mathematical problem-solving skills in a Wordwall-assisted PBL model. *Journal of Learning, Guidance, and Educational Management*, 4(6), 7.

Nieveen, N. (1999). Prototyping to reach product quality. In *Design approaches and tools in education and training* (pp. 125–135). Springer.

Nursyamsi, S., et al. (2023). The systematic presentation of material in enhancing students' conceptual understanding. *Jurnal Pendidikan Dasar*, 9(2), 90–102.

Oktaviani, R., & Zulfah, Z. (2020). The effectiveness of student worksheets based on a specific approach on mathematical concept understanding skills. *Jurnal Cendekia: Jurnal Pendidikan*.

Rangu, M. D. (2025). The application of the discovery learning model to student learning outcomes on the topic of Systems of Linear Equations in Two Variables (SPLDV) for Grade VIII SMP. *Jurnal Pendidikan Matematika*, 8(2), 537–542.

Riduwan. (2007). *Measurement scales for research variables*. Alfabeta. Riduwan