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# Enhancing mathematical problem-solving skills through problem-based learning with Liveworksheets assistance

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## ABSTRACT

This study examines and analyzes differences in mathematical problem-solving abilities among students taught using Problem-based Learning (PBL) with Liveworksheets assistance and those taught using conventional learning models supported by worksheets on the division topic. The research employed a quasi-experimental design involving 185 fourth-grade elementary school students. Samples were selected using simple random sampling, resulting in 66 students as participants. Data were collected through tests and documentation. The findings reveal a significant improvement in problem-solving skills among students taught using the PBL model with Liveworksheets assistance, evidenced by a higher N-gain score of 0.70 compared to the control group's score of 0.42. Thus, integrating Liveworksheets into PBL effectively enhances students' mathematical problem-solving abilities. This study implies innovative technology-assisted learning models can significantly improve mathematics learning outcomes.

# *Meningkatkan kemampuan pemecahan masalah matematika melalui problem-based learning berbantuan Liveworksheets*

***Kata Kunci:***

Liveworksheets, *pemecahan masalah matematika*, Problem-Based Learning, *desain kuasi-eksperimen, pembelajaran berbantuan teknologi*

## *ABSTRAK*

*Penelitian ini bertujuan untuk menguji dan menganalisis perbedaan kemampuan pemecahan masalah matematika pada siswa yang diajar menggunakan* Problem-Based Learning *(PBL) berbantuan* Liveworksheets *dengan siswa yang diajar menggunakan model pembelajaran konvensional berbantuan Lembar Kerja Peserta Didik pada materi pembagian. Penelitian ini menggunakan desain* Quasi-Experimental Design *dengan populasi sebanyak 185 siswa kelas IV Sekolah Dasar. Pengambilan sampel dilakukan menggunakan teknik* simple random sampling, *menghasilkan 66 siswa sebagai partisipan. Data dikumpulkan melalui tes dan dokumentasi. Hasil penelitian menunjukkan peningkatan yang signifikan pada kemampuan pemecahan masalah siswa yang diajar dengan model PBL berbantuan* Liveworksheets, *dibuktikan dengan skor N-gain yang lebih tinggi sebesar 0,70 dibandingkan dengan kelompok kontrol sebesar 0,42. Dengan demikian, integrasi* Liveworksheets *ke dalam PBL secara efektif dapat meningkatkan kemampuan pemecahan masalah matematika siswa. Penelitian ini mendukung penggunaan model pembelajaran inovatif berbantuan teknologi untuk meningkatkan hasil pembelajaran matematika.*

**Contribution to the literature**

This research contributes to:

- Enriching the understanding of the influence of the PBL model assisted by Liveworksheets.
- Providing empirical evidence on the effectiveness of PBL assisted by Liveworksheet on problem-solving skills.
- Adding literature on the importance of determining the right learning model and media to improve problem-solving skills.

## 1. INTRODUCTION

Education is the key to improving personal resources. Through education, humans can develop their abilities to become qualified people with skills, knowledge, and character [1]. Education is closely related to learning [2]. Learning is an aid provided by teachers to students so that they can gain knowledge, master skills, and develop demeanor and principles [3]. Learning carried out in class requires students to engage in activities [4]. The existence of science that continues to develop cannot be separated from the role of mathematics [5].

Mathematics subjects are part of the education system in elementary and secondary schools as stated in the Law of the Republic of Indonesia Number 20 Article 37 of 2003 concerning the National Education System. In the article, mathematics is one of the compulsory subjects that students must study at the elementary or secondary school level. Mathematics is one of the sciences considered important in all human life [6]. Mathematics can help humans understand natural problem-solving, social problems, and economics [7].

Mathematics at the elementary stage of education, stated by the Ministry of Education and Culture and Technology Number 7 of 2022, includes (1) the concept of numbers; (2) calculations on numeric, fractional, and decimal numbers; (3) patterns awareness; (4) planes; (5) size and attributes; and (6) statistics [8]. Some of the above scopes are grouped into several elements in the Merdeka curriculum. Each element in each phase has its learning outcomes. The number of these elements affects the students. If they are not proficient in the basic operations of the division, it can be difficult for students to understand mathematical material at the next level [9].

Factors that underlie the difficulty of learning division operations include (1) not mastering the concepts and basic skills of multiplication and subtraction operations; (2) lack of attention during lessons; (3) low interest in learning; (4) parents paying less attention to children's study habits at house; and (5) teacher's approach to students, the amount of subject matter, lack of time, ineffective remedial, lack school discipline, and the teacher's lack of patience when dealing with students [10]. Mathematics learning aims to enable students to reason critically, analytically, systematically, and creatively through problem-solving [11].

Learning to solve problems is thinking systematically, regularly, and meticulously or using various scientific methods [12]. Solving mathematical problems is a higher-order thinking process requiring a more complex analysis [13]. However, in reality, many students have difficulty in solving problems. Students often consider mathematics a scary subject because it is difficult to understand its theories and concepts [14]. This problem is evidenced by the OECD PISA score in 2018, which placed Indonesia in 73$^{rd}$ place in the field of mathematics with a score of 379 out of 79 participating countries.

Problems in mathematics also occur at SD Negeri Dabin 3 Gubug District. According to the results of an interview with the fourth-grade teachers, students experienced difficulties when doing mathematics problems due to a low understanding of the concept of division and low numeracy skills, especially in multiplication calculation operations and division. Not only that, students also have difficulty solving story problems related to division. Mathematics lessons are considered difficult and boring subjects by students because fourth-grade teachers lack innovation in managing learning. The teachers only use unattractive media. In the learning process, fourth-grade teachers use the lecturing method without presenting problems to start the learning process.

Furthermore, the teachers still use conventional learning models. As a result, learning is only teacher-centered, and most students are not actively involved in learning, so they cannot fully understand the material and solve mathematical problems. When conducting assessments, teachers still use manual student worksheets, which makes students less interested.

Based on document data collected by researchers at SD Negeri Dabin 3 Gubug District, many students in Mathematics have not reached the learning objectives attainment criteria. The learning objectives attainment criteria in mathematics subjects are more than 70. Data on daily mathematics test scores for the fourth-grade students of SD Negeri Dabin 3 Gubug District showed that 25% of students got a score of more than 70, and 75% of students were unable to reach learning criteria.

One of the ways to overcome these problems is to apply a learning model that suits the needs of students, such as the problem-based learning (PBL) model. The government recommends that the PBL model be applied [15]. The PBL model makes actual problems the main theme so students can reason critically to find solutions or solve problems [16]. PBL is a teaching model that can support students in adding the potential needed today when students are faced with a real problem to acquire critical reasoning skills and problem-solving [17]. Another opinion says that the PBL model is a student-centered teaching approach that guides students in group learning through activities to analyze problems, set goals, gather resources, synthesize ideas, and solve reflective problems [18]. The PBL learning syntax includes five main learning steps: (1) adapting to the issue; (2) organizing students to learn; (3) guiding investigations both individually and in groups; (4) growing and displaying works; and (5) dissecting and comparing problem [19]. To maximize the learning model, teachers need to use media as a learning tool suitable to the material and students' characteristics [20].

Teachers can apply learning media to attract students' attention, explain the concept of division, and make innovative assessments using Liveworksheets. The Liveworksheet software is free. Students could paint on worksheets online and then send answers to teachers online [21]. This software is good for students because it can increase their motivation to learn. For teachers, this software is effective and efficient [19]. Liveworksheets can contain interesting content, either in the form of text, animated videos, moving images, links, audio, and various types of questions so that students are interested in learning [22].

Several previous studies have suggested that the PBL model assisted by the Liveworksheets application can positively impact learning. One of the studies was conducted by Yanti *et al.* [23]. She stated that applying the Liveworksheets-assisted PBL model can improve science learning outcomes. The results of another study conducted by Syar *et al*. [24] revealed that applying the Liveworksheets-assisted PBL model could improve the mathematics learning outcomes of fourth-grade students. Sarjimin *et al* [25] stated that there was an outturn of the Liveworksheets-assisted PBL model on motivation

with very good categories. The previous studies also revealed that using a video-assisted PBL model in Liveworksheets significantly improved students' mathematical problem-solving ability [5]. Other research has also shown that students' problem-solving skills with PBL models are better than conventional learning models [26]. Based on some of the results of the above research, the PBL model assisted by Liveworksheets can positively influence learning. However, in previous research, there has been no study on the application of the Liveworksheets-assisted PBL model in the problem-solving ability of fourth-grade students.

Therefore, this study aims to analyze and describe the difference in problem-solving skills between classes that apply the Liveworksheet-assisted PBL model and those that apply the conventional learning model that is assisted by student worksheets. Although there are many studies on using the PBL model, there are still shortcomings in selecting technology-based learning media to improve problem-solving skills in the division material. Based on previous researchers' findings, this study's novelty is to compare live worksheet-assisted PBL with the conventional learning model assisted by student worksheets on the ability to solve division problems. This approach highlights the integration of modern digital tools with established learning methods. It also aims to address gaps in applying technology to enhance specific mathematical problem-solving skills.

## 2. METHOD

This study employs a quantitative method with a quasi-experimental design of a non-equivalent control group design. This kind of study has a control group but manipulates outside variables that fully affect the experiment. After receiving ethics approval, the research was conducted. In this experiment, the population was all fourth-grade students in three schools. The sampling in this study used the simple random sampling technique. The researchers performed two draws to determine samples from the three elementary schools. The first draw was used to determine the class to be sampled, and the second was used as the control and experimental classes. Based on the draw, the experimental group was the fourth-grade students of school C (32 students) who would get treatment with the Liveworksheets-assisted PBL model. The control group consisted of fourth-grade students from school A (34 students). After receiving consent from parents and students, the research was conducted.

The data-gathering technique was a test of mathematical problem-solving. The test consisted of an initial test (pretest), which aimed to determine students' abilities before being treated, and a final test (posttest), which aimed to determine students' abilities after being treated. The test data collection instrument was first tested for content validity by specialists in the field of mathematics. The SPSS 27 program assisted with the item validity and reliability tests. The data can be said to be valid if the question items tested show a significance level of 5% or $_{\text{are observed}}$ to be more than $_{\text{critical}}$. Question instruments were tested in classes that have studied the material being tested. In this study, the try-out test was carried out in the fifth grade of school B with six description questions. The initial data analysis technique was a normality test to ensure both samples were normally distributed and a homogeneity test to ensure that both samples were of the same variance. The hypothesis test used was the t-test. The n-gain test was employed to determine the average increase in values. These statistical methods ensured the reliability and validity of the research findings. The results provided a robust foundation for assessing the effectiveness of the intervention.

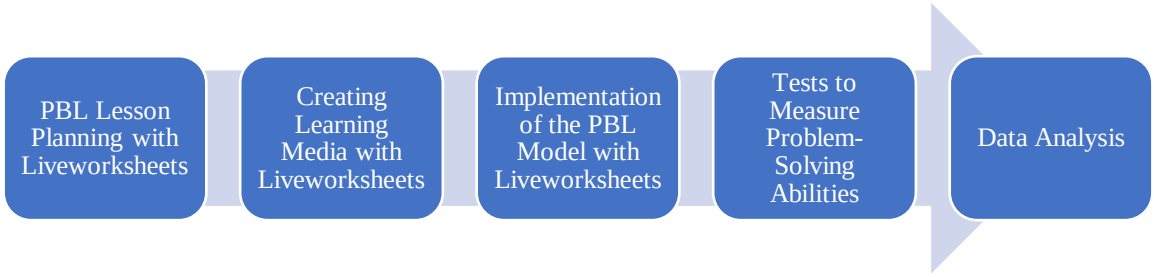


**Figure 1**. Research Procedure

## 3. RESULTS AND DISCUSSION

In this study, two classes were used as samples. The fourth-grade students of school A acted as the control class that implemented conventional learning assisted by student worksheets, and the fourth-grade students of school C acted as an experimental class that applied the Liveworksheets-assisted PBL model. The learning in the experimental class began by compiling teaching modules and learning media. The researcher went to the field to collect data, which was then analyzed using SPSS 27. The researcher conducted learning in the experimental class using the PBL syntax.

### *3.1 The PBL Implementation*

The learning implementation was carried out and adjusted to the syntax of the PBL model [27].

**Table 1**. The Syntax of the PBL model

| Syntax | Description |
|---|---|
| Orienting students toward problems | The teacher conveys the learning objectives and gives a problem to the students. |
| Organizing participants to study | The teacher organizes or concentrates the student on completing the tasks. |
| Guiding students individually and in group investigations | The teacher guides the students in delivering the data obtained from each person to their group of friends, and the teacher also guides the students in ensuring the solution of the given case first. The position of the teacher in this step is to make all students actively involved in finding and solving problems. |
| Improving and presenting the work of students. | The teacher gave other groups the opportunity to share their assumptions about their results. |
| Analyzing and evaluating the problem-solving process | The teacher carries out reflection or perfects the learning report and guides students in compiling a report. |

In learning that applied the PBL model, the researchers used Liveworksheets as a learning medium and a worksheet for students. By using Liveworksheets, students' learning motivation could be improved. The students were divided into several groups and facilitated by one laptop. The teacher shared a link to a Liveworksheet containing a problem presented in text or video. Students answered the questions in the columns provided.

### *3.2 Liveworksheets*

As shown in Figure 2, Liveworksheets were the learning media used to support the implementation of the PBL model. This platform facilitated interactive engagement and self-paced learning for students. Furthermore, it served as an effective tool to enhance problem-solving skills in alignment with the objectives of the PBL approach.

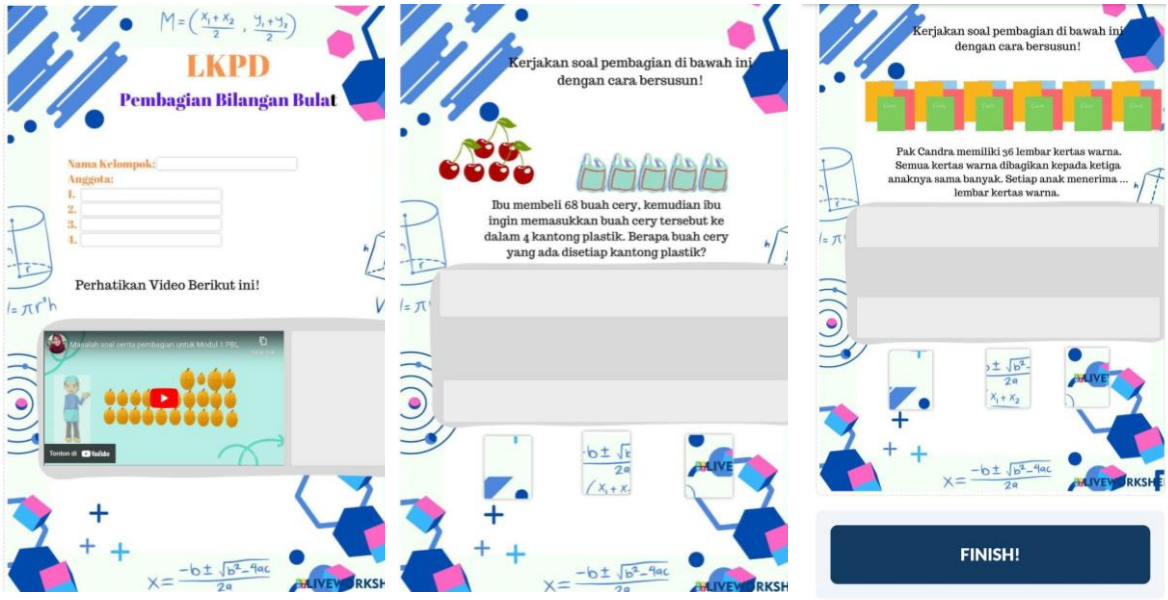


**Figure 2.** Liveworksheets Learning Media

Liveworksheets are only applied to the experimental class. It is considered the right medium, as it provides a dynamic and engaging platform where students can interact in real-time, receive instant feedback, and customize their learning paths [28]. The way to use Liveworksheet is for students to search only for the link that the teacher has provided. On the first page, a sheet will appear containing columns for student identities that students must fill in. If the identity is complete, the student will be presented with an explanation video, and problems will be packaged as videos or texts. There is a column below the video to fill in the answers to the questions. When finished, students can press the finish button.

### *3.3 Data Analysis Results*

This research data describes the student post-test scores in the experimental and control classes within four meetings. Table 2 presents a description of the post-test score data.

**Table 2.** The Post-test Score Data

| Statistic Descriptive | Experimental Group | Control Group |
|---|---|---|
| Mean | 80,88 | 63,53 |
| Median | 82,50 | 62,00 |
| Std. Deviation | 11,077 | 13,650 |
| Minimum | 55 | 38 |
| Maximum | 96 | 88 |
| Range | 41 | 50 |

Table 2 shows that the average post-test score in the experimental group that applied the Liveworksheets-assisted PBL model was higher at 80.88 compared to the control group that applied the conventional learning model assisted by student worksheets, which was 63.53. These results show that the skill to resolve division problems in students who learn the PBL model was better than those who learn conventional learning models assisted by student worksheets. Furthermore, a hypothesis test was executed to decide the significant influence of the Liveworksheets-assisted PBL model. However, the normality test and homogeneity test were executed first.

The normality test was performed using the One-Sample Kolmogorov-Smirnov Test at a significance level of 5%. If the significance value is more than 0.05, then the data is normally distributed. If it is lower than 0.05, then the data is not normally distributed. This test is essential for determining whether parametric or non-parametric statistical methods should be applied. The results of the normality test guide further analysis and ensure the appropriate choice of statistical techniques. Table 3 displays the normality test results.

**Table 3.** The Normality Test Output on the Post-test Data

| Tests of Normality | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Group** | **Kolmogorov-Smirnov[a]** | | | **Shapiro-Wilk** | | |
| | | **Statistic** | **Df** | **Sig.** | **Statistic** | **df** | **Sig.** |
| Posttest | Control | .122 | 34 | .200* | .961 | 34 | .255 |
| | Experiment | .103 | 32 | .200* | .954 | 32 | .191 |

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 3 shows that the significance value in both groups was higher than 0.05. Therefore, Ho is accepted, and Ha is rejected. Thus, it could be deduced that the data is normally distributed. A homogeneity test was performed to discover the similarity of the populations of the two groups. The test was carried out using the F (Leven's) test. If the significance value is more than 0.05, Ho is accepted, which means there is no dissimilarity in variance between the two groups (homogeneous). If the significance rate is lower than 0.05, Ho is rejected, which means there is a dissimilarity in variance between the two groups (not homogeneous). Based on the homogeneity test, it was concluded that the variances of both groups are similar. This indicates that the two groups can be compared reliably. The homogeneity test results are presented in Table 4.

**Table 4.** The Homogeneity Test Output on the Post-test Data

| Tests of Homogeneity of Variances | | | | | |
|---|---|---|---|---|---|
| | | **Levene Statistic** | **df1** | **df2** | **Sig.** |
| Posttest | Based on Mean | 2.516 | 1 | 64 | .118 |
| | Based on Median | 2.277 | 1 | 64 | .136 |
| | Based on the Median and with adjusted df | 2.277 | 1 | 63.454 | .136 |
| | Based on trimmed mean | 2.610 | 1 | 64 | .111 |

Table 4 shows that Ho is accepted while Ha is rejected. Thus, the data is homogeneous because there is no difference in variance. The hypothesis test can be conducted if the data is normally distributed and homogeneous.

Hypothesis testing was conducted to test the ability to resolve mathematical problems on division material after learning in experimental and control classes. The hypothesis test was performed using the t-test on SPSS 27. If the significance value is more than 0.05, Ho is accepted. The results of the hypothesis test can be seen in Table 5. Table 5 shows that the significance value is less than 0.05, which is 0.000. It means that Ho is rejected and Ha is accepted. Thus, it could be concluded that there are differences between the control class and the experimental class. Furthermore, an N-gain test was carried out to determine the magnitude of the increase in students' scores between pretest and posttest. The N-gain test results further supported the hypothesis test findings, indicating a significant improvement in the experimental class. This implies that the intervention used in the experimental class effectively enhanced students' mathematical problem-solving abilities.

**Table 5.** Hypothesis Test Output Table

| Independent Samples Test | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| Post-test | Equal variances assumed | 2.516 | .118 | -5.648 | 64 | .000 | -17.346 | 3.071 | -23.481 | -11.210 |
| | Equal variances are not assumed | | | -5.684 | 62.673 | .000 | -17.346 | 3.052 | -23.445 | -11.246 |

The gain value ranges from 0-100 as the ideal maximum score set by the researcher. If students get a score of 0 during the initial test and get a score of 100 during the final test, the gain value obtained is 100. However, if students score 100 during the initial and 100 during the final tests, the gain value obtained is 0 [29]. The increase in the pretest scores and the post-test of control class students and experimental classes is presented in Table 6.

**Table 6.** N-Gain Test Results

| Group | Average | | Number of Students | G | Criteria |
|---|---|---|---|---|---|
| | Pretest | Posttest | | | |
| Experimental | 34,68 | 80,88 | 32 | 0,70 | High |
| Control | 36,7 | 63,52 | 34 | 0,42 | Moderate |

Based on the N-Gain test above, both classes of samples showed an increase. An increase of 0.70 in the experimental group was included in the high criterion, and an increase of 0.42 in the control group was included in the moderate criterion. The average scores of both classes are shown in Figure 3.

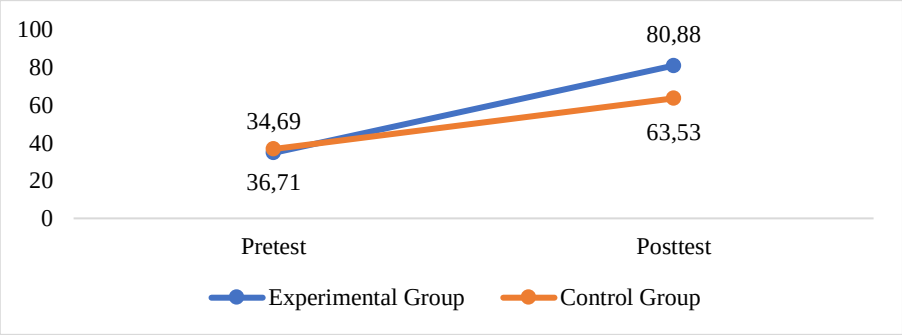


**Figure 3.** Pretest and Posttest Average Score Increase Graph

Figure 3 shows no significant difference between the two samples before treatment. However, after the treatments, the experimental class outperformed the control class. Therefore, the Liveworksheets-assisted PBL model could refine the problem-solving ability of fourth-grade elementary school students.

The effects of the statistics tests display that the utility of the Liveworksheets-assisted PBL effectively affected the mathematical problem-solving on the division material. This is evidenced by the difference in initial ability before and after treatment.

Several aspects affect the success of this study, one of which is the syntax of the learning model. The syntax of the PBL model is student orientation to problems, organizing students to study, guiding and organizing investigations, growing and providing work outcomes, and analyzing and comparing the problem-solving process [30]. Learning in the experimental class and control class was carried out within four meetings. The difference between the experimental class and the control class lies in applying the learning model and using learning media. Before the treatment, the samples were given pretest questions to determine the students' initial abilities.

In the first meeting in the experimental class, the students seemed enthusiastic when learning. However, when faced with a problem, the students seemed confused because they could not understand the mathematical problems [31]. They were only enthusiastic to watch the video. In the control class, the students tended to be passive and could not solve problems properly. They only understood the concept of division using repeated subtraction.

At the second meeting, the students were in the process of adapting to the PBL model with the help of Liveworksheets. Learning began by presenting the problem displayed on a live video worksheet. While understanding the problems in the video, the students remembered the steps to solve problems. But in the end, when appointed for a presentation to the front class, the students were not entirely correct. Some students could not do problem planning. Supposedly, before carrying out problem planning, they must first understand the problem, plan the problem-solving, and then review the completeness of the problem-solving [32]. The good impact of this second meeting was that learning became more active, and students looked attracted when discussing with their groups. In the second meeting in the control class, the students were not able to answer questions systematically. They also did not play an active role in learning.

At the third and fourth meetings, the students began to engage in learning, as seen by the students' activeness in solving problems contained in the Liveworksheets. Even so, some students were still not active and could not solve problems. To overcome this problem, the teacher grouped students who did not understand with students who understood. This action was aimed to make students learn from each other. During learning, the students utilized electronic media, such as YouTube videos on Liveworksheet pages [23]. The teacher guided students in solving problems and then asked them to present the discussion results to their group. By applying the Liveworksheets-assisted PBL model, the students could build their knowledge through a series of information obtained during problem-solving. Four steps can be used to resolve the issue: understanding the issue, problem-solving planning, carrying out problem-solving planning and reviewing the completeness of problem-solving [33].

After being given different treatments, both classes were given a posttest. Based on the results obtained by the researcher, the answers of the control class could not systematically solve the problem of division. Some students in the control class preferred to answer directly without writing down the problem-solving plan (known, asked, answered, and concluded). They only write the results of the division using the *portrait* method. In contrast to the experimental class, they were able to solve problems in sequence by mentioning what is known, asking, answering, and concluding the answer. These differences were influenced by students' motivation to learn. The use of manual student worksheets in the control class was considered less interesting, and the work on the questions took longer because they had to write on paper. It is different from Liveworksheets, which was able to increase students' learning motivation because it utilized technology, was presented colorfully, had audio-visual media, and saved time so

that students did not need to be tired of writing. The interactive nature of Liveworksheets provided students with immediate feedback, making learning more engaging. Additionally, the digital format allowed for easier access and flexibility in completing assignments.

This study's results align with the results of a previous study conducted by Yanti *et al.* [23] which stated that the Liveworksheet-assisted PBL model had an impact on the fifth-grade students' science learning outcomes. Also, the results of another study conducted by Sari and Jusra [34] revealed that the PBL model assisted by Liveworksheets impacted students' creative thinking skills. Other research also shows that using the PBL model with the help of technology can improve students' abilities [35]. Previous studies also revealed that students who acquired the video-assisted PBL model on Liveworksheets significantly improved their mathematical problem-solving skills [5]. From the antecedent study, it could be seen that the PBL model assisted by Liveworksheets affects the problem-solving ability.

## 4. CONCLUSION

The research shows a difference in how fourth-grade elementary school students solved problems. The experimental class students did differently compared to those in the control class. The results show a clear difference. The experimental group has a mean post-test value of 80.88, which is higher than the control group's mean value of 63.52. the researchers suggest that the PBL model can help teachers make learning more fun. This way, students will not see mathematics as something scary. This study shows that using new technology in learning can help make math education better.

## AUTHOR CONTRIBUTION STATEMENT

AAM contributed to conceiving and designing experiments, conducting experiments, analyzing and interpreting data, and writing articles. NA contributed to improving and provide input on the research manuscript.

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