Psychology, Evaluation, and Technology in Educational Research
7 (2), 2025, 153-164

Available Online: http://petier.org/index.php/PETIER

How project-based collaborative learning affect on numeracy ability of elementary school teacher education students

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Received: 24 November 2024; Revised: 7 December 2024; Accepted: 14 January 2025

Abstract: Based on project-based collaborative learning, this study attempts to evaluate the numeracy skills of prospective elementary education teachers. The study design is pretest-posttest control group, and the research methodology is experimental and quantitative. Purposive sampling strategies are used to create experimental and control classes.While project assignments are completed individually in the control class, they are administered in groups to the experimental class. Ten multiple-choice and yes-or-no (objective) questions are used in the pre-test and post-test results to gather information on students' numeracy proficiency. Project-based collaborative learning research findings are applied to enhance the numeracy skills of prospective elementary education teachers. The score's outcomes after acquiring the experimental class were 0.001 and The experimental class used group projects, while the control class used individual projects. The control class's pre-test and post-test collaborative learning results differed by less than 0.001.

Keywords: Student Numeracy; Collaborative Learning; Project

How to Cite: Nuraini, N. L. S., Cholifah, P. S., Rini, T. A., Aurelia, D., & Nabila, S. (2025). How project-based collaborative learning affect on numeracy ability of elementary school teacher education students. *Psychology, Evaluation, and Technology in Educational Research*, *7*(2), 153-164. https://doi.org/10.33292/petier.v7i2.256

INTRODUCTION

A developed country can be seen through people's lives, such as how the community thinks and behaves. The higher the education level of the people, the better the quality of life. A person who is good at managing information can be a way of reminding cognitive, thinking, and behaving (Arby et al., 2019). This cognitive improvement can be through literacy activities. Literacy is an ability related to all knowledge or skills in listening, reading, speaking, and writing activities (Nugrahani et al., 2020). Literacy offers many good programs based on these literacy skills, such as numeracy literacy, scientific literacy, media literacy, financial literacy, and cultural literacy (Rakhmawati & Mustadi, 2022). Numeracy literacy, or the ability to solve mathematical problems is something that must be familiarized at all levels of education because it can make students solve analytical or non-routine problems that have many ways of solving (Oktaviyanthi & Agus, 2019). Mathematical literacy is the ability to solve mathematical problems, and use mathematics in everyday life.

10.33292/petier.v7i2.256

The capacity to apply fundamental number concepts and counting operations in daily life is known as numeracy (Setianingsih et al., 2022). According to the most recent data from UNESCO's Programme for International Student Assessment (PISA), Indonesian pupils aged 15 and older had the 39th-best reading skills among the 41 countries examined. This demonstrates that Indonesians continue to have extremely low literacy rates (Runtu, 2023)

This happens because most students solve counting problems only, even though numeracy ability problems must be solved with the ability to reason logically to be solved (Sanvi & Diana, 2022). Based on this evidence, numeracy skills must be improved through problem-solving exercises. This is due to the fact that mathematical abilities are required for solving problems (Xiao et al., 2019). The statement above is in line with the research by Hermawan et al (2019) that shows how problem-based learning, scientifically approached mathematics literacy problems, and discovery learning may support students' reasoning and argumentation. Aside from that, the ability can be acquired through project assignments. Giving project assignments can be one way that students can get used to solving non-routine problems, which include numeracy literacy (Taher, 2023).This task is in the form of making their own problems related to numeracy and literacy and finding solutions. The issues and solutions created by students are then combined into teaching material projects. These projects can be collaborative.

Since they can increase students' knowledge in achieving learning objectives, collaboration skills are especially important in classroom activities. Additionally, collaborative groups of students will generate more knowledge (Ulhusna et al., 2020). Collaboration can help someone recognize that everyone's ideas are unique, which can lead to new ideas (Fajriyah, 2022). Students are taught to communicate through collaborative activities since one of the pedagogic goals of collaborative learning is to acquire social outcomes that include communication and collaboration skills (Meijer et al., 2020). Based on the numerous opinions regarding the necessity of collaboration in problem solving, the numeracy project is provided through collaboration.This collaborative exercise may allow students to partner up or create groups to achieve their goals (Stehle & Peters-Burton, 2019). In addition, collaborative learning is the ability to solve problems in a different way (Utami, 2022). In this study, the initial purpose of the collaboration was to work on the numeracy problem-solving project question and its resolution.

Previous research has shown promising results regarding numeracy and project-based learning implementations. A study by Setianingsih et al (2022) demonstrated that project-based learning improved students' numeracy abilities in junior high school students, with significant differences in pre-test and post-test scores. Similarly, research by Rakhmawati & Mustadi (2022) found that project-based learning enhanced elementary students' numeracy skills through collaborative problem-solving activities. Another relevant study by Oktaviyanthi & Agus (2019) revealed that project-based learning helped develop students' mathematical literacy and problem-solving abilities. However, there is still limited research specifically examining the effects of project-based learning on numeracy skills among prospective elementary education teachers. Team-based projects have an impact on the numeracy of prospective elementary school teacher students.

The numeracy of students aspiring to teach elementary school is impacted by team-based assignments. because group projects give students the chance to hone and perfect their communication and scientific performance skills (Fisher et al., 2020). According to research by Nursulistyo et al (2021), team-based learning also affects critical thinking abilities. In relation to these research, no one has offered an analysis of how project-based learning (PJBL) affects prospective elementary education teachers numeracy skills. The Effect of Project-Based Colla-

borative Learning on the Numeracy Ability of prospective elementary education teachers numeracy was a study conducted to examine how collaborative learning affected the assessment of prospective elementary education teachers numeracy skills.

METHODS

Experimental research using a quantitative approach is the research methodology employed in this study. Numeracy proficiency is the dependent variable in this study, whereas collaborative learning is the independent variable. Two classes—experimental and control groups—were used in the pretest-posttest control group design of this study. Numeracy project assignments were given to both classrooms, but the experimental group completed them collaboratively in small groups consist of 4-5 students, while the control group worked on the project individually.

To facilitate the collaborative learning process, the experimental group was provided with google docs workspace to collaborate, specific themes/topics divided into four major parts to facilitate circulation during peer assessment of group projects. Meanwhile, in the control group, the selection of themes is left to each individual student, and there is no peer assessment of the projects that have been made. The research participants were administered two tests: a pretest prior to treatment and a post-test following treatment.

The population comprised all prospective elementary education teachers class of 2021 students who completed two basic mathematics courses. Subject selection used purposive sampling, resulting in 57 total students (31 experimental, 26 control). Data collection methods used include questionnaires, tests, and documentation. Instrument development through expert validation. Data collection utilized three main instruments, namely a pre-test and post-test consisting of 10 multiple-choice questions to measure numeracy ability, a project assessment rubric evaluating both the process and the final product, and a student questionnaire on collaborative learning experience. The instruments in the research used are learning tools based on PjBl (project-based learning) numeracy in the form of sample questions and discussions developed according to indicators with topics around operating numbers, geometry, algebra, and representation numbers. The context used in instrument selection is the personal and social context.

Tabel 1. Result of Validity Test

Item	r	r table	Criteria
Q1	0.401	0,2609	Valid
Q2	0.336	0,2609	Valid
Q3	0.370	0,2609	Valid
Q4	0.480	0,2609	Valid
Q5	0.544	0,2609	Valid
Q6	0.304	0,2609	Valid
Q7	0.453	0,2609	Valid
Q8	0.585	0,2609	Valid
Q9	0.339	0,2609	Valid
Q10	0.660	0,2609	Valid

This research focuses on implementing PjBL-based learning with The final product is in the form of teaching materials that are prepared collaboratively. A questionnaire instrument and the test are used to measure the numeracy ability of prospective elementary education teachers before and after the implementation of learning. The research procedure includes a preparation stage, where at this stage the research instruments, in the form of questionnaires

and tests, are prepared to determine the initial numeracy abilities of prospective elementary education teachers. The instrument was further validated by two experts in the fields of elementary learning and mathematics.

Tabel 2. Result of Reliability Test

N Item	α	r table	Criteria
10	0.585	0,2521	Reliable enough

The validity of the test items is processed using the product moment correlation equation (Rxy). The decision is based on the significance value with a significance level of 95% (α = 0.05). While the reliability value is determined using the Alpha Cronbach reliability test. To ensure validity and reliability, the instruments were pilot tested with a sample of 30 participants prior to the main study, with the results as shown on Table 1 and Table 2.

The study was approved by the university's institutional review board, and all participants provided informed consent prior to taking part. In the implementation stage, activities were carried out to analyze the characteristics of prospective elementary education teachers, especially prospective elementary education teachers in the class of 2021. In this analysis, tests were also carried out and questionnaires were given to measure the initial numeracy abilities of prospective elementary education teachers. Furthermore, a PjBL-based learning tool was prepared that facilitates students in collaborating to prepare numeracy teaching materials in elementary schools. Learning is carried out according to the PjBL stages in 4 meetings. The next stage is evaluation, which begins with administering tests and questionnaires to measure students' numeracy abilities after PjBL-based learning. Collaborative teaching materials produced by students will also be evaluated among peers (peer assessment) to determine the strengths and weaknesses of the teaching materials produced. The evaluation results are followed up with product revisions as well as the publication process product.

As a preparatory test, the Shapiro-Wilk test is used in this study's data analysis to ascertain whether the data is normal. To ascertain whether or not the data variance is homogeneous, a homogeneity test is also conducted using Levene's test. Furthermore, a hypothesis test was performed using an independent sample T-test to see whether there were differences between experimental groups in the collaborative learning pre- and post-test results. The effectiveness was assessed using the N-gain score. For every statistical test, the significance level was set at α = 0.05.

RESULTS AND DISCUSSION

Project assignments completed cooperatively in experimental and control classes are used in this study to assess students' numeracy skills. Several tables below provide unambiguous evidence of the experimental and control classes' learning outcomes both before and after treatment (pre-test and post-test, respectively).

Table 3. Statistical Description Table

	Pre-Control	Post-Control	Pre-Experiment	Post-Experiment
Valid	16	16	15	15
Mean	6.375	5.938	6.067	5.467
Std. Deviation	1.962	2.016	1.907	1.685
Shapiro-Wilk	0.901	0.931	0.945	0.945
P-value	0.084	0.257	0.455	0.445
Minimum	2.000	3.000	3.000	2.000
Maximum	9.000	9.000	9.000	8.000

Based on Table 3 of the results of data processing using JASP on data in the experimental class, the following results were obtained: The number of valid samples in the pre-test and post-test was 16, the average score (mean) on the pretest = 6,375 and on the post-test = 5,938, the standard deviation (Std. deviation) on the pre-test = 1,962 and on the post-test = 2,016, on the pre-test the minimum value obtained = 2 and the maximum value = 9. In the post-test, the minimum value = 3 and the maximum value = 9. The results of the data obtained in the control class are: the number of valid samples in the pre-test and post-test is 15, the average score (mean) on the pretest = 6,067 and on the post-test = 5,467, the standard deviation (Std. deviation) on the pre-test = 1,907 and on the post-test = 1,685, on the pre-test the minimum value obtained = 3 and the maximum value = 9, while in the post-test the minimum value = 2 and the maximum value = 8.

Table 4. Data Normality Test Results

No.	Group	p value	Information
1.	Pre-Test Experimental Class	0.084	Normal
2.	Post-test Experimental class	0.257	Normal
3.	Pre-Test Control Class	0.455	Normal
4.	Post-Test Control Class	0.445	Normal

To find out whether the data is normal or not, use the normality test as in Table 4. To perform data normality calculations using Shapiro Wilk in the JASP application. To find out whether it is normal or not, if the significance value, or $p > 0.05$, is normal, and if the significance value, or $p < 0.05$, can be said to be abnormal. Based on Table 4, if pre-test and post-test data in both experimental and control classes have p values or significance > 0.05, which means normal, it can be concluded that all data groups are normally distributed. After knowing the normality of the data, the next stage is the homogeneity test.

Table 5. Homogeneity Test Results

No.	Group	p value	Information
1.	Pre-test	0.824	Homogeneous
2.	Post-test	0.588	Homogeneous

The homogeneity test is used to test whether the variance of the data is homogeneous (equal) or inhomogeneous. The homogeneity test is performed using Levene's Test, with $p > 0.05$ being said to be homogeneous and $p < 0.05$ being said to be inhomogeneous (Husni et al., 2017). The results of the homogeneity test on the data can be seen in the Table 5. Based on Table 5, it can be seen that the pre-test and post-test values in the experimental class with a p value of 0.824 and the control class with a value of 0.588 have a significant p value, with the data can be considered homogeneous if the significance value utilised is more than 0.05. Therefore, it can be said that the data's variance is homogeneous. Once the homogeneity of the data has been established, a hypothesis can be formulated and tested.

Table 6. T Test Results

No.	Group	p value
1.	Experiment	0.001
2.	Control	<0.001

The results of the hypothesis test can be seen in the Table 6. Based on Table 6 where both variables have a p value of <0.05, the experimental class has a value of 0.001 and the control class < 0.001. So that was rejected while accepted. This means that there are differences in the pre-test and post-test results of collaborative learning between experimental classes that

use group projects and control classes that use individual projects. This hypothesis test is used to statistically evaluate the accuracy of a statement and determine whether it should be rejected or accepted (Kamo, 2023). The significant value used in this hypothesis is < 0.05. Therefore, if the p value is 0.05, it is rejected while accepted. If the p value is greater than 0.05, it is accepted; otherwise, it is rejected. The hypotheses used are as follows:

Ho: There was no difference in pre-test and post-test results of collaborative learning between experimental classes using group projects and control classes using individual projects

H1: There are differences in pre-test and post-test results of collaborative learning between experimental classes using group projects and control classes using individual projects

Table 7. N-Gain Test Results

No.	Group	p value
1.	Experiment	0.001
2.	Control	<0.001

Class	N Gain Score	Category	Percentage	Interpretation
A	0.72	0.824	72%	Quite effective
B	0.7	0.588	70%	Quite effective

To measure the increase in the experimental class and control class between before and after project-based collaborative learning on numeracy ability, the N-Gain (normalized gain) test is used as in Table 7. The N-Gain score test computation in Table 7 yielded an average N-Gain score of 72% for the experimental class with a fairly effective interpretation. While for the control class of 70% with quite effective interpretation. So it can be concluded that project-based collaborative learning is quite effective in improving students' numeracy skills.

Data from test results in experiments project-based collaborative learning to ascertain how using a project-based collaborative learning approach affects students' numeracy abilities, demonstrating positive outcomes with variations in mean test scores. Research on how project-based learning affects elementary school teachers' preparation both before and after the experimental exam in order to enhance numeracy abilities. A pre-test was administered prior to learning the Project Based Learning (PjBL) Model in order to observe the preliminary findings, and a post-test was also administered following learning the PjBL Model. The PJBL used in numeracy learning includes 5 stages, namely: Before learning begins, students are divided into small groups consisting of 5-6 people. Next, students place themselves in their groups to start working on their projects. The first stage in PJBL syntax is problem identification for problems given by the lecturer team. The problem given is related to numeration. Next, after receiving the distribution of materials for each group, students solve problems related to numeracy and prepare collaborative teaching materials based on PJBL.

The second stage is designing a solution through a literature study. As a result of research activities from literature studies, students collect sources of information regarding numeracy problems to design their projects. The third stage in the PJBL syntax is preparing a project plan or scheduling. The third stage involves students discussing and collaborating with their team colleagues to compile the information obtained at the research stage into a project design written in teaching materials. The fourth stage is monitoring the work on student projects carried out by the lecturer team. Next, the fifth stage is evaluating the project results for improvements.

The T-test's significant value test stage, which is 0.001 < 0.05, was then performed based on the PJBL procedures followed. This revealed that there was a difference in the average test results for the usage of project-based collaborative learning, rejecting H0 and accepting Ha. In

addition, the experimental class that used collaborative project-based learning improved somewhat more than the control class, which falls into the category of quite effective, with an N-gain score of 72% as opposed to 70%. This small but notable difference can be attributed to several factors: (1) the collaborative environment facilitated peer learning and knowledge sharing; (2) group discussions enabled multiple perspectives in problem-solving; (3) regular feedback from team members helped strengthen understanding; (4) social interaction during project work enhanced engagement. This finding aligns with Oktaviyanthi & Agus (2019) who found that collaborative learning environments enhance mathematical problem-solving abilities through peer interaction and collective knowledge construction.

Project-based learning, or PjBL, also has characteristics similar to the development of numeracy literacy skills, namely that in completing projects, students will use various understandings and work collaboratively. This is in line with the statement from Munahefi & Lestari (2023). that model project-based has proven effective for improving literacy and numeracy skills. Because project-based collaboration learning has also proved to help students working on specified numeracy projects, which will increase conceptual understanding and technical skills in numbers (Fisher et al., 2020). This is in line with the opinion of Niswara & Untari (2019), which states that the use of project-based learning can increase motivation in project preparation, issue solving, teamwork and cohesion, and resource management. They finish the job by creating challenges and fixing them through discussion with colleagues. From the possibility they are having difficulties to finding solutions.

Besides that, overall patterns in student responses data show responses from 56 students across two classes, providing a wide range of responses, with some clear patterns emerging as shown in Figure 1.

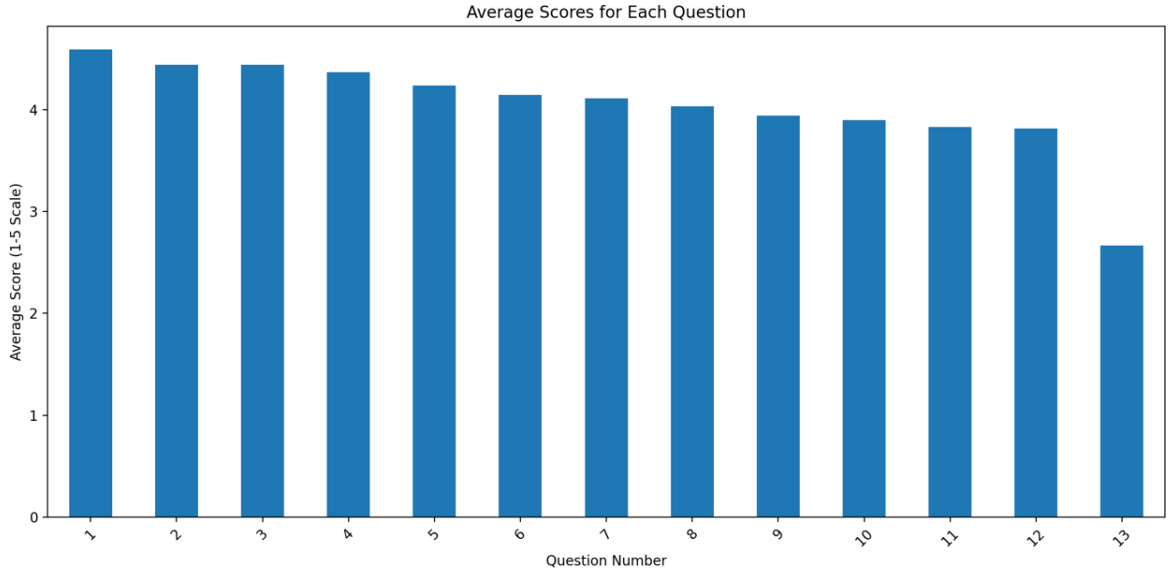

Figure 1. Average of Students response on collaboration learning

Description:
1. I appreciate the contribution of every team member.
2. I was able to respect different team members.
3. I feel responsible for completing my own tasks/parts.
4. I have the willingness to work for the common goal.
5. I can share responsibilities in collaboration tasks.
6. I feel the benefits of skill improvement (leadership, confidence, communication, and decision-making) through collaborative learning.

7. I was able to work together efficiently.
8. When in a group, I perform individual tasks and also interact (providing reasoning/input).
9. I support and teach fellow team members when performing collaborative tasks.
10. I feel more comfortable doing tasks alone.
11. I am able to manage conflicts that arise during collaborative learning.
12. I prefer doing tasks in a team.
13. When in a group, I focus on individual tasks rather than interaction (providing reasoning/input).

Based on Figure 1, many students reported positive experiences with collaborative learning, indicating that they enjoy working in teams, support and teach their peers, and feel responsible for their individual contributions. For example, over 80% of students agreed or strongly agreed that they "support and teach fellow team members" and "can work efficiently in a team." Similarly, around 90% of students reported that they "respect team members who are different" and "have the willingness to work towards a common goal. The findings of this data analysis are consistent with a study by Nursulistyo et al (2021) that found that students' critical thinking abilities can be impacted by team-based learning. The pupils in the experimental class are quite active, based on their actions. Students actively visit the pieces and engage in group discussion sessions.

The results of research show that most students would prefer to work as a team, as seen from Figure 2, in which 76.7% of students prefer to work as a team.

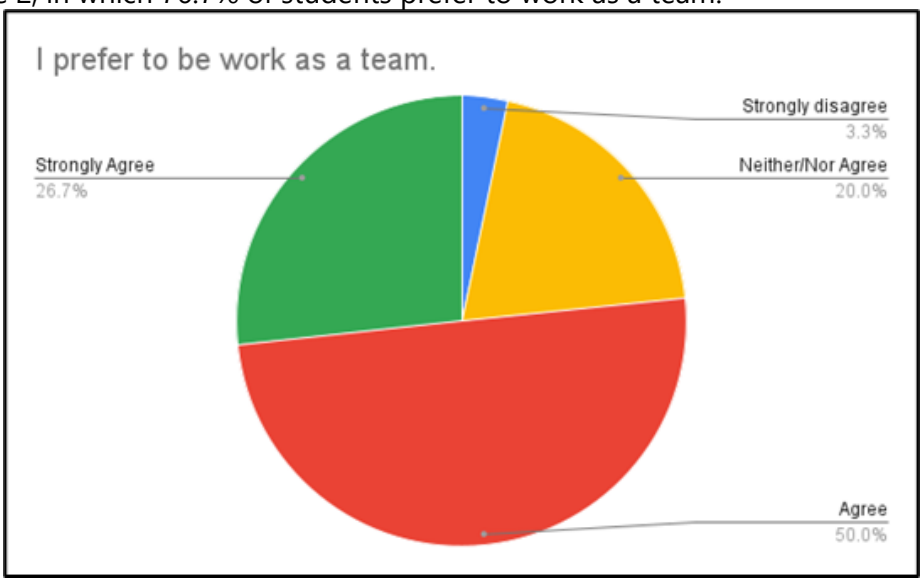

Figure 2. Student's response about working as a team

The data highlights several strengths in the students' collaborative learning experiences. The majority of students reported that they can work efficiently in teams, respect their peers, and contribute to the group's goals. This suggests that the students have developed important collaborative skills, such as communication, conflict management, and shared responsibility. These results are consistent with Meijer et al (2020) study on the social benefits of collaborative learning, which found that, from the standpoint of behavioral alignment, a high achiever mentoring a low achiever is an example of positive behavior because it mimics peer tutoring, in which students work together, support one another, and ultimately learn from one another. This is also in line with the findings of a study conducted by Darius et al (2021), which indicate that students would like to participate in digital learning individually in groups of five. Regarding the process of learning during class group projects, the majority of participants stated that they valued collaborating with others in a team (Lochner et al., 2020). Therefore, it can be concluded that students prefer collaborative learning over solo learning when project-

based learning is implemented. Additionally, the results of the N-gain score and hypothesis test demonstrate that project-based collaborative learning effectively improves students' numeracy competency.

During the implementation of project-based collaborative learning, several significant challenges emerged and were addressed through specific solutions. Time management posed an initial challenge as students struggled with coordinating group work effectively. This was addressed through the implementation of structured timelines and clear role distribution among group members. Another challenge involved participation equity, where varying levels of involvement among group members were observed. To address this, a peer assessment system was introduced, which helped encourage more balanced participation, as seen in Figure 3.

Figure 3. Peer assessment activity

Quality control also presented a challenge in maintaining consistent project quality across different groups. This was managed through regular progress monitoring and systematic feedback sessions that helped maintain standards while supporting group development.

However, the data in Figure 1 also reveals areas for improvement in collaborative learning because some students struggle with the social aspects of group work and some challenges with collaborative learning. A significant number of students (around 40%) reported a preference for individual work over group work, indicating that they feel more comfortable and focused when working alone. Additionally, about 30% of students said they tend to focus more on their individual tasks rather than engaging in discussions and providing input to the group. This finding, also supported by earlier research conducted by Meijer et al (2020) acknowledges that some students experience problems with group work.

The data suggests that students generally have positive attitudes towards collaboration and teamwork, but there are some areas for improvement. Most students stated that they are capable of working well in groups, support their peers, and contribute to the group's goals. This indicates that students have developed important collaborative skills, such as communication, conflict management, and shared responsibility. At the same time, the data reveals that some students struggle with the social aspects of group work, preferring to work independently rather than engage in group discussions and interactions. This could be due to factors such as individual learning styles, personality traits, or previous experiences with group work.

While many students reported enjoying and benefiting from collaborative learning, a significant number of students expressed a preference for individual work. This suggests that some students may feel more comfortable and productive when working alone rather than in a group setting. One possible explanation for this finding is that some students may feel that they can

better control the pace and quality of their work when working individually, without the potential distractions or conflicts that can arise in group settings. Additionally, some students may have had negative experiences with group work in the past, leading them to prefer individual tasks.

The research also revealed significant potential long-term benefits of implementing project-based collaborative learning. Students developed transferable collaborative skills that will be valuable in their future teaching careers. The approach enhanced their professional preparation as future teachers and notably improved their confidence in handling numerical concepts. Furthermore, the practical nature of the projects provided better preparation for real-world teaching scenarios they will encounter in their careers. These thorough results contribute new information unique to the numeracy development of PGSD's students while also supporting and expanding on earlier study Fisher et al (2020) and Nursulistyo et al (2021). The results strongly suggest that project-based collaborative learning not only improves numeracy skills but also develops essential professional competencies needed for future elementary school teachers. Additionally, teacher preparation emerged as a crucial factor, highlighting the importance of developing skills in facilitating collaborative learning environments and the need for specific training in project-based instruction methodologies.

CONCLUSION

The findings from this study demonstrate that project-based collaborative learning can be an approach to enhance numeracy skills for certain prospective elementary education teachers populations. Specifically, the results indicate that the experimental class, which worked on numeracy projects collaboratively, showed significantly improved numeracy outcomes compared to the control class that worked on numeracy projects individually. These findings suggest that project-based collaborative learning may be a beneficial instructional strategy for improving numeracy skills. However, further research should explore the use of project-based collaborative learning with different student populations, such as those varying by age or prior academic performance, and with different collaborative strategies or learning activities. This could include comparing the effectiveness of having students work in small groups versus the whole class, or analyzing the role of peer feedback to gain a better understanding of the scope and limitations of this approach.

ACKNOWLEDGMENT

We would like to thank the State University of Malang for funding this research so that it can run smoothly and be completed as it should.

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