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The Effectiveness of PBL and PJBL Assisted by Digital Book to Improve the Mathematical Literacy of Fifth-Grade Elementary School Students

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Abstract

This study examined the effectiveness of Problem-Based Learning (PBL) and Project-Based Learning (PjBL) assisted by Digital Books in improving the mathematical literacy of fifth-grade elementary school students. A quantitative quasi-experimental study used a pretest-posttest non-equivalent control group design with 90 students at SDN Pancawati II, Indonesia. The students were assigned to three groups: PBL assisted by Digital Books, PjBL assisted by Digital Books, and conventional learning. Data were collected through validated mathematical literacy tests and observations of teacher and student activities. The data were analyzed using Shapiro-Wilk, Levene's test, paired-sample t-tests, One-Way ANOVA, Tukey HSD, and N-Gain. The results showed significant pretest-posttest improvements in all groups ($p < .001$). The PBL group obtained the highest posttest mean (85.97) and N-Gain (0.7949), followed by the PjBL group (81.13; 0.7735) and the conventional group (60.90; 0.6994). ANOVA showed significant differences among the three groups, and Tukey HSD confirmed significant pairwise differences. These findings indicate that both Digital Book-assisted models are effective, while PBL provides the strongest improvement in mathematical literacy.

Keywords Problem Based Learning; Project Based Learning; Mathematical Literacy

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1. INTRODUCTION

Education in the 21st century demands a significant transformation in the way teachers deliver material and how students process information, especially in mathematics, which is often considered difficult by most students. This paradigm shift requires educators to no longer merely transfer knowledge unidirectionally, but also to cultivate a mindset that is adaptive to technological changes. In this context (Buchori & Siswanto, 2023) emphasizes that the integration of technology-based learning models is essential to improve students' mathematical understanding in the digital era. Mathematical literacy is not merely the ability to perform mechanical calculations, but rather the individual's capacity to formulate, use, and interpret mathematics in various complex real-life contexts (OECD, 2023a). Students are expected to see numbers as tools to solve everyday problems, not just symbols to be memorized. However, the reality on the ground often shows a different picture where students' interest in learning tends to decline for subjects that are considered difficult. The main challenge in elementary schools today is the low interest of students in geometry and fractions, which are often presented abstractly without adequate supporting media for them. This condition is exacerbated by conventional

methods that tend to be boring and do not actively challenge students' logical thinking. Without any real innovation, the gap between curriculum expectations and the actual abilities of students in the field will widen each year. The importance of understanding mathematical concepts from an early age becomes the main foundation for students to face higher levels of education and increasingly competitive global challenges (Az-zahra et al., 2023).

The use of the Problem-Based Learning (PBL) model has emerged as one of the solutions that has been empirically proven to improve learning outcomes and higher-order thinking skills (Bahrudin, 2025). This model places students at the center of learning, where they are confronted with contextual problems that must be solved through collaboration and in-depth analysis. In practice, students are encouraged to seek the essence of the given problem rather than just fixating on rigid formal formulas. The teacher acts as a facilitator who directs the discussion, while students learn to construct their own understanding through social interaction. However, the implementation of PBL in the field is often hindered by the lack of media that can visualize the problems in an engaging manner for elementary school students who are still in the concrete operational stage of thinking (Khafidhoh & Mahmudah, 2022). Poor visualization or overly verbal explanations often make problem scenarios biased and difficult for children to understand. Mathematical literacy requires consistent mental stimulation through problem scenarios that are relevant to their daily lives so that they feel the need to learn it. Efforts to strengthen literacy through PBL have become a primary agenda that must be systematically implemented in elementary school environments so that curriculum achievement targets can be optimally met. With the integration of real-world problems, students will be more motivated to seek logical and systematic solutions to every mathematical challenge presented. The habituation of critical thinking through this model will shape students' character to be resilient in facing various mathematical problems in the future.

On the other hand, the Project-Based Learning (PjBL) model offers an approach that is more product-oriented and involves long-term processes that fully engage students' creativity (Nuraeni & Aprianti, 2023). Through project work, students learn that mathematics is a real tool for creating works or completing practical tasks around them. This makes knowledge retention stronger because students are directly involved in every stage of the product creation they make. The integration of digital media in PjBL has been proven to significantly improve learning outcomes in mathematics for fifth-grade students (Ginting et al., 2025). Students feel a greater sense of responsibility for their work because the process involves independent exploration and the use of technology they enjoy. However, the implementation of this model requires very careful planning from the teacher so that each stage of the project remains within the corridor of basic competencies. Without clear and structured guidance, project-based learning risks becoming an activity that is merely "playing around" and wasting time. Therefore, the use of project-based learning tools or media is very helpful in honing students' process skills in this digital era (Lestari et al., 2023). In the end, PjBL is considered one of the most effective models for comprehensively developing 21st-century competencies at the elementary education level. The team collaboration that develops during project work also trains the emotional and social intelligence of elementary school students. shows that PjBL assisted by digital learning media is effective in improving students' critical thinking skills and learning engagement. The integration of digital media in PjBL also helps students become more independent and responsible in completing learning tasks (Siswanto, 2024).

Preliminary observations conducted at SDN Pancawati II, supported by classroom observations and interviews with fifth-grade mathematics teachers, revealed that many students experienced difficulties in solving contextual mathematical problems requiring reasoning rather than routine calculations. Learning activities were still predominantly teacher-centered, resulting in students relying on memorizing formulas instead of understanding mathematical concepts and applying them in authentic situations (Azizah & Sucahyo, 2022). These findings were further confirmed by a preliminary mathematical literacy assessment administered before the intervention (Fadholi et al., 2024; Faisal et al.,

2024). The average pretest score of the conventional class was 46.67, while both experimental classes obtained an average score of 52.63, indicating that students' initial mathematical literacy was still relatively low. Most students encountered difficulties in formulating mathematical models from contextual problems, selecting appropriate solution strategies, and interpreting mathematical results in meaningful real-life contexts. These empirical findings demonstrate that improving mathematical literacy among fifth-grade students at SDN Pancawati II is an urgent educational priority and provide a strong justification for selecting this school as the research setting.

In relation to PBL and PjBL, Digital Books provide cognitive support throughout important learning stages, including problem orientation, information exploration, project planning, solution development, and reflection. In PBL, Digital Books help students interpret contextual problems by providing visual and interactive representations that reduce ambiguity (Fatmiyati & Juandi, 2023; Febrianti, 2021). In PjBL, Digital Books support students in exploring information, designing products, monitoring project progress, and reflecting on mathematical concepts involved in the project. Recent studies indicate that technology-supported inquiry learning becomes more effective when digital resources are integrated with appropriate pedagogical models rather than used independently as supplementary materials (Hwang et al., 2023).

Based on the entire background that has been presented, this research focuses on efforts to compare the effectiveness between the PBL model and the PjBL model assisted by digital books. It is important for education practitioners to know which model has the most significant impact on strengthening students' mathematical literacy (Fiorella & Mayer, 2022; Firdaus & Harjono, 2025). The results of this research are expected to serve as a practical guide for elementary school teachers in determining the most effective teaching strategies (Kusumawati et al., 2024; Susiliastini & Sujana, 2022). The need for high-quality digital books is becoming increasingly urgent in line with the implementation of the Merdeka Curriculum, which demands high flexibility. Good mathematical literacy at the elementary level will equip students with the ability to make logical and objective decisions. This research also aims to make a tangible contribution to the development of academic literacy in the primary education environment.

This research employed a quantitative approach using a quasi-experimental method with a Pretest-Posttest Non-Equivalent Control Group Design. This design was selected because the study involved existing classes that could not be randomly assigned individually. The research compared three learning treatments: the class using the Problem-Based Learning (PBL) model assisted by Digital Books, the class using the Project-Based Learning (PjBL) model assisted by Digital Books, and the class using conventional learning through the lecture method. Each group received a pretest before treatment and a posttest after treatment to measure changes in students' mathematical literacy.

The research was conducted at SDN Pancawati II on April 23, 2026. The sample consisted of fifth-grade students selected through cluster random sampling, involving three existing classes. The learning process was implemented by three different fifth-grade teachers, with each teacher responsible for one treatment group. To minimize teacher-related bias as a confounding variable, each teacher implemented a validated lesson plan (RPP) based on the assigned learning model while maintaining the same curriculum objectives, mathematical literacy indicators, learning materials, meeting duration, assessment procedures, and evaluation criteria. Teachers were also provided with guidance regarding the research procedures to ensure consistent implementation (Nurmasari et al., 2024; Ormrod, 2023; Santoso, 2024).

The research instruments included teaching modules, teacher and student activity observation sheets, and mathematical literacy tests in the form of multiple-choice questions. The instruments were validated by two expert lecturers and were declared feasible for use after revision. The researcher acted as an observer to monitor the implementation of learning activities and ensure that each model was conducted according to its respective syntax (Santoso, 2024). These control procedures were applied to

ensure that differences in students' mathematical literacy outcomes were primarily associated with the effectiveness of the learning models assisted by Digital Books.

The present study therefore addresses a specific empirical gap: PBL and PjBL have frequently been examined separately, and digital books are often treated as supplementary media rather than as structured cognitive support within a learning model. By comparing PBL assisted by Digital Books, PjBL assisted by Digital Books, and conventional learning within the same school context, this study provides a direct comparison of the relative effectiveness of the two student-centered models. The study was guided by three hypotheses: PBL assisted by Digital Books produces better mathematical literacy than conventional learning; PjBL assisted by Digital Books produces better mathematical literacy than conventional learning; and PBL assisted by Digital Books produces better mathematical literacy than PjBL assisted by Digital Books.

2. METHODS

This research was conducted at SDN Pancawati II on April 23, 2026. The study was carried out in three classes, namely the class using the Problem-Based Learning (PBL) model assisted by digital books, the class using the Project-Based Learning (PjBL) model assisted by digital books, and the class using conventional learning with the lecture method. The implementation of the learning process was conducted by three fifth-grade teachers as practice teachers, while the researcher acted as an observer of teacher activities and student activities during the learning process. The observer was responsible for monitoring both teacher and student activities throughout the learning process.

The results of teacher activity observations in the Problem-Based Learning (PBL) model assisted by digital books over 4 meetings showed an average percentage of 98.1%, which is categorized as very good. This indicates that the teacher was able to carry out all learning stages—from the introduction, core activities, to the closing—optimally and in accordance with the PBL syntax.

In addition to observing teacher activities, this study also examined student activities throughout the learning process. The purpose of this observation was to determine the extent of students' engagement in following the learning stages using the PBL model assisted by digital books. The data obtained are as follows:

3. FINDINGS AND DISCUSSIONS

Findings

This The results of student activity observations in the Problem-Based Learning (PBL) model assisted by digital books over 4 meetings showed an average of 95%, which is categorized as very active. This indicates that students were actively involved in the learning process, including understanding problems, discussing, exploring information, and presenting group work results.

After describing the results of teacher activity and student engagement in the PBL model assisted by digital books, the next section presents the observation results of the Project-Based Learning (PjBL) model assisted by digital books. The results obtained are presented below:

Based on the observation results of teacher activities in learning using the Project-Based Learning (PjBL) model assisted by digital books, the average percentage was 92.5% and categorized as very good. Teacher activities in the first meeting were still in the good category (82.5%). This was because the teacher was still in the adaptation stage in integrating the PjBL model assisted by digital books, particularly in formulating project-based questions, guiding students' independent inquiry, and managing learning time, which tends to be more complex.

Although teacher activities improved in each meeting, the average score of teacher activities in PjBL learning assisted by digital books was still slightly lower than in PBL learning. This indicates that implementing PjBL with technology requires more complex classroom management skills and a longer learning time. As a result, a more intensive adaptation process is needed for its implementation.

Students in the active category achieved an average of 88.1% in learning activities using the Project-Based Learning (PjBL) model assisted by digital books. During the first meeting, students were still considered moderately active (75%). This was due to their adaptation to the project-based learning model and the use of digital books, as well as a lack of confidence in asking questions and expressing opinions.

Overall, although student activity increased in each meeting, the level of student engagement in PjBL assisted by digital books was still lower compared to the PBL class. This indicates that project-based learning requires a longer adaptation period than PBL, especially in terms of task management, collaboration, and independent learning skills.

The observation results show that teacher activities in the control class using the lecture method were in the good category, with an average of 86.9%. This is still lower compared to the PBL class assisted by digital books and the PjBL class assisted by digital books.

The observation results show that student activity in the control class using the lecture method was categorized as active, with an average of 85.6%, compared to the PBL and PjBL classes. This is due to the fact that the teacher plays a more dominant role in the learning process, while students generally act as recipients of information. Students still engage in some activities such as discussion, exploration, and problem-solving, but they are more often involved in listening, taking notes, and completing exercises.

In conclusion, the results of teacher activity and student engagement observations across the three learning models show clear differences. The PBL model assisted by digital books improves both teacher performance and student activity because it focuses on problem-solving steps and encourages students to think critically, discuss, and find their own solutions.

Description of the mathematical literacy results from the pretest and posttest scores shows that there were three groups given different treatments, namely the PBL model assisted by digital books, the PjBL model assisted by digital books, and conventional learning using the lecture method. This was used to examine the improvement in students' mathematical literacy skills before and after learning in each group. The results in the control class using the lecture method are as follows:

Based on Table 7, the recap of pretest and posttest scores in the control class, it can be explained that the average pretest score is 46.67 with a minimum score of 35 and a maximum score of 55. Meanwhile, the average posttest score is 61.03 with a minimum score of 50 and a maximum score of 68. Therefore, it can be concluded that the pretest score < posttest score.

Based on Table 8, it can be explained that the mean pretest score was 51.83, with a minimum score of 44 and a maximum score of 65. Meanwhile, the mean posttest score was 86.27, with a minimum score of 78 and a maximum score of 95. Thus, the pretest score is lower than the posttest score (pretest < posttest). The results obtained in Project-Based Learning (PjBL) assisted by digital books are as follows:

Based on Table 9, it can be explained that the mean pretest score was 51.83, with a minimum score of 44 and a maximum score of 65. Meanwhile, the mean posttest score was 81.40, with a minimum score of 72 and a maximum score of 90. Thus, the pretest score is lower than the posttest score (pretest < posttest). In the conventional learning group, the mean pretest score of 46.67 increased to 61.03 in the posttest. Although there was an improvement, this result remained the lowest compared to the other groups. In the group using the PBL model assisted by digital books, the highest increase occurred, rising from a mean pretest score of 52.63 to a posttest score of 85.97. This indicates that the PBL model had a

greater impact on improving students' mathematical literacy compared to both the PjBL model and the lecture method. In the group using the PjBL model assisted by digital books, the mean pretest score of

Overall, there was an improvement in mathematical literacy across all learning groups. The PBL model assisted by digital books showed the highest improvement, followed by the PjBL model assisted by digital books, while the lecture method showed the lowest improvement. Therefore, the PBL model assisted by digital books can be considered the most effective in improving elementary students' mathematical literacy compared to the PjBL model and the lecture method.

Descriptive analysis is used to present and describe research data, including the number of students, maximum scores, minimum scores, and average scores. The results of the descriptive analysis calculated using SPSS 24 can be presented in the following table.

Based on the Shapiro-Wilk test results for each dataset, it was found that in the conventional learning pretest, the significance value (Sig.) was 0.856, while the conventional learning posttest had a value of 0.445. In the PBL group assisted by digital books, the pretest Sig. value was 0.857, while the posttest value was 0.677. In the PjBL group assisted by digital books, the pretest Sig. value was 0.857, while the posttest value was 0.897.

Based on the data above, the significance values obtained were: Based on Mean = 0.907, Based on Median = 0.907, Adjusted df = 0.907, and Based on Trimmed Mean = 0.900. All of these significance values are greater than 0.05, indicating that the data on mathematical literacy outcomes in the conventional learning group, the PBL group assisted by digital books, and the PjBL group assisted by digital books have homogeneous variances.

Based on the results of the Paired t-test in Table 13, It can be observed that all classes obtained a significance value of 0.000 < 0.05. This indicates that there is a significant difference between the pretest and posttest results in each class.

However, the t-test alone cannot determine the differences in improvement between groups overall. Therefore, a further test using One-Way ANOVA was conducted on the posttest data to examine whether there were significant differences among the groups. The purpose of the ANOVA test is to determine the most effective learning model in improving students' mathematical literacy, namely between PBL assisted by digital books, PjBL assisted by digital books, and conventional learning.

Based on the results above, the obtained values were Fcount = 277.199, Sig. = 0.000, and α = 0.05. Since Sig. (0.000) < 0.05, H_0 is rejected and H_1 is accepted. Therefore, it can be concluded that there is a significant difference in the mean mathematical literacy scores among the three groups, namely the PBL group assisted by digital books, the PjBL group assisted by digital books, and the conventional learning group. This indicates that variations in learning models have an influence on students' mathematical literacy outcomes. Based on these results, the relationship with the research hypotheses can be explained as follows:

Although the ANOVA test shows an overall significant difference (omnibus test), it does not specify which groups differ significantly from each other. Therefore, a post hoc test using Tukey HSD is required to analyze the differences between groups in more detail.

Based on the post hoc test results using Tukey HSD, the following comparisons between groups were obtained, PBL assisted by digital books vs conventional learning. A mean difference of 25.067 was found with Sig. 0.000 < 0.05, indicating a significant difference. The PBL group assisted by digital books had a much higher average score than the conventional learning group. PjBL assisted by digital books vs conventional learning. A mean difference of 20.233 was obtained with Sig. 0.000 < 0.05, indicating a significant difference. The PjBL group showed higher average scores compared to the conventional learning group. PBL assisted by digital books vs PjBL assisted by digital books. A mean difference of -4.833 with Sig. 0.000 < 0.05 was found, indicating a significant difference between the two models. The

PBL group had a higher average score than the PjBL group.

The post hoc test results show that, The PBL model assisted by digital books produces significantly better mathematical literacy outcomes compared to conventional learning, The PjBL model assisted by digital books produces higher mathematical literacy outcomes than conventional learning, The PBL model assisted by digital books produces higher mathematical literacy outcomes than the PjBL model assisted by digital books.

Research hypothesis results, PBL assisted by digital books vs Conventional learning, Accepted. The PBL model assisted by digital books is proven to produce better mathematical literacy outcomes compared to conventional learning. PjBL assisted by digital books vs Conventional learning, Accepted. The PjBL model assisted by digital books is proven to produce better mathematical literacy outcomes compared to conventional learning. PBL assisted by digital books vs PjBL assisted by digital books, Accepted. The PBL model assisted by digital books is proven to produce better mathematical literacy outcomes compared to the PjBL model assisted by digital books.

Based on the N-Gain analysis results, it is known that the three research groups showed different levels of improvement in mathematical literacy. The conventional learning group obtained an N-Gain score of 0.6994, which is categorized as moderate. This indicates that conventional learning provides a fair improvement, but it is not yet optimal in enhancing students' mathematical literacy. Meanwhile, the group applying the PBL model assisted by digital books obtained an average N-Gain score of 0.7949, which is categorized as high. This indicates that the implementation of the PBL model assisted by digital books is highly effective in improving students' mathematical literacy. The group applying the PjBL model assisted by digital books obtained an average N-Gain score of 0.7735, which is also categorized as high. This means that the PjBL model assisted by digital books is also effective in improving students' mathematical literacy.

Overall, both learning models assisted by digital books (PBL and PjBL) resulted in higher improvements compared to conventional learning. However, descriptively, the PBL model shows the highest N-Gain score compared to the PjBL and control groups.

Based on the research results, it can be concluded that the implementation of Problem-Based Learning (PBL) and Project-Based Learning (PjBL) models assisted by digital books influences students' mathematical literacy. The results of the paired sample t-test, One-Way ANOVA, Tukey HSD post hoc test, and N-Gain test indicate an overall improvement in students' mathematical literacy across all research groups.

The use of the Problem-Based Learning (PBL) model assisted by digital books produces better mathematical literacy outcomes compared to conventional learning. Based on the paired sample t-test, the PBL group obtained a significance value of $0.000 < 0.05$, indicating a significant difference between pretest and posttest scores. The mean improvement in the PBL group was 33.333, which is the highest among all groups. Furthermore, the Tukey HSD test showed a mean difference of 25.067 between the PBL group and the conventional group with a significance value of $0.000 < 0.05$. These results indicate that the PBL model assisted by digital books is more effective than conventional learning in improving students' mathematical literacy.

The strengths of the PBL model lie in its student-centered learning process, which involves contextual problem-solving activities that students must analyze and solve individually or collaboratively. PBL trains students to understand problems, formulate strategies, analyze information, and draw conclusions. These activities are closely aligned with the indicators of mathematical literacy, namely formulating, applying, and interpreting mathematical concepts in various contexts (Kurniawan et al., 2025; Pratiwi et al., 2022).

The use of digital books also supports the learning process by presenting materials in an interactive, engaging, and easy-to-understand format. Digital books help students gain more effective learning

experiences, encouraging critical thinking and deeper conceptual understanding. Thus, the PBL model assisted by digital books is proven effective in improving students' mathematical literacy compared to conventional learning (Anggraini, 2024; Saputra et al., 2023).

Furthermore, the Project-Based Learning (PjBL) model assisted by digital books also produces better mathematical literacy outcomes compared to conventional learning. The paired sample t-test results showed a significance value of 0.000 < 0.05, indicating a significant difference between pretest and posttest scores. The PjBL group experienced a mean improvement of 28.500. In addition, the Tukey HSD test showed a mean difference of 20.233 between the PjBL group and the conventional group with a significance value of 0.000 < 0.05. This indicates that the PjBL model assisted by digital books is also more effective than conventional learning in improving students' mathematical literacy.

The PjBL model provides opportunities for students to learn through projects, making them more active, creative, and directly involved in the learning process. Through project activities, students develop collaboration skills, critical thinking, and the ability to apply mathematical concepts in real-life problem solving. These activities enhance students' understanding of mathematics in real-world contexts, thereby improving their mathematical literacy (Suhendra et al., 2025; Oktaviani & Sokhifah, 2024). In addition, digital books in the PjBL model provide more engaging and interactive learning resources that support the completion of student projects. Thus, the PjBL model assisted by digital books is effective in improving students' mathematical literacy compared to conventional learning (Maulida & Ghufron, 2025; Prasetyo et al., 2023).

The PBL model assisted by digital books is more effective than the PjBL model assisted by digital books. Based on the One-Way ANOVA test, a significance value of 0.000 < 0.05 was obtained, indicating differences in mathematical literacy among the three groups. The Tukey HSD post hoc test showed that the PBL model resulted in higher mathematical literacy than the PjBL model (Mayer, 2021). This is also supported by the N-Gain results, where the PBL group obtained a mean score of 0.7949 (high category), while the PjBL group obtained 0.7735 (high category), although both are effective, PBL shows a higher improvement.

The superiority of PBL over PjBL lies in its stronger focus on structured mathematical problem-solving processes. Students are directed to understand problems, analyze information, determine solution strategies, and draw conclusions systematically. This process aligns closely with mathematical literacy indicators (Setyawan et al., 2025; Lestari et al., 2023). Meanwhile, in the PjBL model, learning focuses not only on problem-solving but also on project completion. As a result, students' attention is divided between understanding mathematical concepts and producing a project, making mathematical literacy practice less intensive compared to PBL (Wahyuni et al., 2022; Prabowo & Sari, 2022).

In conclusion, innovative learning models assisted by digital books are effective in improving students' mathematical literacy. However, the PBL model assisted by digital books is proven to be the most effective compared to both the PjBL model and conventional learning. Therefore, the PBL model assisted by digital books can be considered an effective alternative learning model for enhancing students' mathematical literacy (Nuraini et al., 2024; Wibisono & Sari, 2022).

Based on the results of the analysis and discussion, it can be concluded that the implementation of the Problem-Based Learning (PBL) and Project-Based Learning (PjBL) models assisted by digital books is effective in improving the mathematical literacy of elementary school students compared to conventional learning. This is demonstrated by the results of the paired sample t-test, One Way ANOVA, Tukey HSD, and N-Gain tests, which show a significant improvement in all research groups. The implementation of the Problem-Based Learning (PBL) model assisted by digital books produces better mathematical literacy skills compared to conventional learning. This is evidenced by the paired sample t-test results, which show a significance value of 0.000 < 0.05, indicating a significant difference between pretest and posttest scores. In addition, the Tukey HSD post hoc test shows a mean difference of 25.067 between the PBL group and the conventional group with a significance value of 0.000 < 0.05.

These results indicate that the PBL model assisted by digital books is more effective than conventional learning in improving students' mathematical literacy skills. The PBL model is effective because it is student-centered and emphasizes contextual problem-solving activities. The use of digital books also helps students understand mathematical concepts in a more interactive, engaging, and accessible way, making the learning process more effective.

Thus, it can be concluded that innovative learning models assisted by digital books are effective in improving students' mathematical literacy skills. However, the PBL model assisted by digital books is the most effective compared to both the PjBL model and conventional learning.

Based on these findings, teachers are recommended to implement the PBL model assisted by Digital Books by integrating interactive features at critical stages of the learning process, particularly during the problem orientation stage. Contextual illustrations, animations, videos, and interactive examples in Digital Books should be utilized to help students identify mathematical problems, understand problem contexts, and develop appropriate solution strategies. Thus, Digital Books can function not only as learning resources but also as cognitive scaffolding that supports students in constructing mathematical understanding.

For future researchers, it is recommended to conduct further studies using a delayed post-test design to examine the long-term retention of students' mathematical literacy after the implementation of Digital Book-assisted learning. Further investigations may also explore the effectiveness of PBL and PjBL assisted by Digital Books across different grade levels, mathematical topics, and learning contexts to strengthen evidence regarding the sustainability of technology-based mathematics learning.

Table 1. Summary of Teacher and Student Activity Observations

Learning group	Teacher activity	Student activity	Category
PBL + Digital Book	98.1%	95.0%	Very good / Very active
PjBL + Digital Book	92.5%	88.1%	Very good / Active
Conventional	86.9%	85.6%	Very good / Active

Table 2. Descriptive Statistic of Mathematical Literacy

Group	N	Pretest Mean	Posttest Mean	SD Posttest
Conventional	30	46.67	60.90	4.626
PBL + Digital Book	30	52.63	85.97	4.181
PjBL + Digital Book	30	52.63	81.13	4.305

Table 3. Inferential Test Result

Analysis	Result	Interpretation
Shapiro-Wilk	All Sig. > .05	Normal distribution
Levene	Sig. = .907	Homogeneous variance
Paired t-test	All Sig. = .000	Significant pretest-posttest improvement
One-Way ANOVA	F = 277.199; Sig. = .000	Significant difference among groups
Tukey HSD	PBL–Control = 25.067; PjBL–Control = 20.233; PBL–PjBL = 4.833; all Sig. = .000	All pairwise differences significant
N-Gain	PBL = .7949; PjBL = .7735; Control = .6994	PBL and PjBL high; control moderate

Discussion

The findings demonstrate that learning design, rather than digital media alone, is central to the observed improvement. All three groups improved significantly, but the magnitude of improvement differed. The conventional group increased from a mean of 46.67 to 60.90, whereas the PBL group increased from 52.63 to 85.97 and the PjBL group from 52.63 to 81.13. The paired-sample t-tests confirm that each intervention was associated with significant improvement, while the ANOVA and Tukey HSD results establish that the posttest differences among the groups were statistically significant.

PBL assisted by Digital Books produced the strongest outcome. The model requires students to understand a contextual problem, identify relevant information, determine a mathematical strategy, carry out the solution, and interpret the result. These activities correspond closely with the components of mathematical literacy described in the manuscript and with the framework of (OECD, 2023b). The Digital Book strengthens the process by presenting contextual illustrations, explanations, and interactive representations that help students move from a concrete situation toward a mathematical model. Previous studies cited in the manuscript likewise report positive effects of PBL, digital learning media, and technology-supported mathematics instruction.

PjBL assisted by Digital Books also produced a substantial improvement and a high N-Gain of 0.7735. Project activities create opportunities for students to apply mathematical concepts in authentic tasks, collaborate, communicate, and produce a tangible outcome (Musa & Sulisworo, 2023). The result is consistent with research on project-based mathematics learning and digital media reported by (Nuraeni & Aprianti, 2023), (Ginting et al., 2025), (Rafli et al., 2025), and (Maulidya & Aeni, 2024). Nevertheless, PjBL requires students to plan, distribute tasks, monitor progress, and complete a product. These additional demands can reduce the intensity of direct mathematical problem solving within a limited instructional period.

The activity observations support this interpretation. Teacher activity reached 98.1% and student activity 95.0% in the PBL group, compared with 92.5% and 88.1% in the PjBL group. The conventional group recorded 86.9% teacher activity and 85.6% student activity. The pattern indicates that the experimental classes created more opportunities for active participation. In PBL, the problem itself organizes student interaction and keeps the learning process closely connected to the target competency. In PjBL, engagement grows as students become accustomed to project procedures, but the adaptation process is more complex.

Although the findings favor PBL, the result should be interpreted within the study context. The sample consisted of 90 fifth-grade students from one elementary school, the intervention was implemented with existing classes, and the treatment period was limited. Teacher implementation was controlled through validated lesson plans and common assessment procedures, but teacher differences cannot be completely eliminated. Future studies should therefore examine larger and more diverse samples, longer interventions, delayed posttests, and different mathematical topics. Such studies can determine whether the observed advantage of PBL is sustained over time and across contexts.

4. CONCLUSION

The study concludes that both PBL and PjBL assisted by Digital Books are effective for improving fifth-grade students' mathematical literacy, and both outperform conventional learning in the reported posttest comparison. PBL assisted by Digital Books produced the highest improvement, with a posttest mean of 85.97 and an N-Gain of 0.7949, while PjBL assisted by Digital Books achieved a posttest mean of 81.13 and an N-Gain of 0.7735. The conventional group reached a posttest mean of 60.90 and an N-Gain of 0.6994. The paired t-tests, One-Way ANOVA, and Tukey HSD consistently indicate statistically significant differences.

For practice, PBL assisted by Digital Books is recommended when the primary objective is to strengthen mathematical literacy through structured contextual problem solving. PjBL remains a valuable alternative when teachers also prioritize creativity, collaboration, communication, and product development. In both models, Digital Books should be designed as cognitive scaffolding rather than as passive electronic textbooks. Future research should use larger samples, longer interventions, delayed posttests, and broader mathematical content to test the durability and generalizability of these findings.

REFERENCES

Anggraini, D. V. (2024). Hasil belajar matematika pada kurikulum merdeka. *JURNAL MathEdu (Mathematic Education Journal)*, *7*(2), 139–146.

Az-zahra, F. A., Lukman, H. S., & Balkist, P. S. (2023). Development of PBL-Based Mathematics Teaching Modules to Improve The Mathematical Critical Thinking Skills of Elementary School Students. *INOMATIKA*, *5*(2), 131–150. https://doi.org/10.35438/inomatika.v5i2.392

Azizah, I. A., & Sucahyo, I. (2022). Flipbook-Based Digital E-book Learning Media on Mechanical Wave Materials to Practice Critical Thinking Skills. *Prisma Sains: Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, *10*(3), 712–718.

Bahrudin, D. (2025). Penerapan Model Problem Based Learning Pada Matematika. *Sigma: Jurnal Pendidikan Matematika*, *8*(2), 418–425.

Buchori, A., & Siswanto, J. (2023). *Technology-based learning innovation in mathematics education in the digital era*. Universitas PGRI Semarang Research Publication.

Fadholi, A., MY, M., & Jamrizal. (2024). Analisis Model Pembelajaran Problem Based Learning Pada Kemampuan Berpikir Kritis Siswa Pada Mata Pelajaran Fiqih di MTs Mahdaliyah Kota Jambi. *Jurnal IHSAN Jurnal Pendidikan Islam*, *2*(2), 151–174. https://doi.org/10.61104/ihsan.v2i2.154

Faisal, M., Dhoruri, A., & Mahmudah, F. N. (2024). Pengaruh Model Pembelajaran Problem Based Learning Terhadap Peningkatan Kemampuan Literasi Matematika. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *13*(2), 577. https://doi.org/10.24127/ajpm.v13i2.8663

Fatmiyati, N., & Juandi, D. (2023). Efektivitas Flipped Classroom Terhadap Kemampuan Pemahaman Konsep dan Berpikir Kritis Matematis: Systematic Literature Review. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *6*(3), 1161–1176. https://doi.org/10.22460/jpmi.v6i3.17405

Febrianti, F. A. (2021). Pengembangan Digital Book Berbasis Flip PDF Professional untuk Meningkatkan Kemampuan Literasi Sains Siswa. *Caruban: Jurnal Ilmiah Ilmu Pendidikan Dasar*, *4*(2), 102–115.

Fiorella, L., & Mayer, R. E. (2022). *Learning as a Generative Activity: Eight Learning Strategies That Promote Understanding*. Cambridge University Press.

Firdaus, F., & Harjono, A. (2025). Trends in Practicum Tool Development with PjBL to Improve Digital Literacy, Process Skills, and Learning Outcomes: A Systematic Review. *Current Educational Review*, *1*(1), 30–37.

Ginting, Y., Widiarti, N., & Yuwono, A. (2025). Trends in Interactive Media-Based Project-Based Learning (PjBL) Models in Elementary Education: A Literature Review. *Jurnal Perspektif*, *9*(2), 366–380.

Hwang, G. J., Tu, Y. F., & Chen, C. H. (2023). A context-aware ubiquitous learning approach to supporting inquiry-based learning with digital technology. *Australasian Journal of Educational Technology*, *28*(5), 20–29.

Khafidhoh, M., & Mahmudah, W. (2022). Pengembangan Media Pembelajaran Matematika Berbantuan Flipbook Berbasis Problem Based Learning yang Memfasilitasi Kemampuan 4C Siswa. *Jurnal Ilmiah Soulmath: Jurnal Edukasi Pendidikan Matematika*, *10*(2), 137–148.

Kurniawan, B., Sutopo, A., & Widyasari, C. (2025). Dampak Pembelajaran Berdiferensiasi Terhadap Hasil Belajar Matematika di Sekolah Dasar. *Ideguru: Jurnal Karya Ilmiah Guru*, *10*(1), 836–844.

Kusumawati, W., Purwosetiyono, F. D., & Handayani, S. H. R. (2024). Efektivitas Model Problem Based Learning Berbantuan Geogebra terhadap Kemampuan Literasi Matematis Siswa pada Materi Fungsi Kuadrat. *JagoMIPA: Jurnal Pendidikan Matematika Dan IPA*, *4*(1), 156–166. https://doi.org/10.53299/jagomipa.v4i1.484

Lestari, I., Arifin, S. P., Widyasari, Y. D. L., Zain, M. M., & Rachmawati, H. (2023). The Coaching of Dunia Coding Program to Improve Computational Thinking Ability at As Shofa Junior High School Pekanbaru: Pembinaan Program Dunia Coding untuk Meningkatkan Kemampuan Computational Thinking Pada SMP As Shofa Pekanbaru. *Dinamisia: Jurnal Pengabdian Kepada Masyarakat*, *7*(1), 136–146.

Maulida, A. F., & Ghufron, A. (2025). Dampak model pembelajaran matematika berbasis budaya lokal terhadap kemampuan pemahaman konsep bangun datar siswa. *Jurnal Pendidikan Matematika Dan Sains*, *13*(2), 409–418.

Maulidya, S., & Aeni, K. (2024). E-Book Teaching Materials in the Form of PjBL Model Flipbooks Improve Pancasila Education Learning Outcomes. *Jurnal Pendidikan Dan Pengajaran*, *57*, 417–432.

Mayer, R. E. (2021). *Multimedia Learning* (3rd ed.). Cambridge University Press.

Musa, F., & Sulisworo, D. (2023). Development of a Problem-Based Learning E-Module to Enhance Mathematical Literacy Skills through Data Presentation. *International Journal on Emerging Mathematics Education (IJEME)*, *7*(2), 75–88.

Nuraeni, T. N. T., & Aprianti, F. (2023). Implementasi Model Project Based Learning Berbantuan Media Digital Dalam Meningkatkan Hasil Belajar Matematika Kelas V SD. *Jurnal Elementaria Edukasia*, *6*(2), 480–489. https://doi.org/10.31949/jee.v6i2.5554

Nuraini, N., Hadi, K., Apriliana, D., Khumairoh, A., & Salsabila, M. L. (2024). Edukasi dan Deteksi Astenopia (Mata Lelah) pada Peserta Lembaga Pelatihan Informal. *Jurnal Inovasi Penelitian Dan Pengabdian Masyarakat*, *4*(1), 122–132. https://doi.org/10.53621/jippmas.v4i1.299

Nurmasari, L., Budiyono, Nurkamto, J., & Ramli, M. (2024). Realistic Mathematics Engineering for improving elementary school students' mathematical literacy. *Journal on Mathematics Education*, *15*(1), 1–26. https://doi.org/10.22342/jme.v15i1.pp1-26

OECD. (2023a). *PISA 2022 Assessment and Analytical Framework: Mathematics, Reading, Science and Financial Literacy*. OECD Publishing.

OECD. (2023b). *PISA 2022 Assessment and Analytical Framework*. OECD Publishing.

Oktaviani, R. N., & Sokhifah, N. L. (2024). Pengaruh model pembelajaran problem based learning terhadap kemampuan literasi numerasi siswa kelas iv sd kyai rodliyah surabaya. *Jurnal Ibriez: Jurnal Kependidikan Dasar Islam Berbasis Sains*, *9*(2), 205–218.

Ormrod, J. E. (2023). *Educational Psychology: Developing Learners*.

Prabowo, A., & Sari, E. P. (2022). Analisis Experiental Marketing dan Electronic Word of Mouth Terhadap Repurchase Intention pada Penumpang Maskapai Penerbangan di Kota Medan Pasca Pandemi. *Jurnal Wira Ekonomi Mikroskil*, *12*(2), 125–136.

Prasetyo, A. B., Handayani, M., Sulistiyono, E., Firdiyono, F., Febriana, E., Mayangsari, W., Wahyuningsih, S., Pramono, E., Maksum, A., & Riastuti, R. (2023). Fabrication of high purity silica precipitates from quartz sand toward photovoltaic application. *J. Ceram. Process. Res*, *24*(1), 103–110.

Pratiwi, Y. D., Widodo, W., & Sabtiawan, W. B. (2022). Analisis komunikasi sains peserta didik kelas IX SMP Yayasan pada masa pandemi Covid-19. *Pensa E-Jurnal: Pendidikan Sains*, *10*(1), 33–36.

Rafli, A., Putra, P., Angriani, A. D., & Mattoliang, L. A. (2025). Efektivitas Penerapan Model Pembelajaran Project Based Learning (PjBL) terhadap Kemampuan Literasi Matematis Peserta Didik. *Alauddin Journal of Mathematics Education*, *7*(1), 38–49.

Santoso, S. A. (2024). Korelasi Motivasi Belajar terhadap Prestasi Belajar Siswa Kelas 4 di Sekolah Dasar Muhammadiyah Gresik. *Didaktika*, *30*(2), 214–223. https://doi.org/10.30587/didaktika.v30i2.8765

Saputra, H., Utami, L. F., & Purwanti, R. D. (2023). Era baru pembelajaran matematika: menyongsong society 5.0. *Indiktika: Jurnal Inovasi Pendidikan Matematika*, *5*(2), 146–157.

Setyawan, H. A., Putra, D. A., & Setiawan, F. (2025). Analisis penerapan media Powtoon dalam mata pelajaran matematika di sekolah dasar. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *10*(04), 398–410.

Siswanto, J. (2024). Effectiveness of PBL and PjBL models assisted by digital flipbook on students' critical thinking skills. *Journal of Mathematics Education Research*, *2*(1), 1–12.

Suhendra, S., Nindiasari, H., Yuhana, Y., & Mutaqin, A. (2025). Systematic Literature Review: Analisis Kesalahan Siswa Dalam Menyelesaikan Soal Matematika Berdasarkan Kriteria Whatson. *Pedagogy: Jurnal Pendidikan Matematika*, *10*(3), 1234–1252.

Susiliastini, K. N., & Sujana, I. W. (2022). Flipbook: Media Pembelajaran Inovatif Berbasis Etnomatematika pada Muatan Pelajaran Matematika Kelas V Sekolah Dasar. *Jurnal Pendidikan Multikultural Indonesia*, *5*(3), 105–118.

Wahyuni, E., Hidayati, D., & Romanto, R. (2022). Kesiapan guru terhadap pembelajaran berbasis teknologi. *Jurnal Pendidikan Dan Konseling (JPDK)*, *4*(6), 11238–11247.

Wibisono, A. M., & Sari, B. N. (2022). Sistem Pakar Penentu Profil Risiko Investasi. *Journal of Information System*, *7*(1), 79–89.