Journal of Mathematics Education
Website: http://usnsj.id/index.php/JME
Email: pengelolajme@gmail.com
p-ISSN 2528-2468; e–ISSN 2528-2026

DOI: https://doi.org/10.31327/jme.v11i2.2864

DEVELOPMENT OF A SCRATCH-ASSISTED PBL-BASED E-LKPD TO IMPROVE JUNIOR HIGH SCHOOL STUDENTS' COMPUTATIONAL THINKING SKILLS IN ALGEBRA

Marisa Qonita*[1], Aprilia Nurul Chasanah[2], Yesi Franita[3]
[1,2,3] Universitas Tidar

Article Info

Article history:

Received Aug 05, 2026
Revised Aug 10, 2026
Accepted Aug 23, 2026

Keywords:

E-LKPD
Computational Thinking
Problem Based Learning (PBL)

ABSTRACT

This research focuses on creating an electronic student worksheet (E-LKPD) centered around Problem-Based Learning (PBL) through Scratch, aimed at improving students' computational thinking abilities in algebra at Ngadirejo Islamic Junior High School, located in Temanggung Regency. A Research and Development (R and D) method is utilized, following the ADDIE framework (Analysis, Design, Development, Implementation, Evaluation). The subjects of this research were the seventh-grade students in class VII H, and surveys served as the primary data collection tool. Validation outcomes show that the E-LKPD learning material received an average score of 86. 3%, categorizing it as "valid. " Student and teacher feedback also highlighted the E-LKPD's practicality, reflected in a score of 83. 47%. The integration of this resource into mathematics teaching significantly boosted students' computational thinking skills. The average scores climbed from 34. 97 before application to 68. 32 afterward, resulting in an N-gain score of 0. 5342, which is rated as "medium. " Therefore, it can be concluded that the E-LKPD is valid, practical, and effective in enhancing the computational thinking skills of students.

Corresponding Author:

Marisa Qonita,
Departement of Mathematics Education,
Universitas Tidar, Indonesia
Email: marisaqonita@students.untidar.ac.id

How to Cite:

Qonita, M., Chasanah, A. N., & Franita, Y. (2026). Development of A Scratch-Assisted PBL-Based E-LKPD to Improve Junior High School Students' Computational Thinking Skills in Algebra. *JME: Journal of Mathematics Education*, *11*(2), 483-499.

1. INTRODUCTION

Computational thinking has become one of the key skills that is now receiving global attention. This skill encompasses decomposition, abstraction, algorithmic design, and generalization (Fajri et al., 2019; Huang & Looi, 2020; Wing, 2006). Computational thinking (CT) is not limited to computer science; these skills enable individuals to understand and solve complex problems efficiently and can be applied across various disciplines, including education (Araya et al., 2021; Ardianto et al., 2025). In mathematics education, CT skills are crucial because they enhance students' understanding of abstract concepts and improve their logical reasoning and argumentation abilities (N. Christi & Rajiman, 2023; Rahma et al., 2024). Therefore, the application of computational thinking in mathematics education is crucial to support the development of students' higher-order thinking skills.

However, numerous investigations indicate that the computational thinking (CT) skills of high school learners remain fairly inadequate, particularly when it comes to grasping abstract ideas like algebra. Many students view algebra as a challenging topic due to the incorporation of symbols, variables, and significant levels of abstraction. The focus on teacher-led instruction and the absence of interactive learning tools hinder students from attaining a profound understanding of these concepts. The consequences of this situation are evident in the students' limited problem-solving and computational thinking skills. Additional research has further verified that students' CT skills in algebra continue to be fairly low. Utami et al. (2024) discovered that students found it difficult to utilize elements of computational thinking such as abstraction and algorithms to resolve algebraic issues; the majority of students had trouble finding solutions to algebraic problems systematically. Moreover, another study indicated that students' abilities in computational reasoning regarding algebraic functions were still within a moderate to low spectrum (Lisa et al., 2024). These results imply that there is a need for creative teaching methods to enhance students' computational thinking skills, particularly concerning algebra.

The results of the researchers' direct observations at Ngadirejo Islamic Junior High School support this statement. The results of a test administered in one of the classes showed that in the CT skills test, only about 13% of students demonstrated a high level of proficiency, while the rest were classified as having proficiency levels ranging from adequate to very low. The underlying cause of this low proficiency stems from mistakes in recognizing information, devising steps for solutions, and selecting appropriate techniques. An educator at Ngadirejo Islamic Junior High School indicated that students struggle with word problems primarily due to insufficient arithmetic skills and the belief that these problems are difficult to tackle. Additionally, traditional teaching methods and the sparse implementation of non-standard tasks further exacerbate this issue. As a result, these challenges hinder the overall effectiveness of the learning experience in the classroom. However, when teaching materials and methods are in harmony with technological developments, and teachers can apply these effectively, the learning process significantly improves (Kumala et al., 2024). The Problem-Based Learning (PBL) model serves as an effective alternative for enhancing students' computational thinking (CT) abilities.

The PBL educational approach is viewed as effective in enhancing students' computational thinking (CT) skills since it emphasizes hands-on learning through real-life situations and prioritizes problem-solving within context. Studies indicate that implementing PBL centered on computational reasoning notably boosts students' analytical skills (Gultom et al., 2022). Additional research has also revealed that PBL positively affects various elements of computational reasoning, especially in areas like problem decomposition and algorithmic thought processes (Hauda et al., 2024). Moreover, findings from meta-analysis reinforce that PBL significantly enhances students' computational reasoning capabilities

(Zhang et al., 2024). Nevertheless, the implementation of PBL in mathematics education has not yet been fully optimized due to the limited availability of instructional materials specifically designed to accommodate the PBL framework while integrating computational thinking (CT) competency indicators (Lubis & Sinaga, 2021). Accordingly, there is a need for innovative instructional materials in the form of E-LKPDs that can support a more structured and interactive implementation of PBL.

In recent years, a number of studies have examined efforts to improve students' computational thinking skills through worksheets (LKPD) or electronic worksheets (E-LKPD). The findings of these studies indicate that PBL-based E-LKPDs can effectively develop students' computational thinking skills (Al-Hafizha et al., 2025). Another study revealed that interactive E-LKPDs help students understand concepts and practice computational thinking skills through contextual and targeted activities (Ostian et al., 2023). These findings are reinforced by Melinia et al. (2025), who also noted that the development of Student Live Worksheets (LKPD) based on differentiation has proven effective in supporting the development of students' computational thinking skills through interactive and contextual learning approaches. However, in general, the E-LKPDs developed to date still have limitations in facilitating the concrete visualization of computational thinking processes. Most E-LKPDs still focus on text-based activities and have not yet integrated interactive media capable of dynamically representing algorithmic processes. In fact, computational thinking skills require students not only to understand concepts but also to implement them in the form of algorithmic steps. Various programming platforms can be used to enhance these skills, such as Python, Flash, Java, and Scratch. Scratch is a student-friendly visual programming language, even for those without a technical background. This platform allows students to create animations, stories, and games in a simple and engaging way, thereby encouraging exploration and problem-solving (Aminah et al., 2023). Therefore, integrating Scratch as a visual programming tool into E-LKPD is important, as Scratch enables students to explore, model, and apply algorithmic steps while supporting the development of their computational thinking skills more effectively.

Nevertheless, existing studies have not yet sufficiently addressed the development of an E-LKPD that simultaneously integrates Problem-Based Learning (PBL), Scratch, and junior high school algebra within a computational thinking-oriented learning design. Previous studies have explored PBL to promote computational thinking, Scratch to support mathematical and computational thinking, and E-LKPD as an interactive learning medium; however, the integration of these three components into a single E-LKPD specifically designed for algebra learning at the junior high school level remains limited. Furthermore, there is still a lack of learning designs that explicitly align PBL activities and Scratch-based tasks with computational thinking indicators. Thus, a gap remains in the availability of an integrated E-LKPD that not only presents algebraic problems through PBL and Scratch but also facilitates the development of students' computational thinking skills.

Considering these factors, the researchers were interested in developing an E-LKPD based on a Scratch-assisted PBL learning model aimed at helping students enhance their comprehension and tackle mathematical challenges. The main focus of this study lies in the development of a Scratch-assisted Problem-Based Learning (PBL)-based E-LKPD that is valid, practical, and effective for enhancing the cognitive and technical abilities of high school learners. From a theoretical standpoint, this study aspires to contribute to the field of educational science, especially in the areas of media development and learning approaches. On a practical level, the resulting product can serve as a viable interactive educational resource for instructors to boost students' motivation and cognitive abilities as well as assist schools in adopting innovative and creative digital teaching methods.

2. METHOD

The approach taken in this research is grounded in a research and development framework, focusing on exploring, creating, and producing a product, while also assessing its validity and effectiveness (Sugiyono, 2017). The final output is an innovative electronic worksheet (E-LKPD) rooted in Problem Based Learning (PBL) and developed using Scratch, intended for instructing junior high school students in algebra. This worksheet is provided electronically and is compatible with Android devices and computers. The participants involved in this research consisted of 31 female students in 7th grade during the 2025/2026 school year. The study took place at Ngadirejo Islamic Junior High School located in Temanggung Prefecture. The development process for this educational resource adhered to the ADDIE framework, encompassing the stages of analysis, design, development, implementation, and evaluation.

The first stage of the analysis is the process of identifying the problems addressed in this study. This study involves collecting data on the problems that have arisen and then identifying solutions through an appropriate needs analysis. The second stage is the design stage; during this stage, the focus is on identifying the kind of media to be crafted and the design methodology itself, such as the layout of the e-learning platform (E-LKPD), its materials, and its aesthetic design. This stage is essential as it lays down the foundation that will be advanced in the following stages. The third stage is the development stage, where the E-LKPD is built based on the design established in the earlier stage. In this stage, specialists perform a feasibility analysis to pinpoint areas that can be enhanced, allowing the product to be implemented in small groups. The fourth stage is the implementation stage, where the final product is put to use in an actual classroom setting to assess its effectiveness and usefulness. In the ADDIE model, the evaluation stage serves as the final phase, aimed at assessing the results of instructional product development (Cahyadi, 2019). During this stage, researchers conduct an evaluation to assess the developed product based on the results of the pilot testing phase. The tested product then receives feedback from validators, teachers, and students.

In this E-LKPD study, data were analyzed using qualitative and quantitative approaches. Qualitative data came from contributions and suggestions from expert assessors, while quantitative data were obtained from student responses to the E-LKPD and validation results from expert assessors. The analysis results were initially presented in quantitative form and then converted into qualitative form by the researcher. The validation questionnaire was evaluated by calculating scores on a Likert scale of 1–4, using the following formula:

$$P = \frac{\sum x}{\sum x_i} \times 100$$

Notes:
P = Percentage score
$\sum x$ = Total score from validators
$\sum x_i$ = Maximum possible score

The results of the E-LKPD validity calculations were then interpreted qualitatively based on the criteria in table 1.

Table 1. Product Validity Qualifications

Percentage	Validity Criteria
$85{,}01\% - 100\%$	Highly Valid
$75{,}01\% - 85\%$	Valid
$60{,}01\% - 75\%$	Moderately Valid
$50{,}01\% - 60\%$	Less Valid
$< 50\%$	Very Less Valid

The practicality of E-LKPD was assessed through a survey filled out by both math educators and learners. This survey was given to participants after they had utilized E-LKPD during lessons. The practicality of the E-LKPD was computed using the formula below:

$$P = \frac{\sum x}{N} \times 100\%$$

Notes:
P = Percentage score
$\sum x$ = Total score from respondents
N = Maximum score
The results of the E-LKPD practicality assessment were then interpreted qualitatively based on the criteria in table 2.

Table 2. Product Practicality Ratings

Percentage	Practicality Category
$85{,}01\% - 100\%$	Very Practical
$75{,}01\% - 85\%$	Practical
$60{,}01\% - 75\%$	Fairly Practical
$50{,}01\% - 60\%$	Not Very Practical
$< 50\%$	Very Impractical

The effectiveness of the product was evaluated through the results of students' tests before and after the intervention. Afterward, the effectiveness of the intervention was examined using the N-gain method with this specific formula.

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

The categorized of N-Gain scores is based on the guidelines listed in table 3.

Table 3. N-Gain Score Category

Skor N-Gain	Category
$g > 0{,}7$	High
$0{,}3 < g \leq 0{,}7$	Moderate
$g < 0{,}3$	Low

In addition, to identify significant differences between the groups, a hypothesis test will be conducted. However, prior to that, a normality test will be performed to determine whether the data are normally distributed. If the data are normally distributed, the hypothesis test used will be a parametric test, specifically a paired-sample t-test. The purpose of this hypothesis test is to determine differences in students' CT skills before and after the use of the developed E-LKPD.

The E-LKPD learning media developed meets the practical criteria if the results of the questionnaire assessment from teachers and students reach at least the "practical" category, with a percentage of 75.01%–85.00%. Furthermore, the E-LKPD learning media is considered effective if there is an increase in pretest and posttest scores that meets at least the "moderate" criteria (Pixyoriza et al., 2022).

3. RESULTS AND DISCUSSION

3.1. Results

Analysis Stage

Identifying the needs for media development is the main activity in this stage (Cahyadi, 2019). This process involves interviews with mathematics teachers at Ngadirejo

Islamic Junior High School, preliminary observations of student conditions, and an analysis of student needs. The interview results showed that most students had difficulty expressing ideas through various forms of mathematical representation. In addition, teachers had not yet utilized supporting media and still relied on textbooks and worksheets. Furthermore, the analysis took into account the characteristics of students, who generally found mathematics difficult and required more engaging and interactive media. The implementation of the Merdeka Curriculum served as the basis for formulating relevant learning activities and learning objectives.

Design Stage

In the initial phase, the researchers designed an early prototype of PBL-based E-LKPD learning media using Scratch. Key activities included developing the structure of the learning media, which involved determining algebra-related content, themes, fonts, and other design elements in accordance with PBL principles and CT indicators. The selection of algebra content was based on observation results, as algebra is a subject that can enhance students' CT skills (Bilbao et al., 2024; Bråting & Kilhamn, 2021). According to the Merdeka Curriculum, seventh-grade algebra content covers the introduction to algebraic expressions, their components, and algebraic operations.

The initial draft of the E-LKPD is still provisional and will be refined through a validation and revision process based on feedback from validators. The components of the E-LKPD consist of a cover page, instructions, learning objectives, content, practice questions, activity steps, and an evaluation (Sa'adah & Utami, 2025). Therefore, the structure of the E-LKPD was organized sequentially with the aim of designing a clear framework before the product development process began. The design of this E-LKPD consists of a cover page, table of contents, identity section, instructions, learning objectives, content, examples and practice problems, and an evaluation section. In addition, the researchers also designed a Scratch project containing practice problems on algebra, which will later be included in the E-LKPD product. The E-LKPD was created using Canva to produce an attractive design and was then uploaded to the heyzine.com platform so that students could access it online.

Development Stage

The E-LKPD instructional media was created based on the plan formulated during the design stage. The researcher developed an E-LKPD based on Problem-Based Learning (PBL) and supported by Scratch to enhance students' computational thinking skills in algebra, ensuring that the media met the learning objectives and adhered to the previously established design. This process involves creating worksheets in electronic form to make them easier and more effective to use in the learning process. In addition, the researcher also developed Scratch-based practice exercises that will be incorporated into the E-LKPD as links so that students can easily access them. The practice problems in Scratch consist of three levels: Level 3 (difficult), Level 2 (moderate), and Level 1 (easy). The content of this E-LKPD includes a cover page, table of contents, E-LKPD identification, learning objectives, usage instructions, learning activities, Scratch-based practice problems, and a learning reflection. This E-LKPD contains four activities, each of which incorporates components found in the Problem-Based Learning (PBL) model. The following are the results of the development of this PBL-based, Scratch-assisted E-LKPD:

Figure 1. E-LKPD Cover

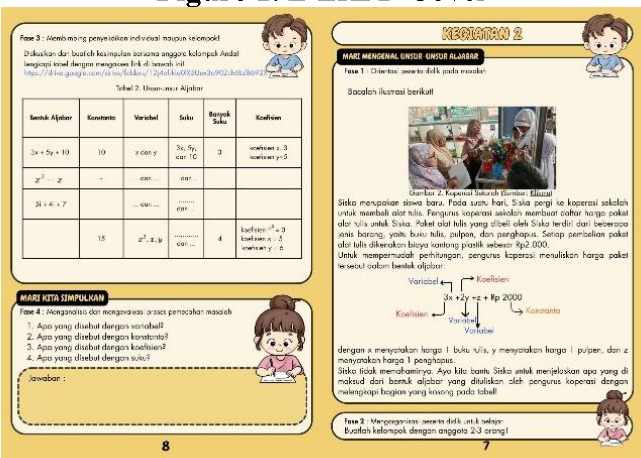


Figure 2. PBL-Based E-LKPD Activities

Figure 3. Screenshot of the main page for Scratch-based practice exercises

Figure 2 illustrates one of the tasks included in the E-LKPD, which incorporates the four stages of the PBL learning approach: identifying the problem, organizing student activities, guiding both solo and collaborative investigations, and analyzing and reviewing the problem-solving procedures. Figure 3 displays the homepage of Scratch, featuring algebra tasks for seventh graders.

Before utilizing the created media, it must undergo a review by experts in the subject area and media specialists. These reviewers assess the media through a survey. The content validation examines the material, structure, and language. Media validation evaluates the suitability of visuals, language application, and interactivity. The assessment process involves filling out a survey. The outcomes of this validation are detailed in the table below:

Table 4. Results of Content Expert Validity

Validator	Total Score	Maximum Score
Validator 1	55	60
Validator 2	58	60
Validator 3	49	60
Total	162	180
Percentage (%)	90	
Category	Highly Valid	

The assessment results from the three subject-matter expert validators presented in Table 4 show that the material in the E-LKPD achieved a 90% rating in the "highly valid" category, indicating that the resource is suitable for use in instruction, provided that several suggestions for improvement are taken into account. The validators' suggestions and comments are presented in table 5.

Table 5. Repairs by a materials expert

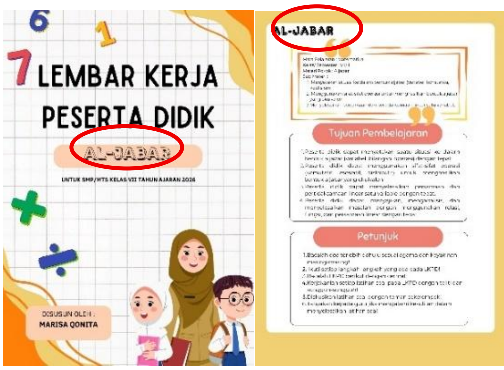
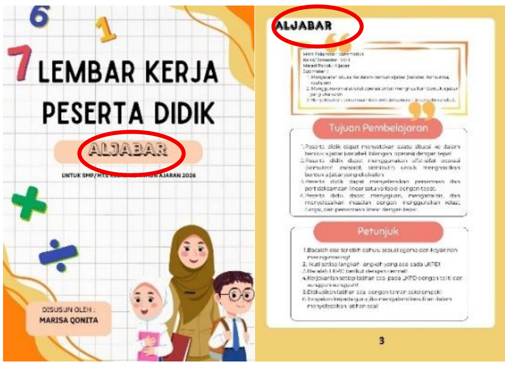
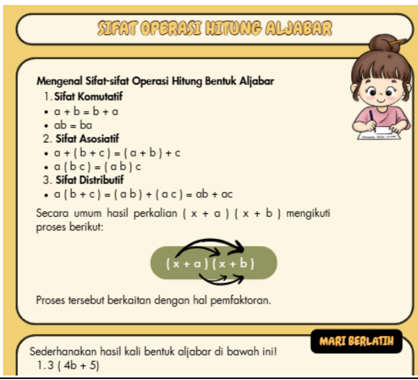
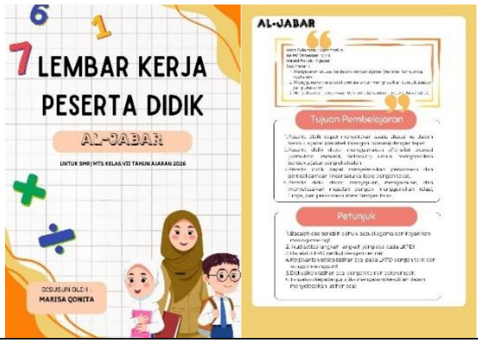
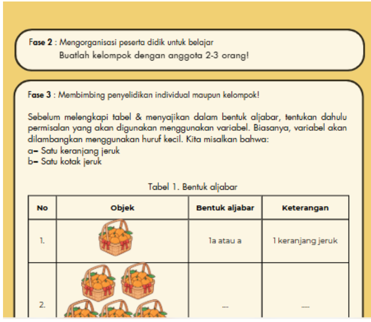
Comments or suggestions: corrections to the algebraic notation in some sections of the E-LKPD	**Comments or suggestions:** correct the confusion regarding the prerequisite material
Before the revision	**Before the revision**
	
After the revision	**After the revision**
	

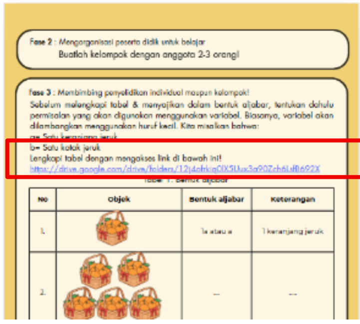
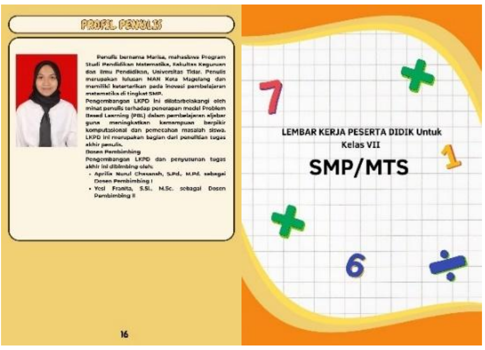
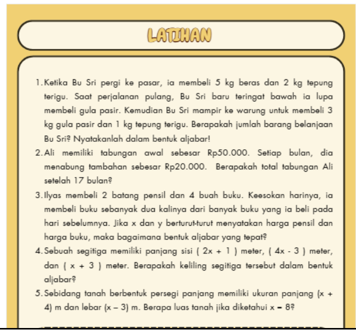
Table 6. Media Expert Validity Results

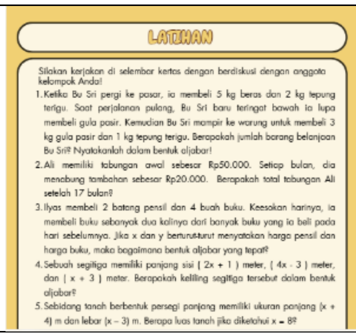
Validator	Score Total	Maximum Score
Validator 1	43	48
Validator 2	39	48
Validator 3	37	48
Total	119	144
Percentage (%)	82,6	
Category	Valid	

Table 6 illustrates that the evaluation by experts of the learning material resulted in a score of 82. 6%, categorizing it as "valid. " Consequently, this Scratch-focused PBL e-LKPD learning resource is appropriate and can be utilized for teaching mathematics. Nevertheless, prior to usage, this educational resource requires modifications according to the feedback from the evaluators. The alterations based on the feedback from the evaluators are presented in Table 7.

Table 7. Repairs by a media expert

<table>
<tr><td>Comments or suggestions: Add page numbers and a table of contents</td><td>Comments or suggestions: on page 3 and similar pages, please include the location where the work was performed</td></tr>
<tr><td>Before the revision

</td><td>Before the revision

</td></tr>
<tr><td>After the revision

</td><td>After the revision

</td></tr>
<tr><td>Comments or suggestions: Add a developer profile and an end credits page</td><td>Comments or suggestions: Add instructions for solving the problems in the practice exercises</td></tr>
<tr><td>After the revision

</td><td>Before the revision

</td></tr>
<tr><td></td><td>After the revision</td></tr>
</table>

Implementation stage

The next stage is implementation, namely the use of the media in real classroom learning situations (Cahyadi, 2019). The product was pilot-tested with seventh-grade students after it had been deemed suitable by expert validators. The E-LKPD, which had been validated, was then tested for practicality through a response questionnaire to determine the media's level of practicality. This implementation involved a math teacher and the students in 7th-grade Class H. Before filling out the questionnaire, the students had already used the E-LKPD as a learning medium in class; afterward, both the teacher and the students provided feedback via the Google Form provided. The results of the responses from the students and the math teacher are presented in the following table.

Table 8. Results of the Student Response Questionnaire

Indicator	Score	Percentage (%)	Rating
Ease of Use of E-LKPD	317	76,20	Practical
Benefits of E-LKPD	409	78,65	Practical
Appearance of E-LKPD	337	81.009	Practical
Total Score	1.063	235,85	-
Average	354,33	78,619	Practical

Table 9. Results of the Mathematics Teachers' Survey

Indicator	Score	Percentage (%)	Rating
Ease of Use of E-LKPD	14	87,5	Very Practical
Benefits of E-LKPD	18	90	Very Practical
Appearance of E-LKPD	14	87,5	Very Practical
Total Score	46	265	-
Average	15,33	88,33	Very Practical

Tables 8 and 9 demonstrate that the feedback from users resulted in an average rating of 83. 47%, with students scoring 78. 61% and mathematics teachers scoring 88. 33%; these findings suggest that the E-LKPD developed is suitable for practical use.

Subsequently, the effectiveness of the E-LKPD was evaluated to assess the enhancement in students' computational thinking abilities before and after utilizing the tool. The medium's effectiveness was measured by comparing students' pre-test and post-test scores, with the following results.

Table 10. Descriptive Statistics Pre-test and Post-test

No	Descriptive Statistics	Pretest	Posttest
1	Highest Score	53	97
2	Lowest Score	17	40
3	Average	34. 97	68. 32
4	Standard Deviation	11. 990	17. 582

The results of the pretest and posttest analyses show that, out of 31 students, the average score was 34.97 on the pretest and 68.32 on the posttest. The average increase of 33.35 points indicates that the use of the developed E-LKPD contributed to an improvement in students' test scores. Additionally, the data from the pre-test and post-test were examined using the N-gain test to assess the enhancement of students' computational thinking abilities before and after employing the media. The outcomes of this analysis are shown in table 11.

Table 11. N-Gain Test Results

	N	Min.	Max.	Mean	Std. Deviation
N_gain	31	.10	.94	.5342	.22428

The data analysis in table 12 shows that the Scratch-assisted PBL-based E-LKPD falls into the moderate category in terms of improving CT skills, as indicated by a mean N-Gain value of 0.5342. Based on the results of the N-Gain test, the Scratch-assisted PBL-based E-LKPD is effective in improving students' CT skills.

Before conducting further testing, the difference between the initial and final test data (d) was analyzed using a normality test, which is essential for determining the appropriate statistical method to apply. The Shapiro-Wilk test was chosen because the sample size was less than 50. The purpose of this normality test was to verify whether the data followed a normal distribution. The results are presented in table 12.

Table 12. Results of the normality test

Data	$\bar{X}$	W	P_{value}	**Test Decision**
$d\ (post - pre)$	24	0. 96583	0. 929	H_0 accepted

Table 12 shows that the calculated W value is 0. 96583, while the P value is 0. 929. The W value is smaller than the P value, so H_0 is accepted, which means that the data d are normally distributed. Since the data are normally distributed, a parametric hypothesis test—specifically, a paired t-test—is used. The purpose of this hypothesis test is to determine the difference in students' CT skills before and after the use of the developed E-LKPD. The following are the results of the analysis using the paired-sample t-test.

Table 13. Results of the paired-sample t-test

Results	$\bar{X}$	$\bar{X}_{post} - \bar{X}_{pre}$	**n**	$t_{calculated}$	t_{table}	**Test Decision**
Pretest	34. 97	33. 35	31	15. 8604	2. 041	H_0 rejected
Posttest	68. 32					

According to Table 13, the computed t-value stands at 15. 8604, while the threshold t-value is 2. 041. Because the computed t-value exceeds the threshold t-value, the decision from the test is to dismiss H_0. These findings suggest there is an improvement in the time before and after utilizing E-LKPD.

Evaluation Stage

At this stage, an evaluation is conducted of various shortcomings and aspects that need to be improved after the product has been deemed valid, practical, and effective based on the stages of the ADDIE model. The evaluation during the analyze stage focuses on determining solutions based on the results of interviews, observations, and an analysis of the needs and problems identified. As for the evaluation during the design phase, a number of suggestions related to the product design were obtained, so the focus was on improving and refining the instructional material. During the development phase, the evaluation focused on the results of the instructional material's validity testing to ensure that the E-LKPD instructional material could be used effectively. The evaluation during the implementation phase focused on the results of the practicality and effectiveness tests of the E-LKPD. Based on these evaluation results, the developed E-LKPD was deemed valid, practical, and effective for use in learning.

3.2. Discussion

Validity Analysis

This E-LKPD learning medium was evaluated by three media experts and three subject matter experts, each group consisting of two university lecturers and one teacher. The media experts assessed the ease of use, legibility of symbols and buttons, and other elements within the developed E-LKPD. The subject matter experts served as evaluators who focused exclusively on the content within the E-LKPD.

The initial point to consider is the media content element, which is evaluated by how suitable the content and language are. Content suitability refers to how well the material aligns with the core competencies and learning outcomes, its organized and systematic presentation, the relevance of the activities to the PBL learning model, and the presence of tasks that promote computational thinking skills. The language component focuses on whether the language used is clear, communicative, straightforward, and free of ambiguity for students. After reviewing the material, the three evaluators agreed that the E-LKPD is classified as "valid" in terms of its content. This classification is due to its alignment with learning objectives, its clear structure, and the connection of the provided tasks and activities to computational thinking skills; additionally, the language is clear and comprehensible. This conclusion is further corroborated by Jayanti et al. (2025), who emphasized that the worksheets developed should satisfy criteria for content suitability, activity integration, and relevance to the thinking skills targeted for development. Nonetheless, the expert reviewers offered various recommendations for enhancing this E-LKPD, as detailed in Table 5.

Furthermore, in terms of the E-LKPD medium, it was evaluated based on visual appeal, language use, and interactivity. Supporting this conclusion is research conducted by Rohimah et al. (2023), which indicated that visual elements, layout, font size, and illustrations made it easier for students to grasp the flow of the presented material. Additionally, a study by Firdaus and Suswanto (2024) demonstrated that effective educational media should take factors like appearance, navigation, and interactivity into account to maximize usability and effectively enhance the learning process for students. The evaluation outcomes suggest that the E-LKPD is categorized as "valid”. Nevertheless, the expert media validators provided several recommendations for improvement, as presented in Table 7. Based on the assessments of both validators, followed by a validity test calculation, the PBL-based E-LKPD developed using Scratch was determined to be highly valid and suitable for use.

Practicality Analysis

The practicality of the learning media can be assessed through the responses of students and teachers regarding the use of E-LKPD during instruction. This practicality pertains to the ease of use and user engagement with the E-LKPD media. The assessment of the media’s practicality in this study was based on student and teacher response questionnaires covering the legibility of symbols and icons in the E-LKPD, the benefits of the E-LKPD, and the appeal of its design. The media is considered practical if it assists teachers in delivering content, reduces student boredom, and transforms abstract concepts into more concrete ones (Capuno et al., 2019; Sulasteri et al., 2018). Therefore, the practicality of this product is not only assessed by whether or not the media can be used but also by the extent to which it facilitates learning and encourages student engagement.

The analysis results show that the E-LKPD is considered practical, with a student response rate of 78.61% and a teacher response rate of 88.33%. Students reported that the medium is easy to use, engaging, and helpful in understanding the material. Teachers also stated that using the E-LKPD in the classroom makes teaching easier because it includes systematic steps aligned with the PBL model. Moreover, this conclusion is backed by a study from Milala et al. (2021), which highlighted that the practical applicability of a resource can be assessed through its user-friendliness, favorable feedback from both teachers and students, as well as its capacity to aid the educational process for both parties. Consequently, the E-LKPD medium can be regarded as practical and fitting for implementation.

Analysis of Effectiveness

The impact of media can be evaluated by analyzing how student performance changes before and after its application, which is measured through pre- and post-assessment tests (Puspita et al., 2020). This research adopted a similar technique by conducting pre- and post-assessments with students. Both assessments were crafted according to competency indicators related to computational thinking; the data collected was then examined with a paired-sample t-test, presuming a normal distribution, to determine the enhancement after media usage. The results from the paired-sample t-test showed a computed t-value of 15. 8604, while the critical t-value stood at 2. 041. Since the computed t-value exceeded the critical t-value, it was concluded that there was a notable change in the effectiveness of the E-LKPD learning tool before and after its application. Additionally, the analysis found that students had an average score of 34. 97 on the pre-test and 68. 32 on the post-test, which suggests that employing E-LKPD positively influenced the computational thinking capabilities of students.

Although students' average posttest scores were still below the school's established minimum competency standard (MCS), the E-LKPD was still classified as effective because, in development research, a teaching medium is considered effective if a change in scores is observed after the intervention compared to before it, even if that improvement does not always result in full mastery (Ati et al., 2024; Devega & Suri, 2019). This is further evidenced by the N-gain value of 0. 5342, categorized as "moderate," indicating an enhancement in students' computational abilities following the utilization of the learning tool. The efficacy of E-LKPD in this research is also corroborated by in-class observations, which indicate that students were highly involved in their learning activities, particularly when addressing PBL-based problems and using Scratch within the E-LKPD framework. Students were engaged in discussions, experimented with different solutions to problems, and investigated methods to create basic algorithms. This observation aligns with findings from Pertiwi et al. (2025), who showed that PBL fosters greater student involvement and participation in the learning process.

Improvement in the moderate category is possible; however, while working on the test, students often get stuck on a single question because they cannot solve it, causing many to run out of time. Several studies indicate that students tend to focus on difficult items, leaving them no time to work on other questions (Laila Sulistiowati, 2022). Additionally, students still struggle with word problems. Buyung & Sumarli (2021) state that students struggle with the stages of understanding the problem, planning a solution, and implementing the solution to word problems because they are not yet accustomed to working on narrative-based problems. Nevertheless, the sample questions and practice problems in the E-LKPD encourage students to answer in accordance with the CT competency indicators; thus, the designed E-LKPD can be considered effective in developing students' CT competencies.

4. CONCLUSION

The outcomes of the analysis and discussion reveal that the E-LKPD centered on Scratch and PBL fulfills the standards for validity, practicality, and effectiveness. This E-LKPD tool received an average validity score of 86. 3% and a practicality rating of 83. 47%. Implementing the Scratch and PBL-based E-LKPD in algebra instructional materials led to a considerable enhancement in students' computational reasoning (CT) skills. This is evident from the average score improvement, which rose from 34.97 prior to the intervention to 68.32 afterward. The results confirm a significant advancement in students' CT abilities, reinforced by an average N-gain value of 0. 5342. This improvement is particularly noticeable in the tasks involving decomposition, abstraction, algorithms, and generalization during the test items. Despite the E-LKPD tool being validated, practical, and effective in enhancing students' computational skills, it does present several constraints. These limitations are apparent in the post-learning tests results, where students' scores still fall short of the school's minimum competency standards (MCS). Moreover, the content of the E-LKPD remains restricted to algebra, with interactive features confined to certain activities. Consequently, future research suggests expanding the E-LKPD development to encompass a wider array of subjects and incorporate additional interactive features to facilitate more effective utilization of the tool.

REFERENCES

Al-Hafizha, A., Rohati, & Pasaribu, F. T. (2025). Pengembangan E-LKPD berbasis problem based learning untuk meningkatkan computational thinking kelas X. *AL-IRSYAD: Journal of Education Science*, *4*(2), 755–766. https://doi.org/10.58917/aijes.v4i2.354

Aminah, N., Sukestiyarno, Y. L., Cahyono, A. N., & Maat, S. M. (2023). Student activities in solving mathematics problems with a computational thinking using Scratch. *International Journal of Evaluation and Research in Education*, *12*(2), 613–621. https://doi.org/10.11591/ijere.v12i2.23308

Araya, R., Isoda, M., & Moris, J. van der M. (2021). Developing computational thinking teaching strategies to model pandemics and containment measures. *International Journal of Environmental Research and Public Health*, *18*(23). https://doi.org/10.3390/ijerph182312520

Ardianto, M. I., Pamungkas, M. D., & Agustyaningrum, N. (2025). How does computational thinking affect mathematical complex problem-solving? *Journal of Education and Training Studies*, *14*(1), 196–212. https://doi.org/10.11114/jets.v14i1.8130

Ati, B. S., Purnamasari, V., & Wikyuni, S. (2024). Efektivitas media konkret terhadap peningkatan hasil belajar Bahasa Indonesia siswa kelas II SDN Plamongansari 02. *Jurnal Pendidikan Tambusai*, *8*(1), 11619–11625. https://doi.org/10.31004/jptam.v8i1.14133

Bilbao, J., Bravo, E., García, O., Rebollar, C., Laakso, M.-J., Kaarto, H., Lehtonen, D., Parviainen, M., Jankauskiene, A., Pears, A., Güven, I., Gulbahar, Y., Öncül, F. Ö., Yenigün, N. T., Pluhár, Z., Sarmasági, P., Dagiene, V., & Masiulionyte-Dagiene, V. (2024). Introducing computational thinking and algebraic thinking in the European educational systems. *International Journal of Education and Information Technologies*, *18*, 11–19. https://doi.org/10.46300/9109.2024.18.2

Bråting, K., & Kilhamn, C. (2021). Exploring the intersection of algebraic and computational thinking. *Mathematical Thinking and Learning*, *23*(2), 170–185. https://doi.org/10.1080/10986065.2020.1779012

Buyung, & Sumarli. (2021). Analisis kesulitan siswa dalam menyelesaikan soal cerita berbasis kemampuan pemecahan masalah. *Variabel*, *4*(2), 61–66. https://journal.stkipsingkawang.ac.id/index.php/jvar/article/view/2722

Cahyadi, R. A. H. (2019). Pengembangan bahan ajar berbasis ADDIE model. *Halaqa: Islamic Education Journal*, *3*(1), 35–42. https://doi.org/10.21070/halaqa.v3i1.2124

Capuno, R., Revalde, H., Etcuban, J. O., Aventuna, M., Medio, G., & Demeterio, R. A. (2019). Facilitating learning mathematics through the use of instructional media. *International Electronic Journal of Mathematics Education*, *15*(1), 677–688. https://doi.org/10.29333/iejme/5785

Devega, A. T., & Suri, P. G. (2019). Pengembangan media pembelajaran interaktif untuk siswa SMK. *Engineering and Technology International Journal*, *1*(1), 11–18. https://doi.org/10.55642/eatij.v1i01.39

Fajri, M., Yurniawati, & Utomo, E. (2019). Computational Thinking, Mathematical Thinking Berorientasi Gaya Kognitif pada Pembelajaran Matematika di Sekolah Dasar. *Dinamika Sekolah Dasar*, *1*(1), 1–18.

Gultom, H., Febrina, S. U., & Praherdiono, H. (2022). The influence of problem-based learning models - computational thinking (PBL – CT) on the ability to thinking analytical view of students' interest in the subject of natural sciences. *International Journal of Education and Literature*, *1*(3), 21–27. https://doi.org/10.55606/ijel.v1i3.37

Hauda, N., Mulyono, B., & Hapizah. (2024). Kemampuan computational thinking materi fungsi eksponensial menggunakan problem based learning. *Jurnal Derivat: Jurnal Matematika Dan Pendidikan Matematika*, *11*(1), 44–53. https://doi.org/10.31316/jderivat.v11i1.6129

Huang, W., & Looi, C. K. (2020). A critical review of literature on "unplugged" pedagogies in K-12 computer science and computational thinking education. In *Computer Science Education* (pp. 1–29). Routledge. https://doi.org/10.1080/08993408.2020.1789411

Jayanti, R. D., Mulyono, B., Hapizah, & Cahyawaty, D. (2025). Design student worksheet on the topic of ratio to support students ' computational thinking skills. *Kreano: Jurnal Matematika Kreatif-Inovatif*, *16*(1), 154–170. https://doi.org/10.15294/kreano.v16i1.16313

Kumala, F. Z., Agarica, F., & Gunawan, G. (2024). Development of educational game learning media with an ethnomathematics approach based on Banyumas culture to improve students' mathematical understanding skills. *AlphaMath : Journal of Mathematics Education*, *10*(2), 221–243. https://doi.org/10.30595/alphamath.v10i2.23347

Laila Sulistiowati, D. (2022). Faktor penyebab kesulitan siswa dalam memecahkan masalah geometri materi bangun datar. *Jurnal Multidisiplin Ilmu*, *1*(5), 941–951. https://www.neliti.com/publications/592161/faktor-penyebab-kesulitan-siswa-dalam-memecahkan-masalah-geometri-materi-bangun#

Lisa, L., Hasratuddin, H., Sinaga, B., Napitupulu, E. E., & Panjaitan, A. (2024). Computational thinking skills in understanding the limit of algebraic functions.

Mathline: Jurnal Matematika Dan Pendidikan Matematika, *9*(2), 365–380. https://doi.org/10.31943/mathline.v9i2.549

Lubis, Y. A., & Sinaga, B. (2021). Development of macromedia flash-assisted mathematics learning media with the application of problem based learning models to improve computational thinking ability and self-efficacy of class X high school students. *Journal of Education and Practice*, *12*(34), 19–26. https://doi.org/10.7176/jep/12-34-03

Melinia, E. A., Mulyono, B., & Desiani, A. (2025). Design of student live worksheet to support students' computational thinking skills through differentiation learning. *Kreano: Jurnal Matematika Kreatif-Inovatif*, *16*(1), 97–115. https://doi.org/10.15294/kreano.v16i1.16368

Milala, H. F., Endryansyah, E., Joko, J., & Agung, A. I. (2021). Keefektifan dan kepraktisan media pembelajaran menggunakan adobe flash player. *Jurnal Pendidikan Teknik Elektro*, *11*(2), 195–202. https://doi.org/10.26740/jpte.v11n02.p195-202

N. Christi, S. R., & Rajiman, W. (2023). Pentingnya berpikir komputasional dalam pembelajaran matematika. *Journal on Education*, *5*(4), 12590–12598. https://doi.org/10.31004/joe.v5i4.2246

Ostian, D., Hapizah, H., & Mulyono, B. (2023). Interactive e-student worksheet based on computational thinking with South Sumatera Traditional Game context. *Jurnal Pendidikan Matematika RAFA*, *9*(2), 101–122. https://doi.org/10.19109/jpmrafa.v9i2.20339

Pertiwi, H. D. P., Maharani, S., & Darmadi, D. (2025). Effectiveness of problem-based learning models assisted with ethno-fun on learning outcomes reviewed from students' computational thinking. *Al-Jabar: Jurnal Pendidikan Matematika*, *16*(1), 117–128. https://doi.org/10.24042/ajpm.v16i1.22421

Pixyoriza, P., Nurhanurawati, N., & Rosidin, U. (2022). Pengembangan Modul Digital Berbasis STEM untuk Mengembangkan Kemampuan Pemecahan Masalah. *Edumatica: Jurnal Pendidikan Matematika*, *12*(01), 76–87. https://doi.org/10.22437/edumatica.v12i01.17541

Puspita, A. M. I., Puspitaningsih, F., & Diana, K. Y. (2020). Keefektifan media pembelajaran powerpoint interaktif untuk meningkatkan hasil belajar siswa sekolah dasar. *TANGGAP: Jurnal Riset Dan Inovasi Pendidikan Dasar*, *1*(1), 49–54. https://jurnal.stkippgritrenggalek.ac.id/index.php/tanggap/article/view/42

Rahma, F. L., Tanjung, M. S., & Putri, I. A. (2024). Studi literatur: Pentingnya berpikir komputasional dalam meningkatkan kemampuan pemecahan masalah matematis peserta didik yang sangat penting untuk dikuasai. *Bilangan: Jurnal Ilmiah Matematika, Kebumian, Dan Angkasa*, *2*(2), 17–27. https://doi.org/10.62383/bilangan.v2i2.36 Studi

Rohimah, Wulandari, A. Y. R., Qomaria, N., Sutarja, M. C., & Rosidi, I. (2023). Pengembangan multimedia interaktif berbasis web pada materi pengukuran, besaran, dan satuan. *Jurnal Natural Science Educational Research*, *6*(2), 103–114.

Sa'adah, U. L., & Utami, M. A. P. (2025). Pengembangan Lembar Kerja Peserta Didik (LKPD) terintegrasi keislaman untuk melatih kemampuan literasi matematika pada materi aritmetika sosial kelas VII SMP. *Fibonacci: Jurnal Pendidikan Matematika Dan Matematika*, *11*, 65–80. https://doi.org/10.24853/fbc.11.1.65-80

Sugiyono. (2017). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. CV ALFABETA.

Sulasteri, S., Rasyid, R. M., & Akhyar, M. (2018). The effect of the use of learning media based on presentation media on interest and mathematical learning outcomes. *MaPan :Jurnal Matematika Dan Pembelajaran*, *6*(2), 221–236. https://doi.org/10.24252/mapan.2018v6n2a8

Utami, N. W., Susandi, A. D., Purwoko, R. Y., Putri, A. A., Ayuningtyas, A. D., & Irfan, M. (2024). Analysis of students' computational thinking skills in solving algebraic problems in cultural contexts. *Edelweiss Applied Science and Technology*, *8*(5), 662–671. https://doi.org/10.55214/25768484.v8i5.1730

Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, *49*(3), 33–35. https://doi.org/10.1145/1118178.1118215

Zhang, W., Guan, Y., & Hu, Z. (2024). The efficacy of project-based learning in enhancing computational thinking among students: A meta-analysis of 31 experiments and quasi-experiments. *Education and Information Technologies*, *29*(11), 14513–14545. https://doi.org/10.1007/s10639-023-12392-2