

The Effect of the Project-Based Learning Model with Digital Learning Media on Science Literacy and Numeracy Skills in Madrasah Ibtidaiyah

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Abstract: *Literacy skills are one of the important aspects of education in Indonesia that should be prioritized from the primary level. Science literacy and numeracy to build critical thinking skills and help face global challenges in the 21st century. This study aims to analyze the effect of the Project-Based Learning (PjBL) model with digital learning media on science literacy and numeracy skills of fifth-grade students of Madrasah Ibtidaiyah in East Java Province through a quasi-experimental method. Through cluster random sampling, 61 students were assigned to three research classes: two experimental and one control group. Test questions, questionnaires, observation sheets, and interviews were used as instruments in this study. Data processing was done using a normality test, homogeneity test, and hypothesis testing using ANOVA. The study results showed a significant value of 0.000 for science literacy and 0.005 for numeracy literacy. Based on the test results of science literacy and numeracy skills, the average value of the class given the PjBL model learning with digital-based learning media is superior to other research classes. So, the PjBL model with digital-based learning media affects students' science literacy and numeracy skills.*

Keywords: Project-Based Learning Model; Digital Learning Media; Numeracy Literacy; Science Literacy

Abstrak: *Kemampuan literasi merupakan salah satu aspek penting dalam pendidikan di Indonesia yang harus diprioritaskan sejak tingkat dasar. Literasi sains dan numerasi untuk membangun kemampuan berpikir kritis dan membantu menghadapi tantangan global di abad ke-21. Penelitian ini bertujuan untuk menganalisis pengaruh model Project-Based Learning (PjBL) dengan media pembelajaran digital terhadap kemampuan literasi sains dan numerasi siswa kelas V Madrasah Ibtidaiyah di Provinsi Jawa Timur melalui metode kuasi eksperimen. Melalui cluster random sampling, 61 siswa ditugaskan ke dalam tiga kelas penelitian: dua kelompok eksperimen dan satu kelompok kontrol. Soal tes, kuesioner, lembar observasi, dan wawancara digunakan sebagai instrumen dalam penelitian ini. Pengolahan data*

dilakukan dengan menggunakan uji normalitas, uji homogenitas, dan uji hipotesis dengan menggunakan ANOVA. Hasil penelitian menunjukkan nilai signifikan sebesar 0,000 untuk literasi sains dan 0,005 untuk literasi numerasi. Berdasarkan hasil tes kemampuan literasi sains dan literasi numerasi, nilai rata-rata kelas yang diberikan pembelajaran model PjBL dengan media pembelajaran berbasis digital lebih unggul dari kelas penelitian lainnya. Jadi, model PjBL dengan media pembelajaran berbasis digital berpengaruh terhadap kemampuan literasi sains dan numerasi siswa.

Keywords: *Project-Based Learning Model; Digital Learning Media; Numeracy Literacy; Science Literacy*

Introduction

Madrasahs are known as educational institutions that operate under the supervision of the Ministry of Religious Affairs. In order to improve education standards while adapting to the dynamics of society's needs as well as the waves of information change, the Gerakan Literasi Madrasah (GELEM) Program has been designed by the Regional Office of the Ministry of Religious Affairs of East Java Province as an initiative to integrate madrasahs into the education system (Mahmud & Bawani, 2023). GELEM is a derivative of the School Literacy Movement designed based on the Minister of Education and Culture Regulation number 23 of 2015, which emphasizes the development of character aspects (Kuswati et al., 2019).

Literacy is indispensable because it is the education mandate in Indonesia, which emphasizes the need to prioritize literacy in primary school education (Hermawan et al., 2020). This step aims to improve the quality of education and equalize student achievement with international standards (Marmoah et al., 2022). Science literacy refers to the capacity to analyze and act using the principles of the scientific method in recognizing and solving problems that arise in daily routines (Irsan, 2021). In-depth science literacy knowledge is important for students, especially to interpret various phenomena that arise in the surrounding environment, including health, economy, contemporary society, and technology (Cho, 2022; Altenberga & Rubene, 2022). Indonesian students are expected to be able to use scientific principles in everyday life to overcome global challenges in the 21st century.

Besides science literacy, numeracy literacy is closely related to every part of life. This numeracy literacy skill relates to counting activities such as shopping, vacation planning, starting a business, or building a house, where usually, this data is presented in numerical or graphical form (Mahmud & Pratiwi, 2019). Students often find learning mathematics difficult because they cannot understand the presented problems, interpret the questions correctly, or remember the right concepts to solve mathematical problems (Mangarin & Caballes, 2024).

Based on the results of preliminary studies through interview activities in May 2023 related to the results of the implementation of AKMI (Asesmen Kompetensi Madrasah Indonesia) in three Madrasah Ibtidaiyah in Lumajang sub-district, it was found that 72% of students for science literacy and 88% of students for numeracy literacy were at the level of needing assistance. Observations and interviews were conducted with fifth-grade teachers on July 29, 2023, to determine the causes of the low AKMI results. The data obtained showed no habituation of reading activities in the learning steps, the exercises did not stimulate students' critical thinking skills, learning activities still used conventional methods with teacher-centered lecture models, and there was no use of props or media in learning activities.

Research conducted in three Madrasah Ibtidaiyah in Lumajang sub-district, East Java, revealed that students experienced several constraints in science literacy and numeracy that led to their AKMI scores not reaching the minimum competency standards. These constraints include: 1) difficulty in understanding the gist of the question or problem presented, 2) reluctance in dealing with problems with long texts, 3) obstacles in solving complex multiple-choice format questions, 4) obstacles in linking concepts that have been learned with the given problem, and 5) difficulties in answering questions that are different from the usual exercises.

Given this phenomenon, a learning model is required to enhance students' science literacy and numeracy skills. Project-based learning is usually seen as an alternative to traditional learning methods, with the teacher acting as a facilitator (Chen & Yang, 2019). Project-based learning is a learning method used worldwide, where students work together in groups for some time to solve real, relevant problems (Grossman et al., 2019; Hanham et al., 2020; Karan & Brown, 2022). Relevant real-world problems can motivate students to actively engage in problem-solving (Mahasneh & Alwan, 2018). In PjBL models, these problems are organized as group projects that are worked on over some time and usually result in a clear end product, such as a presentation, report, or interactive exhibit that can be assessed (Gao et al., 2024; Li et al., 2015; Loyens et al., 2023). PjBL is believed to enhance creativity and critical thinking skills as well as student learning motivation, which are important competencies in today's global era (Chen & Yang, 2019; Guo et al., 2020; Schaddelee & McConnell, 2018; Wijnia et al., 2024).

Several studies have also been conducted to explore the application of PjBL in science learning to improve student learning outcomes. The results show that PjBL can improve students' problem-solving skills, engagement in learning activities, and understanding of complex concepts in science (Afriana, 2022; Baharuddin et al., 2021; Hanklang & Sivasan, 2021; Sari & Maemonah, 2024). PjBL has also been proven effective in improving the numeracy and digital literacy skills of Madrasah Ibtidaiyah students through collaborative approaches and critical thinking (Faridah et al., 2022). Therefore, using project-based learning in science learning benefits student learning and development.

Although PjBL is considered effective in improving student achievement and engagement, its implementation faces various challenges. One of the most fundamental challenges is limited resources. Many madrasah schools, especially in remote areas, do not have adequate access to educational facilities, technology, and learning materials needed to support PjBL projects (Ginanjar et al., 2021). Teachers' readiness to implement PjBL is also an obstacle. Many teachers are unfamiliar with this approach and require intensive training to design and manage practical projects (Wardhani et al., 2023). Teachers may struggle to facilitate meaningful student learning without a solid understanding of the PjBL methodology.

In addition to learning models, 21st-century learning methods can also be utilized to improve science literacy and numeracy because they are considered adequate for improving the quality of human resources (Widyantoro et al., 2022). In today's education, integrating Information and Communication Technology (ICT) is a must that cannot be avoided (Siringoringo & Alfaridzi, 2024). The current development of ICT offers a more flexible, personalized, and engaging learning environment for students by utilizing diverse learning platforms (Huang et al., 2024). Various digital game platforms as the use of learning media in Madrasah Ibtidaiyah have been developed by many teachers, such as Jumanji Board Game, 3D Snakes and Ladders,

and Quizizz (Chusna et al., 2024; Lestari & Prayogo, 2024; Rusdi et al., 2023). Implementing digital media in madrasah is an important step towards a more modern and relevant education, such as increasing higher-order thinking skills (Khairullina & Prastowo, 2024). With teacher supervision, madrasahs have started allowing students to bring devices such as smartphones to class to support learning. Enables students to access learning materials online and engage in digital discussions (Khurohman, 2024).

Several learning strategies involving various components have been identified as practical approaches to solving increasingly complex educational issues (Yuwono & Pasani, 2018). According to research conducted by Yulianti et al. (2019), it can be concluded that the use of appropriate digital learning media is proven effective in overcoming the problem of low numeracy literacy among students.

Based on this explanation, using the project-based learning model incorporating digital learning media has been considered capable of strengthening science literacy and numeracy. This study evaluates the comparative effectiveness of the Project-based and Problem-based learning models in improving science literacy and numeracy skills through digital learning media.

Method

This research was conducted through a quantitative approach with a quasi-experimental method and a pretest-posttest nonequivalent group design. Three classes were involved in the implementation of the research, as shown in Table 1.

Table 1. Research Design

	Preetest	Treatment	Posttes
Experimental class 1	O1	X1	O2
Experimental class 2	O3	X2	O4
Control class	O5	X3	O6

Description:

O1, O3, O5 = pretest

O2, O4, O6 = posttest

X1 = learning treatment with PjBL model and digital learning media

X2 = learning treatment with PjBL model

X3 = learning treatment with PBL model

The population of this study included all grade V students in Madrasah Ibtidaiyah in the Lumajang sub-district. In the sub-district, there were 11 Madrasah Ibtidaiyah, with 495 students. Through cluster random sampling, two Madrasah Ibtidaiyah were selected as samples, namely MIS Tarbiyatul Mubtadiin and MIS Islam Fitriah Banjarwaru. The two Madrasahs were selected based on the results of the AKMI report in 2022 related to science literacy and numeracy below the minimum competency, the availability of facilities and infrastructure for the implementation of digital-based learning, proximity, adequate number of students, and permission from the madrasah head. The selection of experimental and control classes in both Madrasah Ibtidaiyah was conducted randomly.

In this study, there were three research classes: the first experimental class that applied the PjBL model with digital learning media, the second experimental class that applied the PjBL model (without digital media), and the control class that applied the PBL model. The purpose of using two experimental classes in this study is to

analyze which variables contribute to improving literacy skills and whether the PjBL model or digital media influences the improvement.

Data collection instruments were used, including observation sheets, questionnaires, interview designs, and test instruments to measure science literacy and numeracy skills. The interview instrument was designed to record responses from students and teachers during the learning process. In addition, a questionnaire based on a five-level Likert scale was applied to collect students' perceptions of learning activities. The implemented test was a multiple-choice test developed based on the science literacy and numeracy indicators.

Before being used in research, all instruments were validated with two stages: expert validation and validation test for non-samples. The study had two validators: the Head of the Madrasah with an S-2 educational background and the Madrasah Ibtidaiyah Teacher Education Lecturer from IAI Syarifuddin Lumajang. The validity test of non-test instruments (questionnaires) and science literacy and numeracy skills tests were given to 30 respondents other than the sample. It was carried out before the test questions were given to the research sample.

Various methods in data processing have been used, one of which is prerequisite testing, which includes normality tests and homogeneity tests. Then, the data is processed through descriptive statistical analysis, which is eventually followed by hypothesis testing using analysis of covariance (ANOVA). The normality test assessed whether the data distribution followed a normal distribution. The homogeneity test was conducted to ensure that the samples studied (experimental and control groups) had the same ability level. In comparison, the Anacova test aims to test the average difference between two or more groups by controlling other variables that can affect the results. The analysis tool used is SPSS 25.0.

Results and Discussion

Results

The analysis activities in this study began with a normality test using Kolmogorov-Smirnov and a homogeneity test using the Levene test. After the samples in the three research classes were regular and homogeneous, hypothesis testing was carried out, as shown in Table 2 below.

Table 2: Anacova Test Results of Science Literacy Skills

Tests of Between-Subjects Effects						
Dependent Variable: science literacy skills						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6106.026 ^a	3	2035.342	66.711	.000	.778
Intercept	2021.065	1	2021.065	66.243	.000	.537
<i>Pretest</i>	5410.944	1	5410.944	177.351	.000	.757
Class	1007.652	2	503.826	16.514	.000	.367
Error	1739.056	57	36.640			
Total	385550.000	61				
Corrected Total	7845.082	60				

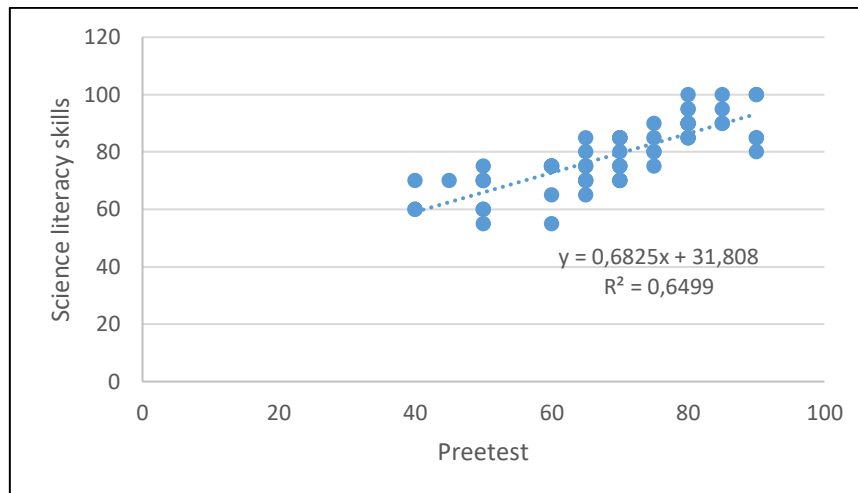


Figure 1: Correlation Graph of Pretest with Science Literacy Skills

Table 2 shows that the significance level of the class variable on science literacy reached 0.000. Since the level is below 0.05, it indicates a significant difference in students' science literacy skills when learning is applied with the PjBL model and digital learning media, PjBL, and PBL, considering students' initial abilities. Figure 1 shows the correlation between students' initial ability and science literacy skills.

From the relationship presented in Figure 1, it is found that the increase in pretest positively. From this relationship, the higher the students' initial ability (pretest score), the more likely students' science literacy skills will also increase.

Table 3. Anacova Test Results of Numeracy Literacy Skills

Tests of Between-Subjects Effects						
Dependent Variable: Numeracy literacy skills						
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	11073.562 ^a	3	3691.187	119.042	.000	.862
Intercept	950.107	1	950.107	30.641	.000	.350
Pretest	5497.817	1	5497.817	177.307	.000	.757
Class	365.573	2	182.786	5.895	.005	.171
Error	1767.421	57	31.007			
Total	347025.000	61				
Corrected Total	12840.984	60				

Based on the data in Table 3, it is found that the class variable has a significance level of 0.005 on numeracy literacy. This value, which is below 0.05, indicates that the null hypothesis (Ho) is rejected. It shows a significant difference in students' numeracy literacy when learning activities are carried out with PjBL and media and PjBL and PBL models by controlling students' initial abilities. The students' initial ability contributes to their numeracy literacy level, as shown in the illustration in Figure 2.

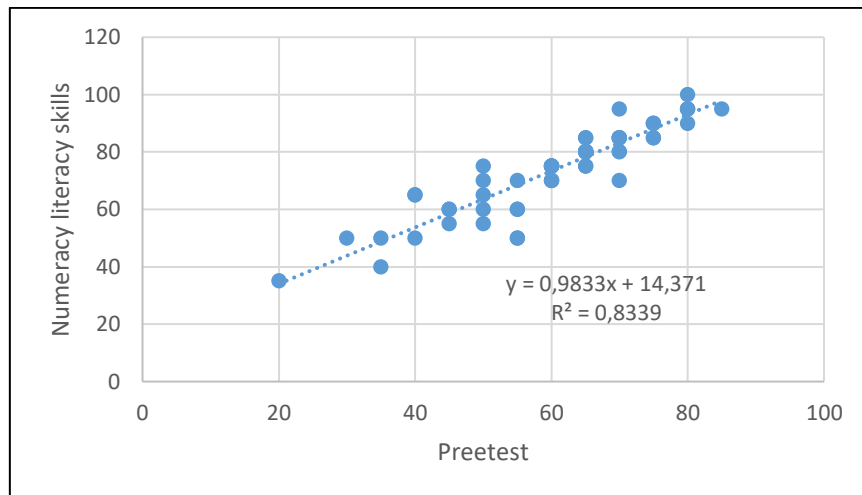


Figure 2: Correlation Graph of Pretest with Numeracy Literacy Skills

Figure 2 shows a linear and positive correlation between *pretest* scores and students' numeracy literacy skills. From the analysis, the higher the *pretest* score, the higher the numeracy literacy skills.

Based on the results of descriptive statistical analysis of pretest and posttest science literacy scores, it was found that students who applied digital learning media in the PjBL learning model were at a higher level than students who only used the PjBL or PBL model alone. In this study, the science literacy ability is illustrated in Figure 3.

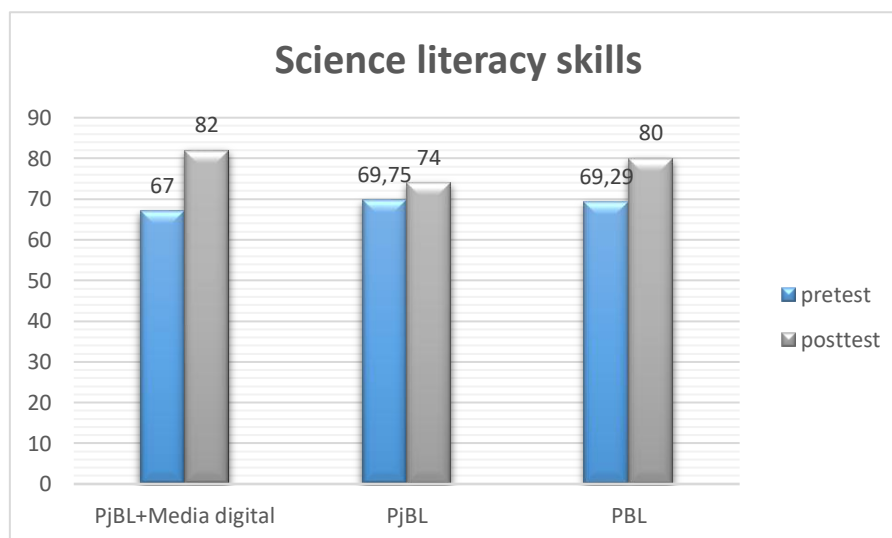


Figure 3: Results of Science Literacy Skills in Three Research Classes

As shown in Figure 3, the initial science literacy skills possessed by students from the three research classes were recorded to have almost the same values, namely 67, 69, 65, and 69.25, respectively. The improvement came when combining the PjBL learning method with digital learning media. As reflected in the final test results, the increase in students' science literacy skills experienced the most prominent increase in the group that utilized the project-based learning model (PjBL) with the support of digital learning media, which was 22.39%. Meanwhile, the increase in the research class that only applied the PjBL and PBL models was recorded at 6.09% and 15.45%, respectively.

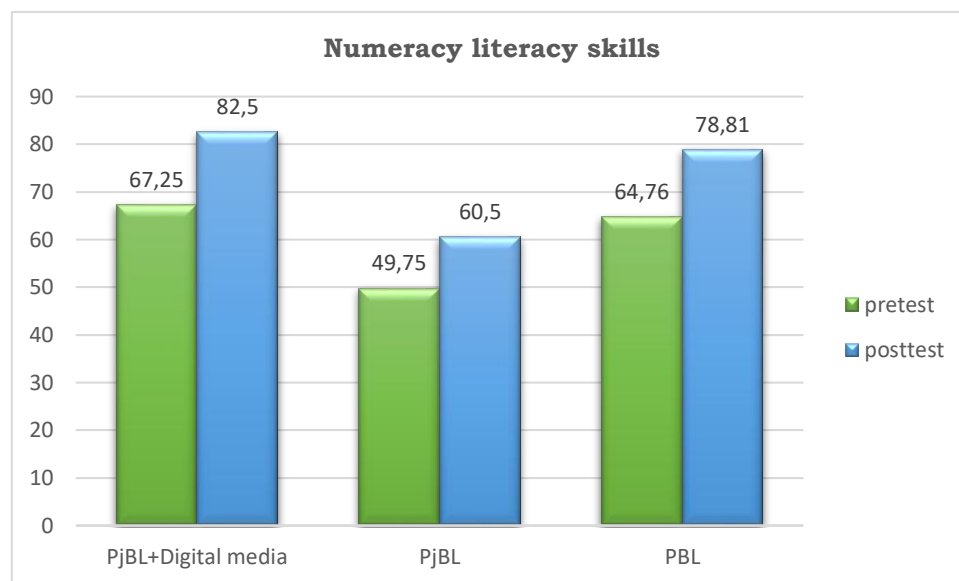


Figure 4: Results of Science Literacy Skills in Three Research Classes

Figure 4 shows that the three research classes had unequal initial numeracy literacy skills. However, the class taught with the PjBL model and digital learning media had the highest average score of 82.5. This result was followed by the class that applied the PBL model and then PjBL (without digital media). Figure 5 shows that the increase in numeracy literacy in the three research classes is in a similar range, between 21% and 23%. Therefore, it can be concluded that the effect of the three learning models implemented in each class on improving numeracy literacy is the same.

The implementation of learning activities is carried out through observation sheets that refer to the lesson plan. It aims to assess the suitability of the steps in the learning model that the teacher has implemented. The results of implementing learning activities in the classes studied can be summarized in Table 4

Table 4. Observation Results of Activities in Research Classes

Class	Applicability			Average
	Meeting 1	Meeting 2	Meeting 3	
Experiment 1	97%	100%	80%	92%
Experiment 2	100%	100%	87%	97%
Control	83%	100%	93%	92%

Based on Table 4, it can be concluded that not all learning steps were implemented by the teacher. Some of the learning steps that the teacher did not implement included: 1) the teacher forgot not to inform the learning objectives, 2) the teacher did not start the learning with prayer because it was not the first hour, 3) the teacher did not give moral messages from the material that had been learned

Discussion

In implementing the learning process with the PjBL model and digital-based learning media, PjBL and PBL are carried out by teachers who have the same competence and are accompanied by observers. Before teachers carry out learning activities, a Forum

Group Discussion (FGD) is first held to ensure that the lesson plan carries out learning activities. It aims to maintain internal validity so that it can be ascertained that the increase in science literacy and numeracy skills is due to the influence of the learning model and digital media applied. Learning activities implemented in the three research classes were carried out using the lesson plans that experts had validated. Observation was also carried out to ensure the suitability of the steps applied by the teacher in the learning process.

In learning activities, students design projects on the problems presented on heat and its transfer, namely by making simple thermometers, rulers, and concept maps. In order to increase the attractiveness of delivering learning materials, teachers use digital learning media such as YouTube videos, online posters, PowerPoint presentations, and digital comics in the learning process. In Figure 5, we can see the results of the products produced through the learning process using the Project Based Learning model in the experimental class.



Figure 5: Student Project Results: Simple Thermometer, Ruler, and Mind Mapping

Figures 3 and 4 show that the lowest mean scores of science literacy and numeracy skills were obtained when the class applied the PjBL model. However, the average value increased significantly after combining the PjBL model with digital media. It can be concluded that digital learning media is a variable that significantly affects the improvement of science literacy and numeracy skills. In implementing the PjBL steps, digital learning media is used to answer basic questions and prepare project planning. The purpose of using digital-based media is to help students find diverse learning resources related to heat and its transfer. The more diverse the students' knowledge, their curiosity about the presented problem will increase. The class becomes more active with students as the center of learning, and the teacher facilitates the learning process to carry out the learning objectives.

Research results [Pradipta et al. \(2022\)](#) indicated that digital learning media can effectively illustrate everyday situations and problems that often arise. Digital learning media in animation presents moving and interactive visual elements to attract students' attention more comprehensively ([Ploetzner et al., 2020](#)). This approach positively impacts the development of students' problem-solving skills. More complex learning abilities can be developed through digital learning media. As ([Eliaumra et al., 2024](#)) Project-based learning models incorporating digital literacy have been shown to improve students' creative thinking skills. These models encourage students to explore and create, fostering an environment where innovative thinking can flourish.

The improvement of science literacy and numeracy literacy in classes that apply the Project Based Learning (PjBL) learning model with digital learning media is supported

by learning activities designed to be interactive, engaging, and creative. Through digital media, students can discover things that trigger their curiosity, motivation, and engagement and provide intellectual satisfaction (Fonseca & García-Peñalvo, 2019; Nicolaou et al., 2019). The project process becomes more efficient as students understand the concepts better and work together effectively. According to Anggraini & Wulandari (2020), applying the Project Learning model facilitates students' participation in learning, improves scientific thinking skills, and deepens understanding of complex concepts. In line with this, Sari (2018) revealed that reflection on the activities and results of the project facilitates students' understanding of their activities during the learning process.

In project-based learning, student activities are focused on active learning activities so that interest in learning and interaction between students in science learning increases (Ansyah, 2023; Ariyati et al., 2023; Budiningsih et al., 2024; Gaffar et al., 2023; Zaeriyah, 2022). In addition, students are also encouraged to work together in small groups to develop solutions to the problems presented. Previous research shows that creativity can be developed through project-based activities integrated with technology in various disciplines. By working together in groups, students can solve problems while improving their aesthetic sense (Lu et al., 2022; Ozkan & Umdutopsakal, 2021).

Students who implement learning with the PjBL model must take responsibility for their learning process by identifying, researching, and developing solutions to problems. This opinion is also supported by Tinenti (2018); Altenberga & Rubene (2022), who states that students who participate in project-based learning have more rights to learn, are more likely to take over learning activities, and are more likely to produce accurate, high-quality work. The end of the project-based learning activity is to present the actual product that has been produced. By presenting work in class, students gain the necessary skills to design a process to determine the final result, train to manage information on a project, and create an actual product from the students' results (Kristiantari, 2019; Eliaumra et al., 2024).

It is evident through the analysis of the correlation graphs in Figures 4 and 5 that students' literacy skills are significantly influenced by their initial skills; the superior the initial skills, the more their numeracy literacy skills improve after the learning activities. Research conducted by Takaria et al. (2022) found that students with higher initial capacity could solve well-structured problems and utilize visual representations as a means of support in solving the problems posed in the test. Lestari (2017) also stated that a positive and significant correlation was found between the basic math skills of junior high school students in Jakarta and the achievement of mathematics learning outcomes.

Based on observations during learning activities, differences in students' initial abilities towards numeracy skills can occur because: 1) before the learning activities, students are accustomed to studying the learning materials at home, thus providing opportunities for a more comprehensive understanding of the basic concepts to be learned; 2) students mastery of basic arithmetic concepts, including addition, subtraction, multiplication, and division; and 3) their capacity to recall previously understood lessons.

The study results show increased students' science literacy and numeracy skills when implementing PJBL learning with digital media, which has significant potential implications for educational policies in madrasahs. Policies that can be taken include:

1) incorporate PjBL as a learning model, especially in science and mathematics subjects, to encourage the development of students' critical and creative skills; 2) invest in technological infrastructure, such as hardware and software, to support the use of digital media in PjBL; 3) develop continuous training programs for teachers to improve skills in implementing PjBL with digital media including teaching techniques, technology use, and project management.

Although PjBL and digital learning media in this study significantly improved science literacy and numeracy skills, there were challenges in its application in madrasah. These challenges include: 1) the PjBL learning model can only be effective when teachers and students are equally ready to implement it in the classroom; 2) it requires much money to provide material tools in making products that are the result of the project; 3) it takes much time for project completion so that it cuts other subjects; 4) students often feel embarrassed when asked to present the results of their project in front of the class. Sumilat et al. (2023); Cho (2022) added that implementing PjBL requires readiness to choose the right project to fit the curriculum and learning objectives. In addition, evaluating the results of PjBL learning is not always easy because the projects' results can vary (Junita et al., 2023). Teachers' skills in evaluating and providing effective feedback can affect the quality of learning outcomes.

Conclusion

Based on data analysis and discussion of the research results, the PjBL model and digital learning media significantly improve students' science literacy and numeracy. It was noted that the average posttest scores of science literacy and numeracy of the classes that used the PjBL model and digital media were significantly higher than the other classes. This finding shows that digital learning media is important in effectively developing students' science literacy and numeracy. Educators' selection of appropriate digital media is essential to support the effectiveness of PjBL. The media should be appropriate to the student's ability level to maximize learning comprehension. Practitioners in Islamic education institutions are advised to cooperate in developing and sharing digital resources for PjBL, such as digital learning modules or projects oriented to local issues that align with Islamic values. It can help overcome resource limitations and strengthen competencies across institutions. Financial support from the government is needed to procure digital infrastructure for internet access, hardware, and digital learning applications that can optimally support PjBL implementation.

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