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Project-Based Learning (PjBL) Liveworksheets to Enhance Learning Outcomes in Number Operations for Fourth-Grade Elementary Students

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Abstract

Teaching integer operations in elementary schools encounters several challenges, notably students' difficulties in applying mathematical concepts to real-life situations. Moreover, the integration of technology in elementary school mathematics worksheets remains limited. This study aimed to evaluate the validity, practicality, and effectiveness of Project-Based Learning (PjBL) Liveworksheets in improving learning outcomes for fourth-grade students in number operations. The participants of this study were 15 fourth-grade students at Mekar Elementary School. The research utilized a Research and Development approach, following the ADDIE model. Evaluations by experts yielded the following scores: media experts rated the worksheets at 81.5 ("Good"), material experts at 85.5 ("Very Good"), and the practicality assessment scored 83.5 ("Good"). Before the implementation of the PjBL Liveworksheet, students had an average score of 70.6, which increased to 79 post-implementations. The n-gain score of 0.30, classified as "Medium," indicates a moderate improvement in student learning outcomes. These findings demonstrate that the use of PjBL Live Worksheets has a positive impact on student learning outcomes, enhancing their enthusiasm for collaborative project work and their ability to engage with digital worksheets. Integrating such innovative tools into the curriculum could significantly contribute to better educational practices and improved student performance in mathematics.

INTRODUCTION

Background of the Study

The rapid advancement of science and technology is significantly influenced by developments in the educational sector (Budiman, 2017). The Liveworksheet application offers various types of tasks

for students, including drop-down menus, Q&A sessions, checkboxes, drag-and-drop activities, audio tasks, and other assignments tailored to student needs (Widyaningrum et al., 2020). Many students perceive mathematics as the most challenging subject. From an early age, students are trained to master mathematical concepts in elementary school. This is distinct from other fields, such as social sciences, because mathematics is considered a fundamental skill (Anggraini, 2021).

Project-Based Learning (PjBL) models not only help students gain ideal insights but also provide efficient learning experiences (Palayukan et al., 2023). Students not only understand specific ideas but also engage in hands-on activities that help them acquire practical skills applicable in the real world. The strengths of this approach lie not only in the final project product but also in the process undertaken to achieve it. Students gain meaningful life skills through problem-solving, teamwork, and creative thinking during the learning process (Pelayukan et al., 2023). Consequently, classroom learning becomes more active and creative through the use of projects.

The operation of integers is quite important for students in everyday life, both in school and in the community (Ramadhani, 2022). The application of integers in society helps address various problems (Supriyadi et al., 2022). For instance, in general trade activities, integers are used to protect money or exchange values through mathematical calculations (Pratama & Setyaningrum, 2018). The use of integers facilitates transactions in commerce, thereby simplifying trade activities within the community.

Problem of The Study

Mathematics education in elementary schools, particularly concerning integer operations, frequently fails to meet the expected mastery criteria (KKM). Interviews with fourth-grade mathematics teachers have revealed that a majority of students find it challenging to grasp and learn integer concepts (Nurmala, et al., 2016). Researchers have advocated for educators to augment students' enjoyment of mathematics by integrating educational media (Triyanto et al., 2018). This approach is proposed to facilitate a more accessible and comprehensible learning experience for students during mathematics lessons.

Further insights gleaned from the interview with the classroom teacher underscore a notable underutilization of digital-based technologies, a deficiency that persists. This inadequacy is primarily attributable to a dearth of resources and infrastructure, compounded by educators' limited proficiency in integrating technology-driven instructional media. Introducing technology to students is crucial for augmenting the quality of learning. Thus, teachers must bolster their comprehension of technology-enhanced learning methodologies.

Based on observations conducted at Mekar Elementary School, it was found that 40% of fourth-grade students did not meet the Minimum Mastery Criteria (KKM) in mathematics. Examination results concerning numerical operations revealed an average score of 70.6, with only 60% attaining the minimum passing grade. According to feedback obtained from discussions with fourth-grade teachers, the predominant instructional tool used is Student Worksheets (LKPD), which offer concise explanations of the topics and a limited number of practice problems. It is evident that students would benefit from a more profound comprehension of both the content and the exercises provided in the worksheets.

Research's State of The Art

Recent studies suggest that Liveworksheet-based approaches can significantly improve learning outcomes. Liveworksheet applications are characterized by attractive and well-structured interfaces. Following task completion, students can review their scores, which motivates them to excel in completing assignments (Wati et al., 2021). Liveworksheet-based Student Worksheets demonstrate notable advantages and effectiveness, particularly in fostering comprehensive student understanding throughout the learning process. The development of worksheet tailored for mathematics education is paramount in creating engaging teaching and learning environments (Tri et al., 2022).

Project-Based Learning (PjBL) is an instructional model that enables teachers to integrate classroom learning through projects. Students engage in exploring educational content via well-structured projects, which entail analyzing questions, finding solutions to problems, and creating products relevant to the subject matter being studied (Nugraha et al., 2023). Essential 21st-century skills such as critical thinking, imagination, collaboration, and communication proficiency are recognized as effective approaches for addressing real-world challenges (Darmawan, 2020). The implementation of project-based learning has the potential to enhance students' cognitive abilities, supported by the instructional methodologies employed in lesson delivery.

In fourth-grade education, one of the fundamental topics is integer arithmetic. Proficiency in integers is vital for students, as integers encompass negative numbers, zero, and positive whole numbers. Integers are a fundamental aspect of mathematics, frequently encountered alongside natural numbers, whole numbers, and fractions (Lentera et al., 2018). Integer arithmetic involves operations with both positive and negative numbers, including zero.

Learning outcomes refer to the abilities or skills that students acquire after the learning process, encompassing cognitive, affective, and psychomotor abilities (Rahma et al., 2021). They involve transformations in individuals' knowledge, understanding, attitudes, and behaviors resulting from educational experiences (Mulia et al., 2021). Essentially, learning outcomes generally indicate students' progress across various dimensions during the learning process. The assessment of learning outcomes should ascertain whether curriculum objectives have been attained.

Gap Study & Objective

Recent research by Hamna & Ummah, (2022) suggests that Liveworksheet, an interactive learning platform, significantly influences mathematics learning outcomes compared to flipped classroom approaches. These findings align with several studies Handayani, 2023); Prabowo (2021); and Indriani & Marhaeni (2022), which demonstrate the positive impact of Liveworksheet-based Electronic Student Worksheets (E-LKPD) on student achievement. Additionally, Amalia et al. (2022) conclude that interactive worksheets built on Liveworksheet are effective in enhancing learning outcomes. While previous research provides compelling evidence for the effectiveness of Liveworksheet in improving mathematical learning, there is a critical gap in the literature regarding its integration with project-based learning (PjBL) models. Existing studies have not explored this combined approach. This study aimed to address this gap by investigating the validity, practicality, and effectiveness of a PjBL curriculum designed and delivered using Liveworksheet. Specifically, the research will focus on the impact of this approach on student learning outcomes in fourth-grade elementary school mathematics, particularly in the area of numerical operations.

METHOD

Type and Design

This study aims to describe the validity, practicality, and effectiveness of Project-Based Learning (PjBL) implemented through Liveworksheet in enhancing student learning outcomes in mathematics. The research employs a development model, specifically the well-established Research and Development (R&D) approach. The ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) was chosen for its systematic structure, ensuring a rigorous evaluation and validation of the developed PjBL curriculum utilizing Liveworksheet (Hidayat & Nizar, 2021). As outlined by Maydiantoro (2019), the ADDIE model provides a clear framework for each development stage.

Data and Data Sources

This research and development project employs both qualitative and quantitative data. Qualitative data collection involves feedback and suggestions obtained during the validity process, while quantitative data comprises validation sheets completed by media experts and subject matter specialists, practicality assessments conducted by teachers, and student attitude surveys related to the learning process. The research team gathered data from the following experts:

A. Media Experts

The panel of media expert validators consists of two lecturers from the Primary School Teacher Education Program: Mr. MA and Ms. N. These lecturers possess expertise in technology utilization and hold educational motives relevant to the subject matter. Their valuable feedback and suggestions will be instrumental in enhancing the Liveworksheet, with a particular focus on design aspects.

B. Subject Matter Experts

Subject matter expert validators include two fourth-grade educators, Ms. HH and Mr. M. Both teachers specialize in mathematics education and actively teach mathematics in fourth-grade classrooms. Their insights and recommendations will contribute significantly to improving the Liveworksheet's content for effective learning.

C. Teacher Evaluators

In this study, teachers evaluated the practicality of the newly developed student worksheets based on Liveworksheet. The evaluation involved two fourth-grade teachers from MEKAR Elementary School.

D. Student Evaluation

In this study, teachers evaluate the practicality of the developed Liveworksheet. Two educators from Mekar Elementary School, who teach fourth grade, actively participate in this evaluation process.

Data Collection Technique

The data collection techniques employed in this study include validation by media and subject matter experts, teacher practicality questionnaires, student response surveys, as well as pretests and posttests. The instruments utilized encompass validation sheets, practicality assessment forms, observation sheets, interview guidelines, questionnaires, and test items. Specifically, these instruments include validation sheets for media and subject matter experts, practicality assessment sheets for teaching, as well as pre-test and post-test evaluations. The trial was conducted in a fourth-grade class at Mekar Elementary School, involving a total of 15 students.

Data Analysis

The data analysis comprises both quantitative and qualitative descriptive analyses. Qualitative descriptive analysis is employed to collect data from interviews with teachers to identify student needs, expert assessments, and to categorize information according to the specific requirements of each instrument used. The data collected include evaluations by media and subject matter experts, assessments of practicality, student responses to learning, as well as pretests and posttests to be administered. A 5-point rating scale is utilized, which is subsequently converted into qualitative data.

The analysis of feedback from experts, critiques, and suggestions for improvement serves as a basis for refining and enhancing the Liveworksheet, integrating insights from previously developed worksheet-based learning approaches. Concurrently, quantitative data analysis is conducted to scrutinize data gathered from media experts, subject matter experts, practicality assessments, and student evaluation sheets. Table 1 illustrates the formula for converting quantitative data into qualitative data, while Table 2 outlines the formula for calculating media expert data.

Table 1. Criteria for Converting Quantitative Data to Qualitative Data

Score	Interval score	Category

A	X > Xi + 1,8 sb_i	Excellent
B	Xi + 0,6 sb_i < X ≤ Xi + 1,8 sb_i	Good
C	Xi - 0,6 sb_i < X ≤ Xi + 0,6 sb_i	Fair
D	Xi - 1,8 sb_i < X ≤ Xi - 0,6 sb_i	Poor
E	X ≤ Xi -1,8 sb_i	Very Poor

Table 2. Criteria for Validity of Learning Tools by Media Experts

Interval score	Category
X > 83,94	Excellent
67,98 < X ≤ 83,94	Good
52,02 < X ≤ 67,98	Fair
36,06 < X ≤ 52,02	Poor
X ≤ 36,06	Very Poor

This study employs both quantitative and qualitative data. Quantitative data will be collected using five response categories: very good, good, fair, poor, and very poor. The results of the quantitative survey will be transformed into qualitative data through Likert scale calculations, facilitating the conversion of numerical scores into qualitative assessments. Table 3 outlines the formula for assessing teaching practicality, while Table 4 details the formula for evaluating subject matter expert data.

Table 3. Grid of Teaching Practicum Implementation Instruments

Interval score	Category
X > 42,06	Excellent
34,02 < X ≤ 42,06	Good
25,98 < X ≤ 34,02	Fair
17,94 < X ≤ 25,98	Poor
X ≤ 17,94	Very Poor

Table 4. Criteria for Practicality

Interval score	Category
X > 109, 14	Excellent
88,38 < X ≤ 109, 14	Good
64,15 < X ≤ 88,38	Fair
46,86 < X ≤ 67,62	Poor
X ≤ 46,86	Very Poor

(Rusnilawati, 2016)

A learning tool is deemed effective if its level of effectiveness meets at least a satisfactory minimum. Moreover, a learning tool is considered practical when the learning process is executed effectively..

The formula for testing N-Gain is interpreted as follows:

$$\text{N-Gain} = \frac{Post-testScore-PretestScore}{MaximumScore-PretestScore}$$

Table 5 illustrates the interpretation of N-Gain values (Aryani, 2017).

Table 5. Interpretation of N-Gain Values

Score	Category
N Gain ≥ 0,70	High
0,30 ≤ N-Gain < 0,70	Medium
N-Gain ≤ n , 0,30	Low

RESULTS

This study yielded a Liveworksheet featuring integer arithmetic content within the framework of Project Based Learning (PjBL), implemented at elementary schools. The developmental stages encompassed (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. From the analysis stage, the study focused on achieving fundamental competencies (KD), including (3.1) addition and subtraction of integers, (3.1.1) methods for solving problems in integer arithmetic operations, (3.1.2) decomposition of problem statements in integer arithmetic operations, and (4.1.1) resolution of problems involving the application of integer arithmetic operations through projects. Below is an exemplar of outcomes derived from the product development design stage.

Figure 1. Cover

Figure 2. Steps of PjBL

Figure 1 illustrates the cover of the Liveworksheet Electronic Student Worksheet (E-LKPD), which functions as the initial interface page when accessing the media. Figure 2 outlines the sequential steps of the Project Based Learning (PjBL) model to be utilized in this instructional approach. The instructional syntax serves as a guideline for effectively completing the learning process and provides teachers with accurate guidelines for implementing project-based learning.

Figure 3. Learning Objectives

Figure 4. Activity 1: Problem Presentation

Figure 3 outlines the learning objectives for integer arithmetic operations, detailing the expected achievements for students in this instructional module. Figure 4 illustrates the problem presentation stage, where students are presented with a video related to integer arithmetic operations. Subsequently, they solve problems and complete the designated columns. This activity necessitates students to accurately analyze both the problems and their corresponding answers.

Figure 5. Activity 2 (Planning)

Figure 6. Activity 3 (Developing the Schedule)

Figure 5 provides instructions for students to form groups, prepare tools and materials, and follow guidelines for the project activities. Figure 6 involves scheduling the project activities. Having a project schedule allows teachers and students to prepare the necessary resources for designing the project. This enables students to create better and more engaging projects in classroom learning.

Figure 7. Activity 4 (Project Creation)

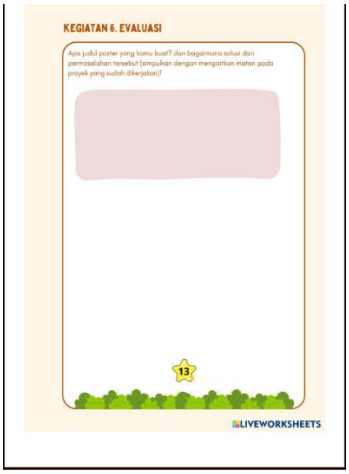

Figure 8. Activity 6 (Project Evaluation)

Figure 7 illustrates the process of creating the project, where students fill in a table to provide feedback, strengths, and weaknesses of the project they have created. Figure 8 involves evaluation, where students fill in columns and explain their completed project. Through evaluation, product development can be further improved. As a result, project creation can be designed more attractively.

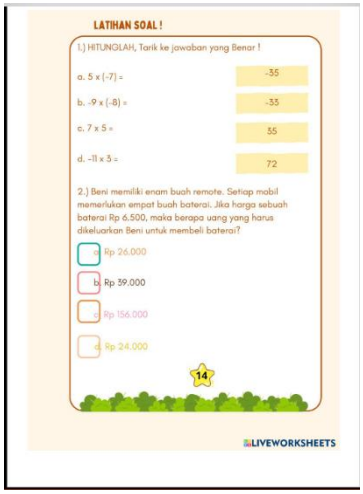

Figure 9. Group Problem Solving Exercise.

Figure 9 depicts a group problem-solving exercise where students are presented with Higher Order Thinking Skills (HOTS) questions, and they fill in their answers in the provided columns. These group exercises are designed to encourage student participation in solving problems collaboratively. Working in groups promotes active learning, as students tend to prefer collaborative work during their learning process.

Validity Test Results

The viability of the developed product is evaluated through validation results provided by media experts, subject matter experts, and practicality experts. Feasibility is gauged by considering average scores. The average score data from media experts is available in Table 6.

Table 6. Media Experts Validation Results

Media Experts	Aspect			Score
	Design	Media Appearance	Learning	
Validator 1	23	33	27	83
Validator 2	24	30	26	80
Total				163
Average				81,5
Category				Good

Based on Table 6, it is evident that the Liveworksheet media scores fall within the good category on average. Therefore, this product can be used for testing after undergoing several reviews and following the recommendations from validators. The field test results encompass practical data analysis, including student evaluation outcomes and teacher assessment data regarding the use of PjBL-based Liveworksheet media. The average scores from teacher evaluations can be observed in Table 7.

Table 7. Subject Matter Experts Validation Results

Subject Matter Experts	Aspect			Score
	Convenience	Presentation	Benefit	
Validator 1	23	33	28	84
Validator 2	25	32	30	87
Total				171
Average				85,5
Category				Excellent

Based on Table 7, it is evident that the Liveworksheet media scores average within the "Excellent" category. Therefore, this product can be considered for implementation after undergoing several reviews and adhering to the recommendations of validators. Field testing results include practical data analysis, encompassing student evaluation outcomes and teacher assessments regarding the use of PjBL-based Liveworksheet media. Data are also analyzed for student response assessments. The average scores of student responses can be found in Table 8.

Table 8. Student Response Assessment Results

Student Response	Aspect			Score
	Appearance	Content Presentation	Usefulness	
Total				766
Average				51,6

Category	Good

Based on Table 8, the field testing practicality of the Liveworksheet media is considered good. Therefore, the PjBL-based Liveworksheet product is suitable for student use. This data was collected after the learning process concluded by obtaining evaluations from classroom teachers. The average scores from the practicality experts are presented in Table 9.

Table 9. Practicality Results

Teacher	Aspect			Score
	Appearance	Material Presentation	Benefit	
Teacher 1	24	30	24	78
Teacher 2	28	32	29	89
Total				167
Average				83,5
Category				Good

Based on Table 9, the PjBL-based Liveworksheet product is considered practical by teachers, as its usability is rated within the good category.

Analysis of Learning Results Test

The analysis of the learning outcomes test is conducted to determine the effectiveness of the Liveworksheet media. Students' knowledge of integer arithmetic operations is evaluated through a validated knowledge test designed to obtain accurate data scores. This test comprises multiple-choice questions related to integer arithmetic operations. The average scores of student learning outcomes are presented in Table 10.

Table 10. Average Scores of Student Learning Outcomes

Pretest	Post test
70,6	79,7

The comparison between the average pretest and posttest scores is illustrated in the bar chart below:

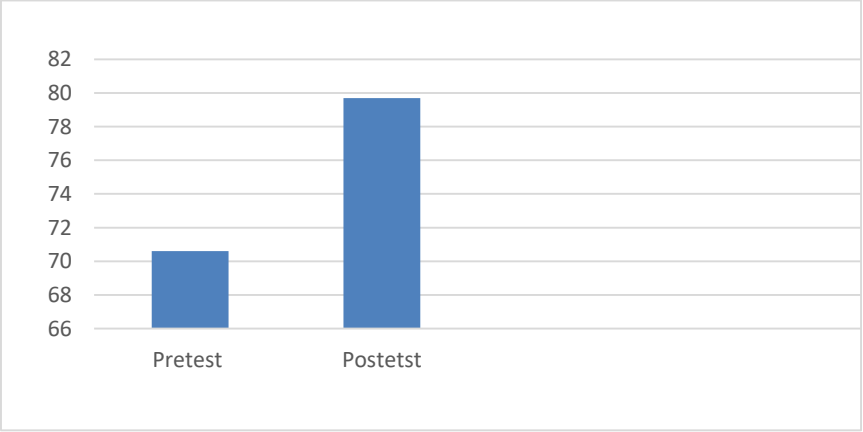

Figure 10. Average Pretest and Posttest Scores

Figure 10 illustrates the average pretest and posttest scores. The trial involved 15 fourth-grade students using the PjBL-based Liveworksheet E-LKPD. During this phase, students were given problems involving integer operations with the expectation of achieving scores above the minimum competency criteria (KKM). After the posttest, students achieved an average score of 79.7 out of 100, compared to 70.6 before using the PjBL model. Therefore, it can be concluded that student learning outcomes increased by 9.1% from the pretest results before using the Project Based Learning (PjBL) model. During the study, students participated in a trial of the project-based learning product and worked on the Liveworksheet E-LKPD. Below is an image showing the results during the product trial (Figure 11 and Figure 12).

Figure 11. Students Working on Liveworksheet E-LKPD

Figure 12. Students Presenting Liveworksheet Results with Project

Students were highly enthusiastic about participating in project-based learning and subsequently presenting the results of their projects. Despite this enthusiasm, students still faced significant challenges in learning integer operations. Numerical problems were not overly difficult for students with weaker arithmetic skills, but word problems proved very challenging for students who were otherwise proficient in arithmetic (Sidik & Wakih, 2019).

Implementing into the N-Gain formula

Table 11. Student Learning Outcomes in the N-Gain Formula

Nilai		N-Gain	Category
Pre-test	Post-test		Moderate
70,6	79,7	0,309	

Based on Table 11, the implementation of student learning outcomes into the N-Gain formula yielded a score of 0.309, categorized as moderate and effective in enhancing student learning outcomes.

DISCUSSIONS

The developed product is the Liveworksheet E-LKPD based on Project Based Learning (PjBL), designed specifically for fourth-grade elementary school students. This E-LKPD aids students in creating projects based on the materials they have learned, either individually or in groups (Murni & Yasin, 2021). The design of the E-LKPD introduces a novel visual approach to presenting (Murni & Yasin,

2021). integer arithmetic material in an engaging manner. It is crafted to support PjBL initiatives, enabling students to implement their learning according to the established design.

Moreover, Liveworksheet not only saves time and reduces paper usage for teachers but also enhances student engagement and motivation (Prastika & Mansniladevi, 2021). Moreover, Liveworksheet not only saves time and reduces paper usage for teachers but also enhances student engagement and motivation (Amalia & Lestyanto, 2021). It functions as an accessible and effective learning tool, showcasing efficiency in educational environments.

Among the strengths highlighted, Liveworksheet also exhibits several shortcomings. Specifically, the provided designs have not undergone extensive development. Moreover, utilizing Liveworksheet for instructional purposes necessitates a balanced consideration of the volume of materials to be incorporated, thereby requiring a blend of teaching methodologies (Wati et al., (2021). As a new educational tool, the Liveworksheet application requires teachers to undergo educational enhancement; they need training to deepen their understanding and effectively implement it as a pedagogical improvement tool (Rosmana et al., 2022). Teachers play a crucial role as facilitators in addressing the identified shortcomings within Liveworksheet.

Challenges encountered during the research include inadequate infrastructure to support the implementation of Information and Communication Technology (ICT) in schools, as well as a shortage of human resources (HR) to adequately support ICT implementation (Akbar & Noviani, 2019). Merely adopting technology is insufficient to meet teachers' needs in their teaching practices. Teachers must possess the ability to integrate technology effectively for educating students, not only being proficient in its use but also taking responsibility for their actions (Handayani et al., 2023). Additionally, students' lack of technological proficiency also impacts their ability to complete Liveworksheet E-LKPD assignments.

In the current era of globalization, project-based learning remains relevant as it engages students directly in the learning process and provides theoretical understanding of concepts. The primary challenge in implementing these projects is the readiness of teachers to incorporate this method into their daily teaching practices. Therefore, teacher training and support are crucial for the successful implementation of projects. Enhancing the quality of education in schools requires effective teacher training and appropriate support (Muktamar et al., 2024).

Project-based learning models have garnered recognition across various educational levels, spanning from elementary schools to universities, owing to their capacity to cultivate essential skills highly sought after in today's society and workforce. The implementation of this model aims to enhance the significance of learning and motivate students to confront real-world challenges (Kamaruddin et al., 2023). Project-based learning plays a critical role in gauging students' interest in issues pertaining to critical thinking skills (Fitri et al., 2023). It is imperative for teachers to provide realistic opportunities for students to engage in independent and productive learning (Macleod & Veen, 2019).

In their study Rhosyida et al. (2021) expound that the implementation of Liveworksheet in mathematics education can present material effectively and enhance students' learning outcomes. Students are motivated to engage with Liveworksheet due to its visually appealing interface. The types of questions presented in Liveworksheet vary, including Drop & Drag, Join (matching), Search (puzzle), multiple-choice, and checkboxes, all designed to captivate student interest in learning. The Liveworksheet application enables teachers to integrate audio-visual elements into student worksheets. This feature allows students to listen to, watch, or read content and directly answer questions provided alongside the audio-visual materials (Sele, 2022). Through the use of this media, teachers can cultivate independent learning among students, thereby fostering active engagement and mastery of the instructional content delivered.

Liveworksheet employs educational technologies such as multiple-choice questions, audio, video, and more to assist in lesson evaluation (Faidah et al., 2023). his application enables teachers to

convert traditional worksheets, which can be printed in document, pdf, jpg, or PNG formats, into interactive online exercises that automatically grade students' work (Firtsanianta & Khofifah, 2022). Accessible via the web, students can complete these worksheets online and submit their answers electronically. Teachers can utilize Liveworksheet's features according to their specific instructional goals and objectives for student learning.

CONCLUSION

The findings of this study demonstrate that integrating Liveworksheet with Project Based Learning (PjBL) is effective in improving students' learning outcomes. Project-based learning encourages greater student engagement in classroom activities. Additionally, students find it easier to understand and actively participate in learning concepts. This approach helps prevent student boredom and contributes to creating meaningful learning experiences. This study faces several limitations, particularly during the implementation phase. The research and development were conducted exclusively with students from Mekar Elementary School, which restricted the diversity of data available for assessing the performance of the Liveworksheet Electronic Student Worksheets (E-LKPD). To enhance the generalizability of the findings, future research should consider utilizing a more diverse sample population encompassing various schools and regions. Another constraint is the exclusive focus on integer arithmetic operations, resulting in limited diversity in the covered subjects. To overcome these limitations, future research should incorporate broader content areas and extend the duration of the study. Based on the findings of this study, it is recommended that teachers use Electronic Student Worksheets (E-LKPD) that incorporate technology during classroom instruction. Additionally, schools should provide specific training for teachers to integrate technology effectively into their teaching practices with these worksheets. Future research should prioritize the development of E-LKPD covering a wide range of topics and materials. To enhance generalizability, future studies should include more diverse samples from a broader array of schools and regions.

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