Journal of Educational Sciences
Journal homepage: https://jes.ejournal.unri.ac.id/index.php/JES

P-ISSN 2581-1657
E-ISSN 2581-2203

Development of a Liveworksheet-Based E-LKPD Oriented Toward Independent Character to Improve Students' Mathematics Learning Outcomes

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ARTICLE INFO

Article history:

Received: 24 Nov 2025
Revised: 16 Des 2025
Accepted: 24 Des 2025
Published online: 05 Jan 2026

Keywords:

E-LKPD, Independence, Learning Outcomes, Liveworksheet, Mathematics

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Article Doi:

https://doi.org/10.31258/jes.10.1.p.285-301

A B S T R A C T

This study was motivated by the low mathematics learning outcomes of elementary school students in Lubuk Basung District, where most students scored below the minimum mastery criterion. In addition, students showed a lack of independent learning habits, relying heavily on teacher guidance. To address these issues, this research aimed to develop an electronic student worksheet (E-LKPD) using Liveworksheet, designed to foster student independence and improve mathematics achievement. The research employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). Participants included fourth-grade students from several elementary schools in Lubuk Basung District. Data were collected through observations, interviews, expert validations, student response questionnaires, and achievement tests, and were analyzed both qualitatively and quantitatively. The results indicated that the developed E-LKPD was highly valid (95–96%), practical with positive student responses (87–89%), and effective in improving outcomes. The experimental class achieved an average score of 83.04, higher than the control class average of 75.87, with the t-test confirming a significant difference. In conclusion, the Liveworksheet-based E-LKPD not only enhanced students' mathematics achievement but also cultivated independent learning, making it a valuable tool for classroom practice.

1. Introduction

Mathematics has long been acknowledged as a cornerstone in the advancement of science and technology. As a discipline, it provides not only the foundation for abstract reasoning but also the tools for solving practical problems in daily life. In the context of elementary education, mathematics serves a dual function: on the one hand, it introduces students to numbers, symbols, and arithmetic operations; on the

other hand, it fosters critical thinking, logical reasoning, and problem-solving abilities that are indispensable for students as lifelong learners (Aprilia, 2022; Nurmilah, 2023). Ideally, the teaching of mathematics should reflect this dual purpose, cultivating both conceptual mastery and transferable competencies. Unfortunately, the reality of classroom practice often falls short of these expectations.

Observations and assessments in Indonesian elementary schools, particularly in Lubuk Basung District, have highlighted a persistent gap between expected learning outcomes and actual student performance. Results from the mid-semester summative assessments in the 2023/2024 academic year indicated that most fourth-grade students failed to meet the minimum mastery criterion of 75. The average scores ranged only from 56 to 62 across three sample schools, with the majority of students categorized as not achieving mastery. This underachievement suggests that conventional teaching practices, dominated by teacher explanations and repetitive exercises, are insufficient to address diverse student needs. Furthermore, the reliance on static textbooks and limited use of interactive media reduces opportunities for meaningful engagement. These conditions create a cycle where students remain passive, dependent on teacher instructions, and less motivated to explore mathematics independently.

The issue of low mathematics achievement becomes even more critical when examined through the lens of character education. Independence as a learner is an essential value in the 21st century, reflecting the ability to take initiative, assume responsibility, and sustain learning without constant external direction. Yet, classroom observations reveal that many students have not internalized such habits. They often wait for explicit teacher guidance before attempting tasks, show reluctance in problem-solving, and lack persistence in completing assignments. These behaviors contrast with the aspirations of the Merdeka Curriculum, which emphasizes nurturing independent, critical, creative, and responsible learners (Samawi & Hariyanto, 2012). Without deliberate efforts to integrate independence into mathematics learning, students risk remaining overly reliant on teachers, limiting their readiness to face academic and real-life challenges.

At the same time, the rapid development of educational technology offers promising opportunities to transform classroom practices. Today's learners, often referred to as Generation Z, are immersed in digital ecosystems and demonstrate a strong preference for visual, interactive, and multimedia-rich learning experiences. The monotony of conventional print-based resources no longer suffices to stimulate curiosity or sustain motivation. Teachers are thus encouraged to adopt innovative digital tools that align with both curriculum demands and students' characteristics. The role of educational technology is not merely to deliver content but to create dynamic environments that promote engagement, interaction, and autonomy (Agustian & Salsabila, 2021; Herman et al., 2022).

Among various innovations, the Electronic Student Worksheet (E-LKPD) has emerged as a viable solution. Unlike traditional worksheets, E-LKPD transforms

static exercises into interactive online resources that integrate text, images, audio, and even video. This format allows students to actively participate in learning by dragging and dropping answers, solving problems in real time, and receiving immediate feedback. More importantly, E-LKPD encourages autonomy, enabling students to explore concepts independently while still aligning with the curriculum. Several studies support the potential of E-LKPD to improve learning outcomes. Puspita and Dewi (2021) demonstrated that E-LKPD designed with an investigative approach significantly improved students' critical thinking skills. Similarly, Firna, Agustiningsih, and Aguk (2021) highlighted that HOTS-based E-LKPD enhanced problem-solving and reasoning skills among elementary students.

In addition, a growing body of research underscores the effectiveness of E-LKPD integrated with digital platforms such as *Liveworksheet*. For instance, Ani and Lazulva (2020) showed that interactive worksheets using scaffolding approaches improved conceptual understanding of science topics. In a similar vein, Amalia, Roesminingsih, and Yani (2022) found that Liveworksheet-based E-LKPD significantly improved learning outcomes in social studies for elementary students. Likewise, Fefriyanti (2022) reported that applying Liveworksheet in thematic learning enhanced students' comprehension and engagement. These studies confirm that integrating E-LKPD with digital platforms not only supports cognitive achievement but also makes the learning process more appealing and relevant to digital-native learners.

Nevertheless, a critical gap remains in the literature. While prior research has demonstrated the impact of E-LKPD on improving comprehension, motivation, and higher-order thinking skills, fewer studies have addressed its potential role in cultivating independence as a character trait. Independence is not merely a by-product of using digital resources; it requires intentional design features, such as self-paced tasks, instant feedback, and opportunities for reflection. Character education scholars emphasize that independence is a core dimension of holistic education, alongside cognitive and social development (Abdul Hadis, 2014; Hudiyono, 2014). Therefore, positioning E-LKPD not only as a tool for knowledge acquisition but also as a medium for strengthening independent learning habits is both timely and necessary.

Among available digital platforms, *Liveworksheet* stands out for its practicality and versatility. This web-based application enables teachers to convert conventional worksheets into interactive formats accessible through web browsers, without requiring additional software installation. Its features allow for the embedding of images, audio, YouTube videos, and hyperlinks, making lessons more dynamic and multimodal. Furthermore, the automatic feedback system benefits both teachers and students: teachers can streamline assessment processes, while students can instantly reflect on their responses, thus reinforcing independent learning habits (Lestari, 2022; Hariyati, 2022; Widiyanti, 2021). This dual advantage positions Liveworksheet as not just a supplementary tool but a transformative platform for integrating content, pedagogy, and character development. Taken together, these observations highlight that the persistent issue of low mathematics achievement in

elementary schools cannot be resolved merely by revising teaching strategies or increasing the volume of practice problems. The problem is multifaceted, involving limited learning resources, monotonous practices, and underdeveloped student independence. In the digital era, combining E-LKPD with Liveworksheet while deliberately cultivating independent learning offers a promising and contextually relevant solution.

Based on this rationale, the present study seeks to develop a Liveworksheet-based E-LKPD that emphasizes independent character building to improve mathematics learning outcomes. The specific objectives are: (1) to design a valid and reliable E-LKPD, (2) to evaluate its practicality in classroom implementation, and (3) to test its effectiveness in enhancing both mathematics achievement and independent learning among elementary school students. By addressing these objectives, the study aspires not only to enrich the literature on digital learning innovation but also to provide teachers with practical resources that integrate academic and character development within mathematics education.

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2. Methodology

This study employed a research and development (R&D) approach to produce and test an innovative learning product in the form of an E-LKPD based on Liveworksheets. The ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) was selected due to its systematic structure and flexibility, which allow continuous revisions to ensure both validity and practical use in real classrooms (Branch, 2009).

Research Design

The research design applied was the Posttest-Only Control Group Design. Two groups of fourth-grade students were assigned different treatments: the experimental group used the developed E-LKPD, while the control group followed conventional instruction. At the end of the lessons, both groups were given a posttest to evaluate their learning achievement, enabling the researcher to identify the effectiveness of the product.

Research Procedure

The study followed the ADDIE stages. In the analysis stage, problems of low mathematics achievement and weak student independence were identified through classroom observations and needs assessment. The design stage resulted in a draft of the E-LKPD created using Canva, aligned with curriculum standards and supported by multimedia features. In the development stage, the draft was validated by content, media, and language experts, with revisions made based on their feedback. The implementation stage included a small-scale trial with six students and a large-scale trial in two elementary schools in Lubuk Basung District. Finally,

the evaluation stage involved both formative revisions during each step and a summative review of the product's overall effectiveness.

Research Subjects

Participants were fourth-grade students from Lubuk Basung District, West Sumatra. The small-scale trial involved six students from SDN 32 Sungai Jariang with varied achievement levels. The large-scale trial involved students from SDN 10 Sangkir and SDN 21 Surabayo, who were divided into experimental and control groups. Teachers were also included to evaluate the practicality of the product.

Data and Instruments

Both qualitative and quantitative data were collected. Qualitative data included observations, interviews, and expert feedback, while quantitative data consisted of validation scores, practicality ratings, and student learning outcomes. Instruments used included observation sheets, interview guides, validation and practicality questionnaires, and multiple-choice achievement tests. The test items were developed in accordance with curriculum standards and analyzed for validity, reliability, difficulty level, and discrimination power (Purwanto, 2014; Jihad, 2013).

Data Analysis

Data were analyzed using both qualitative interpretation and quantitative statistics. Qualitative data from observations and interviews were summarized to provide insights for improving the product. Quantitative data were processed using percentage formulas and Likert scales to determine validity and practicality levels. Effectiveness was measured by comparing posttest scores between groups and calculating normalized gain scores, which were categorized into low, medium, and high improvement levels (Purwanto, 2014). Through this procedure, the study ensured that the developed E-LKPD was valid according to expert judgment, practical for classroom application, and effective in enhancing mathematics learning outcomes while also fostering student independence..

3. Results and Discussion

The study produced an electronic student worksheet (E-LKPD) using Liveworksheet for fourth-grade Mathematics at Gugus I, Lubuk Basung. The development followed the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation.

Analysis

The design stage in this study serves as a creative bridge that connects the real needs of the classroom with the goal of producing a worksheet that is more engaging,

interactive, and aligned with the learning characteristics of students. The design did not appear instantly but developed from a deep understanding of the Merdeka Curriculum which emphasizes students' ability to describe, arrange, and break down two dimensional shapes through various learning activities. The initial learning conditions that were still dominated by teacher centered explanations, the use of the chalkboard, and conventional worksheets encouraged the creation of a more visual and contextual worksheet. In addition, the learning achievement targets of phase B and the learning objectives strengthened the direction of the design so that students could be more active in observing, manipulating, and understanding geometric concepts. The design became clearer after the diagnostic assessment results were analyzed. The data revealed a strong tendency among students toward visual learning styles. The table below presents the number of choices for each learning style category.

Table 1. Results of the Non Cognitive Diagnostic Assessment Questionnaire

Learning Style Category	Number of Responses
Visual learning style	120
Auditory learning style	72
Kinesthetic learning style	88

These results indicate that the visual learning style received the highest score, with 120 responses, far exceeding auditory with 72 and kinesthetic with 88. This finding became the main foundation for designing the worksheet with a strong emphasis on visual presentation. The worksheet was created by prioritizing illustrations, diagrams, clear layout structure, and proportional colors that help students understand the material more easily. The learning activities were also arranged to allow students to interact directly with geometric concepts through activities such as observing, assembling, and breaking down shapes. By integrating student needs, curriculum requirements, and creative presentation, the design stage produced a worksheet that is informative, visually appealing, and highly aligned with the way students process information.

Design

The design stage focuses on creating the final layout of the student worksheet based on Liveworksheet, emphasizing the appearance and usability of the product rather than the process of making it. In this stage, the researcher developed a clean, attractive, and functional worksheet design that aligns with the learning needs of fourth grade students on the topic of plane shapes. The resulting design serves as the foundation for developing an interactive digital worksheet. The initial worksheet design centers on three main components: the cover, the competency section, and the learning activities. Each component was carefully arranged to present clear information, support student understanding, and enhance the learning experience. The final cover design used in the worksheet appears in Figure 1, displaying the worksheet title, institution identity, author information, student identity, and a relevant illustration representing the topic of plane shapes.

Figure 1. Worksheet Cover Design

The researcher then designed the competency section, which contains the learning outcomes, learning objectives, and the sequence of learning goals. This section was arranged concisely and systematically to help students understand the direction of learning. The final design of the competency component is shown in Figure 2.

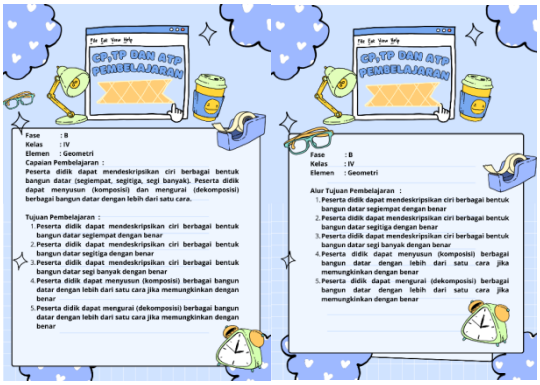

Figure 2. Competency Component Design

The last part of the design stage is the development of the learning activity section, which consists of interactive exercises related to plane shapes. These activities include tasks such as matching, selecting correct answers, completing short responses, and placing answers in the correct position. The final design of the learning activity layout can be seen in Figure 3.

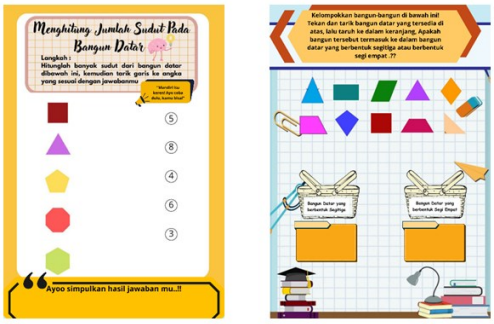

Figure 3. Learning Activity Design

These three design outputs were then compiled into a single worksheet file, exported as a PDF, and uploaded to Liveworksheet for further enhancement until the final version was ready for validation and use. The completed design was prepared to be accessed online through a link, allowing students to work on the worksheet using digital devices such as laptops or mobile phones. Interactive features such as typing answers directly, matching items, choosing options, and watching YouTube learning videos were also included to support an engaging and meaningful learning experience.

Development

The development stage aims to produce a refined final product of the learning media, which is then evaluated through a comprehensive expert validation process involving media validators, material validators, and language validators. This stage ensures that the product is feasible, accurate, and suitable for classroom use. Media validators assess the technical quality and visual design, material validators examine the relevance and accuracy of the content according to curriculum objectives, and language validators evaluate clarity, readability, and appropriateness of the language for students. Through these three forms of validation, the product is improved based on expert feedback so that it can effectively meet learning needs.

Media Expert Validation

Media validation was carried out by Dr. Wahyu Prima, M.Kom, through an instrument consisting of 20 assessment items that evaluated several key components, including the appearance of the student worksheet, the coherence and organization of the material, and the overall usability of the worksheet as a learning tool. The detailed results of the media expert validation are presented in Table 1, which shows the scores for each assessed aspect along with the total percentage obtained.

Table 1. Media Expert Validation

No	Aspect Assessed	Score Obtained
1	Appearance of the student worksheet	31
2	Coherence of the material	22
3	Usability of the student worksheet	23
	Total Score	**76**
	Maximum Score	**80**
	Percentage	**95%**
	Criteria	**Highly Valid**

Based on Table 1, the validation result from the media expert shows a percentage of 95%, categorized as highly valid and very feasible to use, although revisions are still required. The media expert also suggested adding a feature that allows students to erase lines in the matching questions that connect shapes with their correct names.

Material Expert Validation

Material validation was carried out by Dr. Ramatul Hayati, M.Pd, using 15 questions that assessed the suitability of the student worksheet with the learning objectives as well as its relevance to the characteristics of Grade IV students. The results of the material validation can be seen in Table 2.

Table 2. Material Expert Validation

No	Aspect Assessed	Score Obtained
1	Suitability of the worksheet with the learning process	31
2	Suitability of the content with the characteristics of Grade IV students	27
	Total Score	58
	Maximum Score	60
	Percentage	96%
	Criteria	Highly Valid

Based on Table 2, the material expert's validation resulted in a percentage of 96%, categorized as highly valid and very feasible for use, although revisions are still needed. The material expert suggested that the learning objectives should be made more distinct from the learning outcomes. Additionally, the video embedded in the Liveworksheet should be enlarged, and it is recommended to add a note indicating that if the video is unclear, it can be viewed via the projector provided.

Language Expert Validation

Language validation was conducted by Dr. Jendriadi, M.Pd, using 10 questions that assessed the language presentation in the worksheet and its appropriateness for the students' level of understanding. The results of the language expert assessment can be seen in Table 3.

Table 3. Language Expert Validation

No	Aspect Assessed	Score Obtained
1	Language presentation in the student worksheet	15
2	Appropriateness of language with the learning content	23
	Total Score	**38**
	Maximum Score	**40**
	Percentage	**95%**
	Criteria	**Highly Valid**

Based on Table 3, the validation result from the language expert shows a percentage of 95%, categorized as highly valid and very feasible for use. However, the language expert suggested that the font size in the Liveworksheet should be increased to make it easier for students to read.

Implementation

The implementation stage was carried out through product testing, consisting of a small-scale trial and a large-scale trial involving fourth-grade students at Gugus I, Lubuk Basung District. The small-scale trial was conducted to obtain initial

feedback from students regarding the use of the liveworksheet-based student worksheet in mathematics learning. Six students were asked to fill out a response questionnaire consisting of ten Likert-scale items. The results showed that the average percentage of student responses reached 87%, categorized as very feasible. Students stated that the liveworksheet-based worksheet was attractive, easy to use, and helpful in understanding the material, although some difficulties were noted in areas with unstable internet access.

A large-scale trial was then conducted involving 28 students to gather broader feedback on the developed worksheet. The same response questionnaire was administered, and the results indicated that the average percentage of student responses reached 89%, also categorized as very feasible. These findings show that the liveworksheet-based student worksheet was highly appreciated by the majority of students in terms of appearance, usability, and its benefits in supporting mathematics learning. The results from both trial stages confirm that the developed learning media is feasible and effective for use in the classroom.

Evaluation

The evaluation stage was conducted by the researcher to assess the results of the implemented product. This evaluation was based on the trial outcomes of the *liveworksheet*-based student worksheets in mathematics learning. A comparison of student response percentages between the small-scale and large-scale trials is presented in Figure 4.

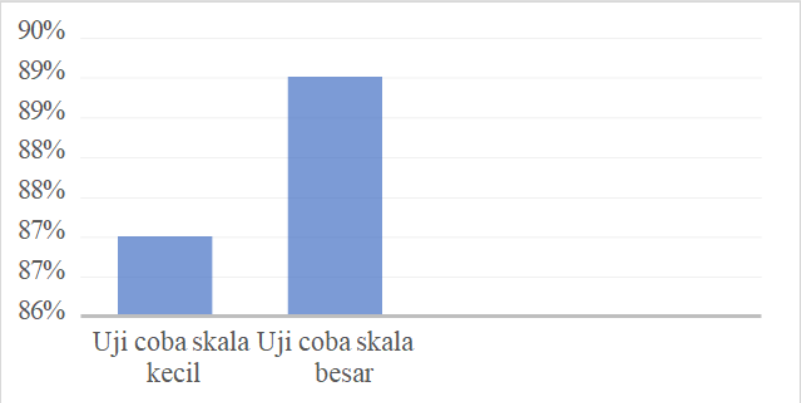

Figure 4. The Graph of Small-Scale and Large-Scale Trial Results

Based on the figure, the small-scale trial obtained a percentage of 87%, which falls into the "highly feasible" category as it lies within the range of 81–100%. Meanwhile, the large-scale trial reached 89%, also categorized as "highly feasible." Therefore, it can be concluded that the *liveworksheet*-based student worksheets in fourth-grade mathematics learning are highly feasible to be applied as a learning medium.

Product Revision

Based on the data analysis, the student worksheet product (LKPD) based on LiveWorksheet for fourth-grade mathematics learning is categorized as highly valid and very feasible for development. However, several revisions were made by the researcher as a follow-up to comments and suggestions from media and content experts regarding the worksheet product. First, in the matching exercise of flat shape images with their types, there was previously no menu to erase incorrectly drawn lines by students. After revision, an instruction was added for students to click the ↻ menu if they make a mistake, making the worksheet easier to use and more interactive.

Second, the learning objectives initially required improvement because they were too similar to the learning outcomes. After revision, the learning objectives were made more specific and distinct from the learning outcomes to provide clearer guidance for students. Third, the video in the worksheet was previously unclear and too small, making it difficult for students to watch. After revision, the video was enlarged and clarified, and an instruction was added indicating that if the video is not clear, students can view it using the provided projector. With these revisions, the LiveWorksheet-based student worksheet has become more effective, clear, and user-friendly for fourth-grade mathematics learning.

Descriptive Data

The study was conducted on two sample classes, namely the experimental class and the control class. The learning process in the experimental class was carried out in three meetings on July 15, 16, and 18, 2025, while the control class was conducted on July 16, 17, and 19, 2025. After the learning activities in both classes, student learning outcomes were obtained through a posttest. The posttest consisted of 20 questions for each class, which had previously been trialed in grade IV at SDN 21 Surabaya Lubuk Basung. The posttest aimed to determine whether the treatment given had an effect on the learning outcomes of both classes. Both classes consisted of 23 students. The posttest scores in the experimental class ranged from 65 as the lowest score to 95 as the highest score, while in the control class, the lowest score was 55 and the highest was 90. Data processing was carried out by calculating the mean (X), standard deviation (S), and variance (S^2) for each class. The complete results of these calculations are presented in Table 4:

Table 4. Mean, Standard Deviation, and Variance of Sample Classes

Class	N	Lowest Score	Highest Score	X	S	S^2
Experimental	23	65	95	83.04	8.62	74.41
Control	23	55	90	75.86	9.12	83.30
Difference	–	10	5	7.18	0.5	8.9

Based on the table above, it is evident that the learning outcomes of students in the experimental class, which received the treatment, were higher than those in the control class, which did not receive the treatment. The average score of the

experimental class was 83.04, while the control class had an average of 75.86. The students' learning outcomes in both classes are illustrated in Figure 5, which presents the frequency histogram of the experimental class:

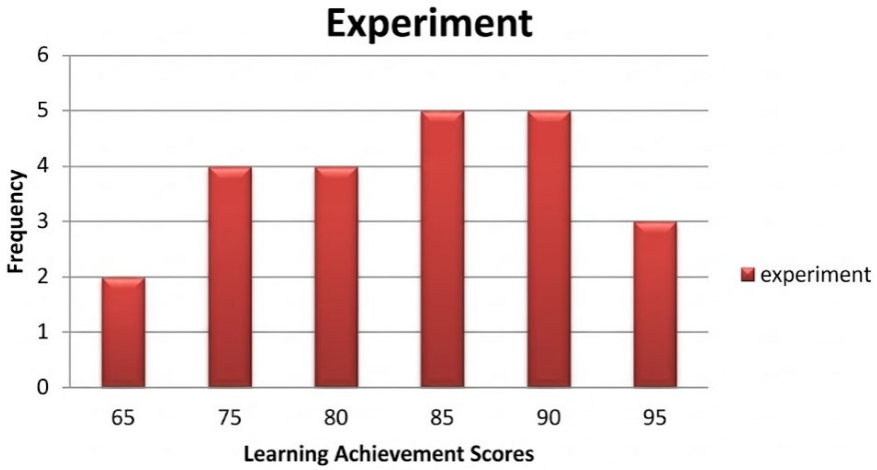

Figure 5. Frequency Histogram of Learning Outcomes in the Experimental Class

To provide a comparison, the distribution of learning outcomes in the control class is also presented. As shown in Figure 6, the histogram illustrates how the students' scores in the control class are spread across the score intervals.

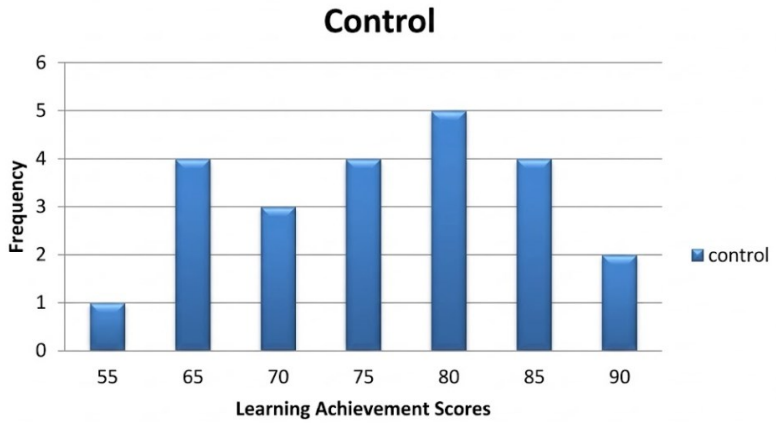

Figure 6. Frequency Histogram of Learning Outcomes in the Control Class

Furthermore, a clearer comparison between the two classes can be observed in Figure 7, which displays the frequency histograms of both the experimental and control classes side by side. This comparison helps highlight the differences in learning outcomes between the two groups.

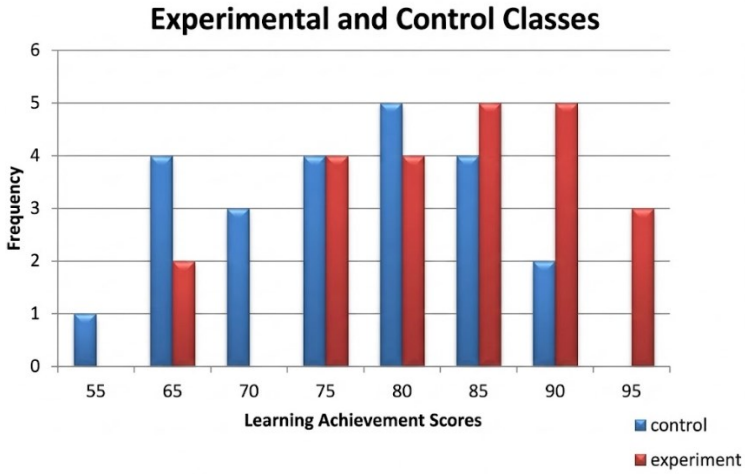

Figure 7. Frequency Histogram Comparing Learning Outcomes of Experimental and Control Classes

These data indicate that providing treatment to the experimental class positively influenced students' learning outcomes compared to the control class.

Normality Test

The normality test was conducted to determine whether the students' learning outcome data from both sample classes were normally distributed. This test used the Liliefors method with the hypotheses: H_0 states that the data are normally distributed, and H_1 states that the data are not normally distributed. The test results showed Lo = 0.1088 for the experimental class and Lo = 0.1083 for the control class, while Lt at the significance level of $\alpha = 0.05$ was 0.179. According to the decision criteria, the data are considered normally distributed if Lo < Lt. The complete results of the normality test are shown in Table 5:

Table 5. Normality Test Results for Final Test

Class	N	α	Lo	Lt	Distribution
Experimental	23	0.05	0.1088	0.179	Normal
Control	23	0.05	0.1083	0.179	Normal

As shown in the table, Lo for both classes is smaller than Lt, indicating that the learning outcome data for both the experimental and control classes are normally distributed.

Homogeneity Test

The homogeneity test aims to determine whether the variances of the two sample classes are homogeneous. This test used the F-test with the hypotheses: H_0 states that the data have homogeneous variance, and H_1 states that the data do not have homogeneous variance. The results showed that Fhitung = 1.11, which is lower than Ftabel = 2.05, meaning that H_0 is accepted. This indicates that the variances of both

sample classes are homogeneous. The complete results of the homogeneity test are shown in Table 6:

Table 6. Homogeneity Test Results for Final Test

Class	N	S^2	Fh	Ft	Description
Experimental	23	74.407	1.11	2.05	Homogeneous
Control	23	83.3			

Thus, the data from both classes meet the assumptions for conducting a t-test to test the hypothesis.

Hypothesis Test

After confirming that the data were normally distributed and had homogeneous variance, a t-test was conducted to compare the mean learning outcomes between the experimental and control classes. The experimental class obtained a mean score ($\bar{X}$) of 83.04 with a standard deviation of 8.62, while the control class had a mean score of 75.87 with a standard deviation of 9.12. The calculated t-value was 2.89, which was higher than the t-table value of 2.015 at a significance level of $\alpha = 0.05$ with 44 degrees of freedom. These findings indicate a significant difference between the two classes. The complete results of the t-test are presented in Table 7:

Table 7. Hypothesis Test Results for Final Test

Class	$\bar{X}$	N	S	t-calculated	t-table
Experimental	83.04	23	8.62	2.89	2.015
Control	75.87	23	9.12		

Based on the testing criteria, Ho is accepted if t-calculated < t-table, and Ha is accepted if t-calculated > t-table. Since t-calculated > t-table, Ho is rejected and Ha is accepted. This indicates that the E-LKPD Liveworksheet is more effective than the conventional LKPD. In other words, the E-LKPD Liveworksheet has a positive impact on the mathematics learning outcomes of fourth-grade students at SD Negeri 21 Surabayo Lubuk Basung.

Discussion

Based on the data analysis, there was a significant difference in learning outcomes between the two sample classes. The average score obtained by students in the experimental class reached 83.04, while the control class achieved an average of 75.87, showing a clear gap in performance. The results of the t-test confirmed that learning supported by the Liveworksheet-based E-LKPD produced higher and more consistent outcomes compared to learning that still relied on conventional worksheets. This improvement reflects the effectiveness of integrating interactive digital media into the learning process, especially in activities that demand active participation and independent exploration from students. The findings also indicate that the experimental class showed more stable understanding patterns and fewer misconceptions in completing the learning tasks.

This difference was further influenced by the quality of interaction that occurred during the learning process, both between teachers and students as well as among students themselves. In the experimental class that used the Liveworksheet-based E-LKPD, learning interactions were dominated by active student participation through exploration of features, discussion of answers, and immediate feedback provided by the digital worksheet. This condition encouraged students to take a more central role in constructing their own understanding, rather than merely accepting information passively. As a result, students became more engaged in building concepts, expressing their ideas, and sharpening their thinking skills according to the demands of interactive learning media. Therefore, learning with the Liveworksheet-based E-LKPD supported students' active, logical, critical, and creative involvement throughout the lesson.

These findings align with previous studies that highlight the positive influence of E-LKPD on students' learning development. Puspita and Dewi (2021) demonstrated that E-LKPD designed with an investigative approach significantly improved students' critical thinking skills in elementary school settings. Likewise, the study by Firna, Agustiningsih, and Aguk (2021) emphasized that the development of HOTS-based E-LKPD contributed positively to enhancing students' reasoning, problem-solving abilities, and conceptual mastery. In addition, research conducted by Amalia, Roesminingsih, and Yani (2022) also revealed that Liveworksheet-based E-LKPD, which integrates interactive features and real-time feedback, was proven effective in improving elementary students' learning outcomes, particularly in social studies subjects. Collectively, these studies support the results of the present research, confirming that the use of interactive digital worksheets provides a more meaningful and advantageous learning experience for students.

4. Conclusion

The research concludes that the implementation of E-LKPD Liveworksheet in fourth-grade mathematics learning significantly enhances student engagement and learning outcomes. Students who used E-LKPD Liveworksheet demonstrated higher understanding and involvement compared to those using conventional worksheets. This interactive learning media encourages students to think critically, creatively, and independently, while fostering collaboration and meaningful classroom interactions. The study confirms that integrating technology-based, interactive worksheets can transform the learning process into a more active, enjoyable, and effective experience for students, aligning with the goal of improving both understanding and participation.

Based on these findings, it is recommended that teachers continue to utilize E-LKPD Liveworksheet as part of their teaching practice and explore further development of the media. Enhancements could include more varied content, improved interactivity, and visually appealing design to sustain students' motivation. Regular evaluation and updates are essential to ensure the tool remains

relevant and effective in supporting student learning. Collaboration among educators and media experts can further refine the worksheets, making them an innovative and practical resource that enriches the learning environment and supports long-term educational success.

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How to cite this article:

Lucardo, W., Aisyah, S., & Fitriana, D. (2026). Development of a Liveworksheet-Based E-LKPD Oriented Toward Independent Character to Improve Students' Mathematics Learning Outcomes. *Journal of Educational Sciences*, *10(1)*, 285-301.