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Students' Cooperative Attitudes in Junior High School Mathematics Learning: A Study of the Influence of the Project-Based Learning Model on Integer Material

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ABSTRAK

Rendahnya sikap kerjasama siswa dalam pembelajaran matematika berdasarkan observasi awal menunjukkan perlunya penerapan model pembelajaran yang dapat meningkatkan sikap tersebur. Tujuan studi ini adalah meneliti pengaruh PjBL terhadap sikap kerjasama siswa dalam pembelajaran matematika dengan metode kuantitatif desain quasi eksperimen berupa *posttest-only control group design*. Populasi penelitian adalah seluruh siswa kelas VII SMP Negeri 20 Surabaya. Dua kelas menjadi sampel penelitian melalui teknik pemilihan *purposive sampling*. Model PjBL diterapkan di kelas VII-I, sedangkan kelas VII-G menggunakan metode pembelajaran konvensional. Instrumen pengumpulan data berupa lembar observasi untuk menilai sikap kerjasama siswa selama pembelajaran. Data dianalisis menggunakan uji normalitas, uji homogenitas, dan uji-t. Hasil uji hipotesis menunjukkan adanya perbedaan rata-rata sikap kerjasama siswa pada kelas kontrol dan kelas eksperimen, di mana kelas eksperimen menunjukkan hasil yang lebih tinggi. Berdasarkan hasil tersebut, model PjBL berpengaruh positif terhadap sikap kerjasama siswa dalam pembelajaran matematika. Studi ini penting dilakukan karena sikap kerjasama merupakan salah satu keterampilan abad 21 yang perlu dikembangkan dalam pembelajaran matemataika.

Kata Kunci: Project Based Learning; sikap Kerjasama; pembelajaran matematika.

ABSTRACT

The low level of students' collaboration skills in mathematics learning, based on initial classroom observations, indicates the need for a learning model that can enhance such skills. This study aims to examine the effect of PjBL on students' cooperative attitude in learning mathematics using a quantitative quasi-experimental design with a posttest-only control group. The population consisted of all seventh-grade students at SMP Negeri Surabaya. Two classes were selected as the research sample using a purposive sampling technique. The PjBL model was applied in class VII-I, while class VII-G used conventional learning methods. The data collection instrument was an observation sheet used to assess students' cooperative attitude during learning. Data were analyzed using normality tests, homogeneity tests, and t-tests. The results of the hypothesis test showed a significant difference in the average attitude of student cooperation between the control class and the experimental class, with the experimental class yielding higher results. Based on these results, the PjBL model has a positive impact on students' cooperative attitude in learning mathematics. This study is important because cooperation is one of the 21st-century skills that needs to be developed through mathematics education.

Keywords: Project-Based Learning; collaboration skills; mathematics learning

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1. INTRODUCTION

With the rapid pace of globalisation and progress, the world of education is required not only to produce graduates who excel in academics but also to possess critical thinking, creativity, communication, and collaboration skills (4Cs). (Guerra, 2024; Ong & Annamalai, 2024; Rapti & Sapounidis, 2024; Suyitno, 2020; Thornhill-Miller et al., 2023). One of the key skills for future social and professional life is the ability to work in a team. (Junita et al., 2023; Kousloglou et al., 2023; Maor et al., 2023; Pratiwi & Agustini, 2024). To that end, schools need to design learning activities that encourage the development of cooperative attitudes in students from an early age.

Cooperation is a scientific attitude that demonstrates a person's ability to interact and work with others in achieving common goals. (Engelbrecht & Borba, 2024; Saimon et al., 2023). This attitude encompasses effective communication, fair task allocation, clear role responsibilities, and the ability to respect differing opinions and resolve conflicts constructively. (Coşkun & Deniz, 2022; Rahayu et al., 2020; Schindler & Lilienthal, 2022). In the context of education, cooperation is an important part of character building for students. Based on Khoirotin & Shofiyah (2024), cooperation is one of the dimensions of the Pancasila student profile that needs to be instilled through daily learning activities. More than just a social skill, cooperation is also an important asset in social life and the world of work, which demands cross-disciplinary and cross-cultural collaboration.

Mathematics education plays a role in developing critical, logical, and analytical thinking skills. (Fitriatien & Khotimah, 2024). In addition, mathematics teaches students to solve problems systematically and make informed decisions based on available data or information. However, mathematics learning is often considered an individual activity, where each student focuses more on achieving the correct results independently (Leksono & Fitriatien, 2021; Pramiswari et al., 2023). Mathematics has excellent potential to encourage cooperation among students, especially when the tasks assigned involve solving complex problems that require a variety of perspectives (Connors et al., 2021; Coşkun & Deniz, 2022; Suyitno, 2020; Lestari et al., 2022). In this case, cooperation can be the key to enriching students' learning experiences through exchanging ideas, discussing, and working together to overcome challenges.

However, interviews conducted at SMPN 20 Surabaya showed that students' attitudes toward cooperation in mathematics learning were relatively low. Many students were not accustomed to active discussion, were reluctant to share information, and showed dependence on one member of the group. Additionally, the lecture and exercise methods commonly used by

teachers did not provide sufficient space for students to interact with one another and build a shared understanding.

To address these challenges, a learning model is needed that can balance cognitive achievement and character building (Chen et al., 2022; Khoirotin & Shofiyah, 2024). PjBL is considered an effective alternative for fostering cooperation among students. Based on Saimon et al. (2023), PjBL is a learning model in which projects or activities are the main elements of the learning process. In this model, students are given learning experiences by solving everyday problems that require group collaboration. Through this process, students are expected to be able to integrate new knowledge gained from their direct experiences in carrying out these activities. Lutfiana (2023) and Pendit et al (2024) states that this model emphasizes the importance of applying knowledge in practical contexts and collaborating to solve problems effectively.

Based on Santoso et al. (2023), this aligns with Vygotsky's social constructivist theory, which posits that learning is the outcome of social interaction and the collaborative construction of knowledge. This theory suggests that students can develop an understanding, foster a sense of community, and cultivate cooperative attitudes through the social interactions that occur within the learning context. Therefore, the implementation of PjBL, which encourages collaboration and joint problem-solving, can strengthen the learning process while fostering cooperative attitudes.

Previous studies have stated that PjBL has a positive impact on the development of students' social attitudes, particularly in terms of cooperation. Research of Andini et al (2024) explains that the application of PjBL can increase interaction between students and encourage individual responsibility in teamwork. Meanwhile, a study by Harahap & Nasution (2023) in mathematics, students were also more active and engaged in group discussions when project-based learning was implemented. These findings indicate that the PjBL model has the potential to support more collaborative mathematics learning.

Given that there has been little research to date that has thoroughly examined the influence of the PjBL model on students' attitudes toward cooperation, especially in the context of learning mathematics, particularly in the subject of integers, this research is important to conduct. The uniqueness of this study lies in the integration of handmade flipping books, which are creative books designed and compiled directly by students in groups. In this project, students are asked to organise integer material into engaging and informative flipping books, enabling them not only to sharpen their understanding of mathematical concepts but also to engage in collaborative processes, communication, and task division. Through this study, it is hoped that it will provide new perspectives and contribute to the development of teaching methods that not only enrich mathematical mastery but also effectively encourage the improvement of students'

cooperative attitudes. Therefore, the researcher implemented the PjBL learning model to determine the influence of students' cooperative attitudes on mathematics learning at SMP Negeri 20 Surabaya.

2. METHOD

Using a quasi-experimental quantitative approach with a posttest-only control group design, this study aims to examine the effect of PjBL implementation on students' attitudes toward cooperation in mathematics learning. The posttest-only design was chosen because it considers the potential measurement effects that may arise if students know the form of the instrument before the treatment is given, as well as to maintain internal validity in classroom conditions that do not allow for optimal pretesting. The research was conducted at SMP Negeri 20 Surabaya, East Java, from November to December. Seventh-grade students were the population, and the sample was determined through purposive sampling based on the subject teacher's considerations. The selection criteria included: (1) equality in initial mathematics ability among classes, as determined by previous daily test scores, and (2) the teacher's willingness to implement the treatment according to the lesson plan.

Based on these criteria, Class VII-I was designated as the experimental class, taught through PjBL. In contrast, Class VII-G was designated as the control class, using conventional teaching methods, with 30 students in each class. Data collection was carried out through observation techniques, using observation sheets as instruments designed to measure students' attitudes toward cooperation based on several indicators, according to Greenstein (2012) (1) actively contributing; (2) working productively; (3) responsible attitude; (4) flexibility and compromise; and (5) mutual respect. The validity of this observation sheet instrument was conducted through expert validity, involving two lecturers who are experts in mathematics education and learning evaluation. This validation was used to ensure the accuracy and relevance of the indicators used. Table 1 presents the grouping of student cooperation attitude levels based on research conducted by Pagarra et al (2023).

Table 1. Cooperative Attitude Category

Value	Category
$80 < x \leq 100$	Very Good
$60 < x \leq 80$	Good
$40 < x \leq 60$	Good Enough
$20 < x \leq 40$	Not Good
$0 < x \leq 20$	Very Poor

The observational data obtained were then analysed through several stages of statistical testing, including normality testing to examine data distribution, homogeneity testing to

determine variance similarity between groups, and t-testing as a parametric test to examine differences in cooperation attitudes between the two groups after treatment was administered. The t-testing formula used was:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

With $\bar{X}_1$ and $\bar{X}_2$ as the means, s_1^2 and s_2^2 as the variances, and n_1 and n_2 as the number of students in each group. The three tests were conducted to ensure that the differences in the results obtained could be interpreted validly.

3. RESULT AND DISCUSSION

The cooperation attitude observation sheet was used as a data collection instrument for students in Class VII-I, designated as the experimental class implementing the PjBL learning model, and for students in Class VII-G, who served as the control class following conventional learning. The assessment was conducted during the learning process, where the observer observed the extent to which students demonstrated cooperative attitudes in completing group tasks contained in the LKPD. The purpose of this observation was to obtain a general description of the level of cooperative attitudes demonstrated by students in each class. Further details regarding the observation data are presented in Table 2.

Table 2. Results of Research on Cooperation Attitudes in Experimental Classes

No.	Cooperation Attitude Score Interval	Frequency
1	70 – 74	1
2	75 – 79	1
3	80 – 84	10
4	85 – 89	3
5	90 – 94	11
6	95 – 99	4
	Total	30
	Average	87,67
	Minimum Value	70
	Maximum Value	98

Source: Primary Data

From Table 2, it can be seen that the cooperative attitude of students in class VII-I is within a specific range of values, with the lowest score being 70 and the highest being 98. The average score obtained is 87.67, which falls into the "very good" category. This explains that, overall, students can demonstrate good cooperative attitudes during the learning process.

Table 3. Results of Research on Attitudes Toward Cooperation in Control Classes

No.	Interval Score Attitude Cooperation	Frequency
1	30-36	1
2	37-43	3
3	44-50	11
4	51-57	5
5	58-64	8
6	65-71	2
Total		30
Average		52,1
Minimum Value		30
Maximum Value		70

Source: Primary Data

From Table 3, it can be seen that the cooperative attitude of students in class VII-G is within a specific range of values, with the lowest score being 30 and the highest being 70. The average score obtained is 52.1, which falls into the "fairly good" category. However, when compared to the experimental class, the level of cooperation among students in this class appears to be suboptimal. This indicates that the implemented learning model has not fully encouraged students to actively engage in group cooperation during the learning process. Furthermore, a statistical analysis was conducted to obtain a clear picture of the differences in cooperative attitudes between the experimental and control groups.

a. Normality Test

The purpose of the normality test is to determine whether the collected results are normally distributed or not. The formulation of the hypothesis with its significance level is as follows $\alpha = 0{,}05$.

With the following testing criteria:

If $\chi^2{}_{hitung} < \chi^2{}_{tabel}$ then the data is normally distributed.

If $\chi^2{}_{hitung} > \chi^2{}_{tabel}$ then the data is not normally distributed.

Table 1. Normality Test Results

Data	Experiment Class	Control Class
Total Students	30	30
Average	87,667	52,1
Standard Deviation	6,5302	8,8033
$\chi^2{}_{hitung}$	7,9747	4,2978
$\chi^2{}_{tabel}$	11,070	11,070
Conclusion	Normally Distributed	Normally Distributed

Source: Primary Data

The results of the normality test indicate that the calculated $\chi^2{}_{hitung}$ value for the experimental class is 7.9747 and for the control class is 4.2978. Both are smaller than the $\chi^2{}_{tabel}$ table value of 11.070. Thus, the cooperative attitudes of students in both classes are typically distributed. The normality of the data is important because it is a prerequisite for using parametric statistical tests. With this assumption met, further analysis, such as the t-test, can be conducted validly, and the results can be trusted.

b. Homogenity Test

The next step is to test two variances to verify whether the data is homogeneous or not. Formulate a hypothesis with a significance level of $\alpha = 0{,}05$.

With the following testing criteria:

If $F_{hitung} \leq F_{tabel}$ accept H_0 (homogeneous variance)

If $F_{hitung} > F_{tabel}$ reject H_0 (non-homogeneous variance)

Table 2. Homogeneity Test Results

Data	Experiment Class	Control Class
Varians	42,644	77,4988
F_{hitung}	1,8173	1,8173
F_{tabel}	1,8608	1,8608
Conclusion	Homogeneous	Homogeneous

Source: Primary Data

Based on the calculation results, the calculated F_{hitung} is 1.8173, while F_{tabel} is 1.8606. Since $F_{hitung} \leq F_{tabel}$, the decision made is to accept H_0. This means that the data from both groups have relatively similar variances or distributions. In other words, both groups exhibit homogeneity, so the t-test can proceed to the next stage since one of the requirements for a parametric test has been met.

c. Research Hypothesis Testing

This study applied hypothesis testing through t-test analysis with the following criteria:

H_o accepted if: $t_{tabel} \leq t_{hitung} \leq t_{tabel}$

H_o rejected if: $t_{hitung} < t_{tabel}$ or $t_{hitung} > t_{tabel}$

Table 3. Research Hypothesis Test Results

Class	N	t_{hitung}	t_{tabel}
Experiment Class	30	2,2013	2,001717
Control Class	30		
Conclusion		H_o rejected	

Source: Primary Data

The hypothesis test above resulted in $t_{hitung} > t_{tabel}$, namely $2{,}2013 > 2{,}001717$, so H_0 was rejected, indicating that there was a statistically significant difference in the mean values of student cooperation between the control and experimental classes.

This difference suggests that collaborative contributions to project activities have a more effective influence on the formation of students' cooperative attitudes than conventional learning methods. Therefore, the implementation of the PjBL model not only supports academic achievement but also fosters essential social values in mathematics learning.

Students in the experimental class who received treatment using the PjBL model showed a significant improvement in their attitude toward cooperation. The average observation score fell into the "very good" category, characterised by mutual assistance, active discussion, and responsibility in completing group projects. These results were supported by Pagarra et al (2023) states that project-based activities significantly increase the frequency and quality of interactions among students in groups, thereby strengthening cooperative attitudes.

This finding is also in line with studies Khoirotin and Shofiyah (2024), which notes that PjBL encourages students' emotional and social engagement because of the direct link between the task and real life. Through projects such as collaborative book flipping, students are encouraged to rely on each other and share roles equally. This aligns with Vygotsky's Constructivist Social Learning theory, which posits that meaningful learning occurs through intense social interaction.

In contrast, students in the control class, who followed conventional learning, showed a cooperative attitude that was categorised as "fairly good." Although there was still group interaction, it tended to be passive and limited, because learning was teacher-centered and did not provide space for role exploration or collective decision-making. This condition shows that without the stimulus of a real project, the potential for student cooperation is not optimally explored. This is different from the study Eliyah et al (2023) this emphasises the importance of emotional and contextual involvement in improving group work effectiveness. This difference is likely due to the lack of connection between the conventional learning tasks given to students in the control class. However, the results of this study have limitations in terms of generalisation due to the small sample size and the limited location of the study to one school.

The uniqueness of this finding lies in the context of the material, namely, integers in mathematics learning, which is rarely associated with a PjBL approach in the form of concrete projects such as flipping books. This project can foster more meaningful interactions between students while also developing their mathematical communication skills in creatively conveying number concepts.

In practical terms, these results demonstrate that the integrity of PjBL in mathematics learning not only strengthens conceptual understanding but also serves as a vehicle for

strategies that foster positive attitudes, such as mutual support, responsibility for obligations, and respect for others' views.

4. CONCLUSION

The results of the study revealed that the implementation of the PjBL learning model affected students' cooperative attitudes in mathematics learning. Evidence of this can be seen in the results of observations and data analysis, which indicate that students in the experimental class, using the PjBL model, had higher cooperative attitude scores than students in the control class, who used conventional learning. Project-based learning activities encourage students to collaborate, engage in active discussions, and complete tasks responsibly within their groups. This process fosters a collaborative atmosphere that is not optimally created in conventional learning.

The PJBL model has proven to be more effective in fostering a cooperative attitude toward learning mathematics. Therefore, mathematics teachers are advised to integrate PjBL into the learning process through concrete projects. In addition to flipping books, other projects that can be used include creating algebra board games, designing coordinate maps, or building miniature bridges using the concepts of ratios and proportions. Such projects not only enhance conceptual understanding but also develop responsibility, communication, and collaborative decision-making skills. School support, in terms of time, facilities, and teacher training, is also a crucial factor in ensuring that this model has a maximum impact on fostering social values in learning. Additionally, it is recommended to conduct a longitudinal study to assess the long-term impact of PjBL implementation, particularly in observing the consistency of students' collaborative attitudes over time within the context of mathematics learning.

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