

IMPLEMENTATION OF PROJECT-BASED LEARNING MODEL AT STATE VOCATIONAL SCHOOL 1 ABUNG SELATAN IN IMPROVING COLLABORATION ABILITIES

Anggita Dara Nacita^{1,a}, Ratih Handayani^{1,b}

¹ Pendidikan Matematika, FKIP, Universitas

Muhammadiyah Kotabumi,

Jl. Hasan Kepala Ratu No. 1052, Sindang Sari 34517

e-mail: ^aanggitadaranacita@gmail.com ,

^bratih.handayani@umko.ac.id

Abstract

The low collaborative skills of students and the inconsistency of previous research findings regarding the effectiveness of collaborative learning indicate the need for the implementation of learning models that are able to support collaboration optimally. The purpose of this study was to analyze the effect of using the Project Based Learning (PjBL) model on the collaborative skills of class X students at SMK Negeri 1 Abung Selatan. The research method used was a quasi-experimental with a pretest-posttest control group design involving two classes, namely class X Culinary 2 as the experimental class and class X Culinary 1 as the control class, with a sample of 31 students, selected using purposive sampling techniques. Collaboration ability data were collected through questionnaires and authentic assessments. The analysis process involved normality tests, homogeneity tests, t-tests, and N-Gain calculations, with research findings showing that although the N-Gain value of the questionnaire in the experimental class was higher than the control class N-Gain = 0.1147 and the experimental class 0.1535. The authentic assessment results showed a higher collaboration score in the control class with an average of 0.5557, compared to the experimental class at 0.4994. The t-test showed no significant difference between the two groups. Based on the t-test results, the average N-Gain value of the experimental class (0.3265) was lower than the control class (0.3352), as well as the calculated T value (0.21037) and T table (2.00030). showed no significant difference between the two groups, so the implementation of PjBL has not provided a significant increase in collaboration. This condition is influenced by the limited project time, less than optimal role division, and the process of student adaptation to the new learning method. More structured project planning is recommended for further research.

Keywords: *Collaboration; Project Based Learning; Quasi-experiment; Vocational high school*

1. INTRODUCTION

Education is a key pillar in societal development for national development. It also plays a crucial role in fostering collaborative skills, an essential skill for individuals to contribute effectively in an increasingly complex and interconnected society. [1]. In this era of globalization, according to [2], Collaboration skills are a very necessary skill in various fields because collaboration encourages the exchange of ideas and different perspectives, which often become the source of innovative ideas. According to Sunbau in [3] Collaboration is the process of working together with other parties to help achieve previously designed goals. [4] It is explained that collaborative skills have an important role in the learning process because they can support academic achievement as well as foster positive social and democratic attitudes in students. According to [5] In the learning process, collaboration shows that they participate in helping each other and complement each other in completing certain tasks to achieve certain goals [6], [7].

Collaboration in learning can be demonstrated through a number of indicators, including: (1) having the ability to work in groups; (2) adapting to various roles and responsibilities working productively with others; (3) having empathy and respecting different perspectives; (4) being able to compromise with other members of the group in order to achieve predetermined goals [8]. As for other indicators according to [9] (1) participate actively and in a balanced way in discussions, (2) have a sense of individual responsibility, (3) show flexibility and compromise, (4) communicate effectively, (5) respect other people's ideas and appreciate members' contributions, (6) be committed to the goals. As for the indicators according to [10] (1) contribution, (2) communication, (3) flexibility, (4) responsibility, (5) mutual respect. This study uses the collaboration skills indicators proposed by [10],

which includes contribution, communication, flexibility, responsibility, and mutual respect. The selection of these indicators is based on the consideration that the indicators [8] are concise, relevant, and operational, making them suitable for measuring students' collaborative abilities in the context of classroom learning. Each indicator represents an important dimension of collaboration, such as students' active involvement in groups, the ability to exchange ideas effectively, readiness to face differences of opinion, responsibility for shared tasks, and mutual respect among group members.[11] Thus, these indicators are considered most appropriate for describing and assessing students' collaborative abilities comprehensively while remaining practically applicable in learning. Therefore, collaboration in learning can be concluded as a process of cooperation between students to complete tasks and achieve common goals through active involvement, role flexibility, empathy, responsibility, and commitment to group problem solving. In the context of mathematics learning in vocational schools, one of the materials that requires conceptual understanding and cooperation between students is exponents. Exponents not only emphasize numeracy skills, but also understanding patterns, relationships between numbers, and their application in everyday life, such as population growth, bacterial development, and scale calculations. Understanding the concept of exponents will be more optimal if students engage in discussions and group work, allowing them to exchange ideas, test their understanding, and solve problems collaboratively. Therefore, learning about exponents is highly relevant for developing students' collaborative skills [12], [13], [14], [15].

Problems related to students' collaboration skills occurred at SMK Negeri 1 Abung Selatan. Based on data obtained through interviews with 10th-grade math teachers, it was discovered that

while group learning had been implemented, students' collaboration skills had not shown optimal results. This was indicated by students still shifting responsibility and tending to rely on other group members to complete assignments.

Based on initial observations in mathematics learning, particularly when students are given group assignments, students were still found to be less active participants, less likely to contribute to discussions, preoccupied with activities outside the group, and not completing their group assignments. This situation indicates that student enthusiasm for collaborative learning remains low. This is reinforced by the documentation in Figure 1, which shows only one student working on the problem, while the rest of the group chatted, used gadgets, or were otherwise uninvolved in group activities. This situation reflects low active participation, a lack of balance in discussions, and a weak commitment to achieving group goals [16], [17], [18], [19].



Figure 1. Acitivity Student

One learning approach that can be used to develop collaboration skills while increasing understanding of the concept of exponents is the project-based learning model (Project Based Learning/PjBL) [20]. Project-Based Learning is a learning strategy that emphasizes real-world experiences through project activities as a means of acquiring new knowledge. The PjBL model is process-

oriented, problem-solving-focused, and student-centered, enabling the integration of mathematical concepts, including exponents, with real-life contexts. Students often find PjBL more engaging and motivating compared to traditional lecture-based methods, leading to deeper learning and better retention of knowledge [21], [22], [23], [24]

Through project-based learning, students can work in groups to design and complete projects related to the concept of exponents, thus not only understanding the theory but also being able to apply it practically. This process requires effective communication, clear division of tasks, and shared responsibility, thus potentially enhancing students' collaboration skills. Thus, PjBL is a relevant learning model for application to exponent material in vocational schools.

Based on the description, this study aims to analyze the effect of implementing a project-based learning model (Project Based Learning) on exponent material on students' collaboration skills at SMK Negeri 1 Abung Selatan.

2. METHODS

This study used a quasi-experimental method with a pretest-posttest control group design to analyze the effect of implementing the Project Based Learning (PjBL) model on students' collaboration skills. This design allows for comparison of pretest and posttest results between the experimental and control groups without full subject randomization [25]. The research subjects were grade X students of SMK Negeri 1 Abung Selatan who were selected purposively, with class X Culinary 2 as the experimental class and class X Culinary 1 as the control class. The experimental class received project-based learning, while the control class used conventional learning.

The research instrument was a four-level Likert scale collaboration skills questionnaire consisting of 30 statements, arranged based on indicators of contribution, communication, flexibility, responsibility, and mutual respect adapted from [26]. In addition, authentic assessment sheets were used to assess students' collaboration skills during the project activities. All instruments have undergone validity and reliability tests, thus ensuring their suitability for use.[27] Data analysis was performed by calculating the average scores of the questionnaire and authentic assessments. The differences in improvement between the experimental and control classes were then analyzed using a t-test to determine the significance of the PjBL implementation on students' collaboration skills.

Table 1. Steps for implementing research

No	PjBL Stages	Learning Activities
1.	Determining fundamental questions	The teacher introduces the concept of bacterial growth through a short video showing that bacteria reproduce rapidly and follow an exponential growth pattern.
2.	Identification of problems	Students observe simple problems related to bacterial growth, such as the increase in the number of bacteria every few minutes under ideal conditions.
3.	Project design	Students are divided into several groups to plan the project by determining the initial number of bacteria and the time of bacterial division based on the illustrations in the video.
4.	Activity planning	Each group formulated the steps for carrying out the project, including determining the assumption that

	bacteria divide into two at a certain time and only divide once at each time interval.
5. Project implementation	Students create a table of bacterial growth over time based on the prepared plan.
6. Development of a mathematical model	Students develop a mathematical model using exponential concepts to represent the pattern of bacterial growth.
7. Project presentation	Each group presents the project results in the form of a table and a mathematical model of bacterial growth that they have developed.
8. Evaluation and reflection	The teacher and students jointly evaluate the project outcomes and reflect on their understanding of exponential concepts and teamwork within the group.

As shown in Figure 2, due to insufficient time, students only conducted a brief reflection on the material they had understood, such as how the concept of exponents is applied to bacterial growth.

BAKTERI			
	Waktu (n)	2^n	Jumlah
1 bacterium			
2 bacteria	1	$2 = 2^1$	2
4 bacteria	2	$2 \times 2 = 2^2$	4
8 bacteria	3	$2 \times 2 \times 2 = 2^3$	8

Figur 2 Acitivity Student for concept exponent

Lastly, due to insufficient time, students only did a brief reflection on the material they had understood, such as how the concept of exponents is used in the form of bacterial growth.

3. RESULTS AND DISCUSSION**A. Result****1. N-Gain calculation results**

N-gain analysis shows that there is a difference in the average collaboration between the Control and Experimental classes.

Table 2. N-gain calculation result

Class	N-gain questionnaire	N-gain authentic assessment	Overall average
Control	0,11	0,55	0,33
Experiment	0,15	0,49	0,32

The results of the analysis show that the overall average of the experimental class is lower than the control class.

2. Normality Test Results

Normality testing was conducted through the application of certain tests such as Lilliefors which were taken from the average N-Gain value of the control class (0.3352) and the experimental class (0.3265). The results of the analysis showed that the calculated Lilliefors value of the control class obtained a value of 0.1124, while the experimental class obtained 0.1308, while the table Lilliefors value was 0.15. Because the calculated Lilliefors value is smaller than the table Lilliefors value, the data from both groups are normally distributed.

Table 3. Normality Test Results

Class	Lilifers Count	Lilifors Table	Information
Control	0,11	0,15	Normal
Experiment	0,13	0,15	Normal

The normality of the data, as shown in Table 2, was analyzed using the Liliefors test, it was found that the calculated Liliefors value in the control class was 0.1124, while in the experimental class it was recorded at 0.1380, both of which were smaller than the table Liliefors value of 0.15. Thus, the data in both classes showed a normal distribution because the calculated L did not exceed the table L.

3. Homogeneity Test Results

The homogeneity test was carried out to determine that the variance values of the two groups were relatively balanced with degrees of freedom (Db) = 1 and $n = 30$. This means that the data is homogeneous.

Table 4. Homogeneity Test Results

Class	Varians	F count	F Table	Information
Xk	0,020038	1,7107	1,8409	Homogen
Xe	0,03248			

4. T-test results

The results of the t-test show that the average number for the control class and the experimental class, the following hypothesis is used:

- H_0 : On average, there was no increase in collaboration skills from the implementation of the project-based model at SMK Negeri 1 Abung Selatan.
- H_1 : On average, N-gain shows an increase in collaboration skills from the implementation of the project-based model at SMK Negeri 1 Abung Selatan.

Based on the results of the t-test, the average N-Gain value of the experimental class (0.3265) is lower than the control class (0.3352), as well as the calculated T value (0.21037) and T table (2.00030). So the calculated $T < T$ table and it can be concluded that H_0 is accepted, meaning there is no difference.

B. Discussion

Research data shows that the application of the Project Based Learning (PjBL) model on exponential material with the context of bacterial growth has not provided a significant increase in students' collaboration skills at SMK Negeri 1 Abung Selatan. The project implementation was carried out through four meetings, starting from the introduction of the concept of bacterial growth that follows an exponential pattern, project design and preparation of mathematical models, analysis of growth tables and graphs, to presentation of results and reflection. Students learned the bacterial growth model using the formula $P = P_0 \times 2^n$, with P_0 as the initial number of bacteria and n as the division time.

The results of the N-gain analysis showed that the experimental class obtained higher collaboration questionnaire scores than the control class, but the authentic assessment showed the opposite results, so that overall no significant differences were found. This condition was influenced by the limited time for project implementation, the many stages in PjBL, and the students' adaptation process to the new learning model. In line with the [28],

PjBL requires adequate time allocation so that each stage of the project can be implemented optimally and provide opportunities for students to explore and reflect in depth. The model fosters critical thinking, problem-solving, creativity, and collaboration, which are essential for the modern workforce[29], [30], [31], [32]

Furthermore, time constraints prevent students from developing optimal collaborative learning behaviors. Based on Skinner's behavioral learning theory, developing these behaviors requires a continuous process of habituation and reinforcement [33], [34]. When learning duration is insufficient, students' opportunities to develop discipline, independence, and responsibility in group work are limited. Therefore, improvements in collaboration are more evident in student perceptions through questionnaires than through direct observation.[35], [36], [37]

Theoretically, project-based learning has the potential to improve collaboration skills. However, this study found that suboptimal project planning, unclear role allocation, and time constraints were inhibiting factors. Future research is recommended to allocate time more proportionally, strengthen student learning behavior support, and utilize more sensitive observation instruments to more accurately measure collaborative development.

4. CONCLUSIONS AND SUGGESTIONS

A. Conclusion

Overall, the implementation of Project Based Learning is proven by the results of the t-test, the average value of the N-Gain of the experimental class (0.3265) is lower than the control class (0.3352), as well as the calculated T value (0.21037) and T table (2.00030). So that the calculated $T < T$ table and it can be concluded that H_0 is accepted, the bottom line is that there is no difference.

does not show a significant difference in the collaboration abilities of vocational high school students, The results of the study show an increase in students' collaboration abilities in general in project-based learning. This increase is reflected in student involvement in group work during the planning and completion process of the project. However, aspects of collaboration such as communication, cooperation, and sense of responsibility are not analyzed separately, so the conclusion of this study is focused on increasing collaboration abilities in general according to the data obtained.

B. Suggestion

Further research is recommended to extend the duration of the research so that the data collection process can be carried out more optimally and in-depth, considering that the time constraints in this research caused several observation activities not to be carried out comprehensively. Further research is expected to use more adequate and structured projects or assignments so as to provide a clearer picture of the development of students' abilities. It is recommended to increase the variety of projects, increase the number of samples, and increase the intensity of interventions so that the research results are more representative. The use of more sensitive measurement instruments and fidelity of implementation checks are necessary to ensure that intervention mechanisms can be analyzed more accurately.

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