

# Effectiveness of Bilingual Project-Based Materials to Facilitate Literacy and Numeracy Teaching

Wahyu Kyestiati Sumarno <sup>1</sup>, Prismahardi Aji Riyantoko <sup>1</sup>, Ali Shodikin <sup>2</sup>

<sup>1</sup> Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia

<sup>2</sup> Universitas Negeri Surabaya, Surabaya, Indonesia

**Abstract** – The purpose of this study is to find out how well bilingual project-based learning resources may improve the literacy and numeracy abilities of primary school students. Numerous researches conducted at many levels presented the effectiveness of the project-based approach. Yet, few of them address the potential benefits of incorporating it into the curriculum, focusing on both language proficiency and mathematical competence. This experimental study utilized a nonrandomized control group design involving two classes of 6-8-year-old students. A two-way ANOVA was used to evaluate the data from 39 students that were gathered through exams and paperwork. The results demonstrated that using bilingual project-based learning resources can be an alternate strategy for improving primary school students' literacy and numeracy skills.

**Keywords** – Literacy, numeracy, bilingual, project-based teaching material.

## 1. Introduction

In the current century, communication skills are essential.

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**Corresponding author:** Wahyu Kyestiati Sumarno,  
Universitas Pembangunan Nasional Veteran Jawa Timur,  
Surabaya, Indonesia


**Email:** [wahyu.kyestiati.ds@upnjatim.ac.id](mailto:wahyu.kyestiati.ds@upnjatim.ac.id)

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It is not only seen as the interaction between a sender and a recipient, but it also involves technology. Unfortunately, in Indonesia, there are many young generations that have relatively low communication skills when using the digital media [1], [2], [3]. This condition results in the low ability to process information, difficulties in representing and expressing thoughts and speech, difficulties in adapting to new environments, and difficulties in understanding human problems that tend to be heterogeneous. In other words, low communication skills will create new problems, considering that technology is developing very rapidly and taking full control over various sectors of human life [4], [5], [6]. Therefore, as a solution, it is very important to promote a communicative approach and a means to accomplish this is through good mastery of literacy. Literacy is not just about reading and writing skills, but more about human cognitive abilities in mastering, understanding, and actualizing information in solving human problems [7], [8]. Schools need to change in order to help students practice and become proficient in literacy-related activities.

Literacy is widely defined. The author of study [9] sees it as the capacity to identify, understand, and compute in multiple contexts. Many different skills are included in literacy, from the fundamentals of reading, writing, listening, and understanding to the more advanced skills of interpreting and expanding on what children have learned [10]. Literacy is a foundation for accessing education. Without basic literacy skills, individuals will face significant barriers to learning and acquiring knowledge. By promoting literacy, Indonesia can ensure that its citizens have the opportunity to achieve quality education, which will empower them reaching their ultimate potential and contribute to society. Therefore, literacy teaching should be started and managed from a very young age; in this case, it is from elementary school because the student brains have a remarkable ability to absorb and retain information for this is the first level of the learning program.

Besides literacy, numeracy is also essential in preparing the gold generation for the future. The term numeracy describes the capacity to comprehend, apply, and utilize mathematical ideas and techniques in a variety of settings [11], [12], [13]. It includes basic arithmetic operations, numerical reasoning, problem-solving, and the competence to successfully illuminate and communicate mathematical facts [14], [15], [16], [17]. For everyday tasks like handling personal finances, making wise decisions, and comprehending mathematical data in a variety of professions, numeracy abilities are essential. Similar to literacy, it should be well-taught from the elementary school.

To promote literacy and numeracy in Indonesia, efforts should focus on improving access to quality education, enhancing teacher training, and developing relevant and engaging curriculum materials. This paper explored the implementation of bilingual (English-Indonesian) project-based materials to increase elementary school learners' literacy and numeracy skills. The authors developed the teaching materials in an effort to facilitate elementary school teachers because such books are very limited in Indonesia. The teaching materials consist of a module supplemented with an Android-based application, called Toy App. Both of them had been validated by experts and are ready to be used in practice.

The project-based learning is chosen because it offers several advantages for elementary school students, as it engages them in active, hands-on learning experiences that go beyond traditional classroom methods [18], [19], [20]. Besides, it also allows teachers to integrate knowledge and content subjects, for example, mathematics and languages, into one creative group project [21], [22], [23]. This integration will encourage a more holistic and comprehensive understanding of the material. It breaks down the artificial barriers between subjects and shows students how they are interconnected. Furthermore, students will develop their information analysis, problem-solving, and critical thinking skills through project-based learning [23], [24], [25], [26], [47]. They learn to identify and address complex problems independently or collaboratively, fostering creativity and innovation. Project-based learning also strengthens teamwork and collaboration because it often involves group projects, promoting teamwork and collaboration among students [27], [28]. They learn to work together, respect different perspectives, and leverage each other's strengths, essential skills for success in the modern workplace and life. Lastly, as students work on projects, they must communicate their ideas, findings, and conclusions effectively.

Project-based learning enhances verbal, written, and presentation skills, preparing students for effective communication in various situations [29], [30], [31]. By implementing project-based approach, teachers can build active learning atmosphere that fosters important skills and stimulate students' future academic and personal success.

Meanwhile, expository learning is defined as a learning approach that involves the presentation of information, facts, and concepts to students in a clear and organized manner [32], [33]. In expository learning, the primary goal is to convey knowledge to learners through direct instruction, explanation, and dissemination of information. Characteristics of expository learning include teacher-centered, structured presentation, clear explanation, and limited exploration [32]. In a teacher-centered approach, the teacher takes on the role of primary source of information. Teachers present content in a structured presentation that is logical and organized or systematic to help students build a coherent understanding of the subject matter. They also explain concepts in clear language and examples to make complex ideas more understandable for students. There are not many opportunities for students to participate in discussions because teachers control the majority of the learning process. The primary focus of this learning is on information delivery. Assessment methods of this learning often include quizzes, tests, and assignments that gauge students' understanding of the presented material. These assessments typically measure how well students have retained and comprehended the information. Expository learning can be effective for introducing foundational concepts and building a shared understanding of essential knowledge.

Learning interest refers to the subjects, topics, skills, or areas of knowledge that an individual is curious about and motivated to explore [34], [35], [36], [37], [38]. It is what captures students' attention and drives them to seek out information, study, and engage in activities related to that particular area. Understanding learning interests is important because it can significantly impact students' motivation to learn and their overall learning experience. When students are genuinely interested in a topic, learning becomes more enjoyable, and they tend to spare time and attempt to become expert in that area [34], [35], [37]. Therefore, it is important to analyze students' learning interests to upmost their study.

English teachers in primary schools should promote literacy activities in their classes because it is very important for students' future learning [39], [40]. This notion reinforces the necessity of correct learning methods to teach literacy and numeracy at an early age.

Additionally, countless studies carried out at various levels demonstrated the efficacy of the project-based methodology [41], [42], [43], [44]. The purpose of this study is to evaluate how bilingual project-based learning and expository learning affect students' development of literacy and numeracy abilities. This research also investigated the effect of interaction between learning (learning with bilingual project-based teaching materials and expository learning) and students' literacy and numeracy improvements.

**2. Research Method**

With a posttest and a nonrandomized control group design, this study was experimental in nature. Two classes of phase A students, ages 6 to 8, with comparable skill levels were chosen from two distinct elementary schools for this design. The parallels stemmed from the accomplishments in literacy and numeracy in the assessment reports from the prior semester. In the experimental class, the students got learning with bilingual project-based teaching materials, while in the control class the students experienced expository learning. The Toy App application was also used in the experimental class to supplement the teaching module. It is an Android-based software that contains literacy and numeracy exercises. There were 19 students in the experimental class and 20 students in the control class, for a total of 39 participants in the study.

Tests and documentation were used to gather data. Teaching materials, a literacy and numeracy ability test, and performance observation sheets were the instruments developed for this study.

Based on their level of interest in learning, each class was split into two groups for data analysis: high and moderate learning interests. The division of groups based on the learning interest was obtained from the results of diagnostic tests. The distribution of research subjects based on the learning interest and the learning model is shown in Table 1. The two-way ANOVA analysis was chosen because this study involved two factors, namely the learning model and study interest. This analysis also provides the results of the interaction between the two factors.

*Table 1. Research subjects distribution*

	High Study Interest (B1)	Moderate Study Interest (B2)
Experimental Learning Model (A1)	A1B1 (10)	A1B2 (9)
Control Learning Model (A2)	A2B1 (10)	A2B2 (10)

Based on this data analysis design, the level of literacy and numeracy achievements in each group was measured.

Group A1 : Group of students who joined bilingual project-based teaching materials

Group A2 : Group of students who joined expository learning

Group A1 B1: Group of students who joined bilingual project-based teaching materials and have strong study interests

Group A2 B1: Group of students who joined expository learning and have strong study interests

Group A1 B2: Group of students who joined bilingual project-based teaching materials and have little study interests

Group A2 B2: Group of students who joined expository learning and have little study interests

The research questions are:

1. Is there any significant difference between the application of bilingual project-based teaching materials and expository learning on the students' literacy achievement?
2. Is there any significant difference between the application of bilingual project-based teaching materials and expository learning on the students' numeracy achievement?
3. Is there any interaction between the learning models and learning interests on the students' literacy achievement?
4. Is there any interaction between the learning models and learning interests on the students' numeracy achievement?

**3. Results**

Table 2 presents descriptive data in order to give an overview or condition of the research subjects in this study. The data showed the students' achievement of literacy and numeracy skills in the experiment and control classes.

*Table 2. Summary of descriptive data*

Class		Descriptive	
		Average	Std Dev
Numeracy	Experiment class	82,95	9,902
	Control class	75,45	8,281
Literacy	Experiment class	87,26	9,927
	Control class	79,50	9,528

Table 2 indicates that there was a difference in scores between the average literacy and numeracy achievements in the experiment class and the control class.

The average numeracy score in the experiment class was 82.95, which was quite far from the control group's average score, which was only 75.45. Additionally, the experiment class's literacy achievement was higher than the control class's. It was 87.26 compared to 79.50 for the control group. However, these values are not sufficient to be used as statistical claims, whether the differences are significant or not. To answer, a statistical test was done.

Before the achievement of literacy and numeracy data was calculated statistically using analysis of variance (ANOVA) to answer the research questions, a requirements analysis test was first carried out which included a normality test and homogeneity test. The Kolmogorof-Smirnov test was used to determine normality, and the Levene test was used to determine homogeneity. The significance level used in this study was 0.05 respectively. Calculation of the Kolmogorov-Smirnov test data results can be seen in Table 3.

Table 3. Summary of data normality test results

Class		Kolmogorov-Smirnov <sup>a</sup>		
		Stat	df	Sig.
Numeracy	Experiment class	,170	19	,152
	Control class	,167	20	,147
Literacy	Experiment class	,172	19	,140
	Control class	,137	20	,200*

All data groups had significance values (Sig.) greater than 0.05, as Table 3 demonstrated. This indicates that the study samples are drawn from a population that is normally distributed. Additionally, the homogeneity test revealed that the variance is homogenous across the entire data group that was used. It is displayed in Table 4.

Table 4. Summary of variance homogeneity test results

		Levene Stat.	df1	df2	Sig.
Numeracy	Based on Mean	,453	1	37	,505
	Based on Median	,322	1	37	,574
Literacy	Based on Mean	,226	1	37	,638
	Based on Median	,215	1	37	,645

An analysis of variance (ANOVA) was used to test the research hypothesis following the completion of the homogeneity and normality tests. The main and interaction effects were tested using variance analysis of the path data. The use of bilingual project-based teaching materials, expository learning, and high and low learning interest were the study's independent variables.

The literacy and numeracy levels of elementary school pupils served as the dependent variable.

In practice, ANOVA testing was analyzed separately based on the dependent variable. Table 5 presents an overview of the computation and data analysis outcomes pertaining to the impact of learning models and learning interest on literacy skills.

Table 5. Two way ANOVA results on literacy ability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1900,697 <sup>a</sup>	3	633,566	10,148	,000
Intercept	269838,011	1	269838,011	4321,952	,000
Class	552,173	1	552,173	8,844	,005
Interest	1235,070	1	1235,070	19,782	,000
Class * Interest	62,443	1	62,443	1,000	,324
Error	2185,200	35	62,434		
Total	274586,000	39			
Corrected Total	4085,897	38			

Table 5 indicated that the "Corrected Model" value got a significance value of 0.000 or less than 0.05. It meant that all independent variables (class, interest, and class interaction with interest) have effect on the dependent variable (literacy ability). In other words, these three independent variables had a significant influence on the students' literacy abilities. The class' significance value was also less than 0.05, which indicated that students' literacy achievement was significantly impacted by the learning model utilized, which applied bilingual project-based teaching materials and expository learning. Meanwhile, variable interest reached similar results which means that the influence of interest in learning, namely high and moderate learning interest on the students' literacy achievement was significant. However, it was different with the "class \* interest" value which was more than 0.05 which suggested that the learning model and learning interest had no effect on the literacy achievement of the students. This can also be seen from the profile plots visualization of the relationship between the two as shown in Figure 1 below.

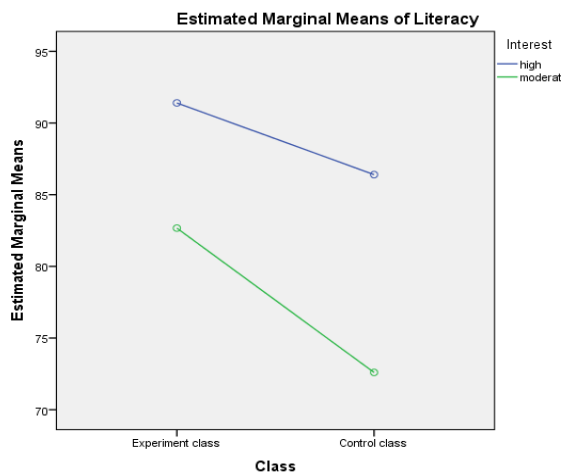


Figure 1. Profile charts showing how learning models and learning interests interact to affect students' literacy achievement

Figure 1 indicated that the direction of the graph between the two tends to be parallel meaning that there was no interaction between the two. Despite the graph's slight downward skew, the change was so small that it had no noticeable effect on the students literacy achievement.

On the other hand, the results obtained from the application of both learning models and learning interest towards numeracy achievement also showed similar results. Table 6 displays the findings of the data analysis concerning the impact of learning models and learning interest on numeracy skills.

Table 6. Two way ANOVA results on numeracy ability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1246,590 <sup>a</sup>	3	415,530	6,139	,002
Intercept	243508,281	1	243508,281	3597,632	,000
Class	518,497	1	518,497	7,660	,009
Interest	686,530	1	686,530	10,143	,003
Class * Interest	7,881	1	7,881	,116	,735
Error	2369,000	35	67,686		
Total	247647,000	39			
Corrected Total	3615,590	38			

Table 7 indicated that "Corrected Model" got a significance value of 0.000 or less than 0.05 which meant that all independent variables (class, interest, and class interaction with interest) gave impact on the dependent variable (numeration ability). This means that there was a significant influence of these three independent variables on the students' numeracy abilities.

The "class" significance value was also less than 0.05, which means that the influence of the learning models, namely the application of bilingual project-based teaching materials and expository learning on the students' numeracy achievement was significant. The value of "interest" showed similar results which meant that the effect of interest in learning, namely high and moderate learning interest on the students' numeracy skill was significant. However, this was different with the "class \* interest" value, which obtained a value of 0.735 or more than 0.05 which showed that the learning model and learning interest did not significantly interact with the students' numeracy achievement. This can also be seen from the profile plots visualization of the relationship between the two as shown in Figure 2 below.

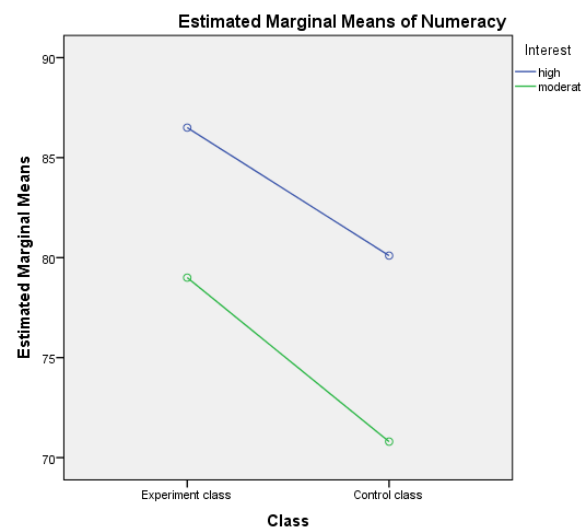


Figure 2. Profile charts illustrating how learning models and learning interests interact with students' numeracy accomplishments

Figure 2 shows that the direction of the graph between the two tends to be parallel. This indicated that there is no interaction between the two. Even when compared to the graph in Figure 1, it can be seen that this graph was almost perfectly aligned.

#### 4. Discussions

Mastery of basic literacy and numeracy for elementary school students is very important for their future academic achievement. Besides, an early introduction to foreign languages, such as English, is also profitable and a good choice. Therefore, teachers should be able to implement a suitable learning approach that will arouse the children's learning interest, remembering that children are easy to get bored. Considering the importance of children's interest in learning, this research involved the learning interest as one of the factors considered in the achievement of bilingual literacy and numeracy of elementary school students.

In this study, project-based approach was selected to make learning more enjoyable. The projects were combined with Android games to attract the students' interest. Learning with games is effective in increasing literacy in children [45]. In addition, this kind of learning is commonly applied to reduce the boredom of early-age students. As previously explained, project-based learning has many advantages. Numerous researches conducted at many levels presented the effectiveness of the project-based approach [18], [21], [29], [30], [46]. Students' critical thinking, problem-solving, learning motivation, engagement, ability to solve complex problems, teamwork, communication, and material management skills have all improved as a result of the project-based approach's implementation [24], [48], [49], [50]. It also gives opportunities to practice organizing projects, managing the time allotment and other resources to finish tasks [41]. Project-based approach provides real world atmosphere that stimulate students' contextual feeling and active participation [23]. In addition, it creates fun classroom that makes both teachers and students comfortable to learn [50]. In this study, bilingual project-based teaching materials were designed to be applied in project-based learning activities to facilitate the introduction of two languages (Indonesian-English) to elementary school students in increasing literacy and numeracy achievements.

The study's first set of findings showed that, in comparison to expository learning, the use of bilingual project-based teaching materials significantly affects early elementary school students' literacy skill achievement. The same thing was also obtained in the attainment of numeracy skills, where learning with bilingual project-based teaching materials had a significant difference compared to expository learning. It should be remembered that in expository learning, learning is still done monolingually. These results are supported by research which showed that project-based learning which integrates bilingual instruction and utilizes children's experiential knowledge is a powerful and promising pedagogical approach [18]. Students' parents also gave good feedback to this approach, such as causing joy and interest in children's learning [51].

The second result in this study showed that the learning interest factor has a significant influence on literacy and numeracy skills. This finding is consistent with some research which showed that students with low mathematical literacy or numeracy skills are typically also less interested in learning mathematics [52], [53]. In a similar vein, pupils who exhibit strong mathematical literacy or numeracy also have strong learning interests in the subject.

This condition happens because interest in learning is an intrinsic factor that encourages students to learn. This kind of motivation makes students more likely to participate actively in the learning process, invest more time and effort, and be more diligent in facing learning challenges. Furthermore, compared to students with moderate or low learning interests, those with high learning interests typically exhibit greater levels of concentration and attention to the material. They will be more focused when following the teacher's explanation or while doing assignments, thus enabling them to understand concepts better. A strong interest in learning encourages students to keep repeating and practicing, even outside of class hours. This helps to improve comprehension of the subject matter, which benefits numeracy (the ability to do math problems) and literacy (the capacity to read and comprehend text). This interest in learning also triggers students to develop critical skills, such as thinking logically, analyzing information, and drawing conclusions. All of these things are quite important in literacy and numeracy skills, where students need to be able to understand and process information in depth.

High interest in learning can also increase students' confidence in facing learning challenges. By having confidence, they are able to overcome difficulties and successfully understand the material. Furthermore, students tend to be more enthusiastic in facing tasks that require literacy and numeracy skills. A strong interest in learning also encourages students to explore various learning resources outside of school, such as books, learning videos, educational games, and others. This can improve their understanding of literacy and numeracy. Students with a good interest in learning tend to have positive experiences in learning. This experience can be in the form of succeeding in an assignment, getting good grades, or even further exploration of a topic that interests them. All of these contribute to the development of literacy and numeracy skills. Therefore, a positive interest in learning has a great impact on students' abilities in literacy and numeracy. This creates a positive circle where a strong interest in learning improves the quality of learning, which in turn improves students' literacy and numeracy skills.

According to the third study result, students' learning interests and the learning model did not interact to help them develop their literacy and numeracy skills. This indicates that the learning models have a big impact that can be felt even when the students' interest is not taken into account. This means that for both students with high and moderate learning interest, the application of learning models with bilingual project-based teaching materials have significantly better literacy and numeracy achievements compared to the application of expository learning.

Additionally, in both learning models—bilingual project-based teaching materials and expository learning—students with high learning interest outperform students with moderate learning motivation in terms of attaining literacy and numeracy skills.

As a result, it is critical to select a learning model that fosters student participation through the use of innovative, engaging, and interactive techniques that can heighten learners interest. High levels of motivation and student involvement in the learning process are directly correlated with high levels of interest in learning, which in turn affects literacy and numeracy skills. Furthermore, parents' perspectives and involvement also have a major impact on students' motivation to learn [30].

## 5. Limitation

This research has several limitations. First, the two schools selected as the sample are public schools that are geographically agricultural villages. The landscape and the type of school are likely to be influential factors. Second, the classification of the selected schools is at a moderate level based on educational report cards. Different results are possible for different school classifications, for example, for high and low school classifications. In addition, the samples are small size and can limit the results. Apart from the interest in learning, factors that need to be considered in the achievement of literacy and numeracy in early childhood include self-regulation [54], home learning environment [55], teacher efficacy [56], educational level of parents [15], collaborative parent-child interactions [30], [57], and gender [15]. The factors mentioned above, although not analyzed or in the focus of this research, can be factors that can influence the results that can be taken into consideration in future research.

## 6. Conclusion

Three inferences can be made in light of the results and the elaborated discussion. First, the literacy and numeracy levels of early elementary school pupils differed significantly depending on whether they used bilingual project-based learning materials or expository instruction. Second, students' attainment of literacy and numeracy was significantly impacted by their interest in learning. Lastly, there was no relationship found between the way the learning model was applied and the learning interests of the students in developing their literacy and numeracy skills.

The application of learning with bilingual project-based teaching materials can be used as an alternative to raising elementary school students' reading and numeracy levels, according to the study's findings. A key component of learning growth is interest in the subject matter. In order for students to advance their literacy and numeracy skills, teachers must create and deliver lessons that can pique students' interests, particularly those in junior elementary school.

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