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The Influence of Project-Based Learning Models on Collaboration Skills and Science Learning Outcome for Junior High School

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Abstract: The aim of this research was to analyzed the differences in collaboration skills between students taught with a project-based learning model and conventional learning model in science subjects. The type of research includes quasi-experiments with a pretest-posttest non-equivalent control group design. The sampling technique used was nonprobability sampling. The population consisted of eleven classes in class VII, and the sample used was four classes. The research instruments were observation of collaboration skills and learning outcomes tests. The data obtained were collaboration skills scores and pretest and posttest scores on temperature and heat material. Data were analyzed using descriptive analysis techniques and inferential analysis (one-way MANOVA) with a significance level of 5%. Before testing the hypothesis, prerequisite tests are carried out (normality, homogeneity of variance, covariance, linearity, and correlation between variables). The results showed that significant differences in collaboration skills and science learning outcomes both simultaneously and separately between students taught using the project-based learning model and students taught using the conventional learning model with a p value <0.05. Referring to the results, it was concluded that there were differences in collaboration skills and learning outcomes between students who were taught using the project model, which was better than the conventional model.

Keywords: Collaboration; Learning outcomes; Project Based Learning Model

Introduction

The independent curriculum currently being developed is a refinement of the previous curriculum as an effort to restore education due to the Covid 19 pandemic. The characteristics of the independent curriculum are the development of soft skills and character through a project to strengthen the Pancasila student profile, focus on essential, relevant and in-depth material to build student creativity and innovation as well as flexible learning to suit the achievements of each student (Kemendikbudristek, 2023). According to Indarta et al. (2022), the concept of independent learning promoted by the independent curriculum has relevance to 21st century learning which further develops students' needs. Activities centered on student needs emphasize how students can think critically, are able to communicate and collaborate and have creativity to prepare them for facing future challenges.

Through learning activities that are centered on student needs, it is hoped that it can facilitate students to develop their own potential as well as being a strategic means to strengthen the character of Pancasila student profiles as a national goal of education. The research of Ramadhanti et al. (2023) stated that the learning process carried out through activities centered on students' needs aims to ensure that they receive meaningful learning. Student activities, especially in science learning, basically emphasize basic concepts and scientific processes. The basic concept is a way of

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thinking and acting to respond to and solve problems that occur around students. The science process is an activity that focuses on developing students' skills in understanding knowledge or concepts as well as discovering and developing facts, concepts and values independently (Nuraini & Muliawan, 2020). The scientific process in science learning is expected to be able to develop creative thinking and problem-solving skills, communication and collaboration skills, as well as creativity and innovation skills. This is in accordance with the essence of science learning, namely conditioning productive learning by producing scientific products, training scientific performance as well as scientific attitudes. Thus, it is hoped that after mastering science, students will have a solid foundation for thinking and acting based on the principles of scientific research.

Students' knowledge and process skills can be sharpened, one of which is by applying various models, strategies and learning methods that are able to guide and condition students to carry out scientific processes (Ayun, 2021; Puspitarini, 2022). One innovative model with learning that involves a lot of student activity is the project-based learning model, abbreviated as PjBL. PjBL carries a constructivist philosophy with the theory that knowledge is the result of cognitive construction through student activities (Tinenti, 2018). Student activities include scientific skills and attitudes that are able to construct knowledge through real and meaningful experiences. Activities through project assignments are also able to train self-confidence, critical thinking skills, creative, analytical, collaboration, communication, problem solving and independent learning (Sumarni et al., 2016). PjBL has learning stages that are able to guide students to develop collaboration skills by facilitating investigative activities, solving problems, and producing real products in the form of project results (Wibowo et al., 2015).

Research related to the influence of PjBL on learning outcomes has been carried out with good, significant results and has a positive effect at the elementary, middle and high school levels. According to Nur Khanifah (2019) , stated that there is a significant influence between the project-based learning model and collaboration skills on student learning outcomes. Meanwhile Rati et al. (2017) revealed that there is a significant influence on the implementation of PjBL on learning outcomes and collaboration skills simultaneously. Similar research also states that there is a positive and significant relationship and influence between PjBL on collaboration abilities and student learning outcomes (Nur Khanifah, 2019; Saenab et al., 2019). However, studies on the influence of PjBL on collaboration skills are still limited to secondary schools, apart from that there is research by (Alamsyah & Widiasih, 2021), which states that there is a significant difference in PjBL on student learning outcomes, but statistically it has not shown a significant difference on students' collaboration skills. Meanwhile, based on theory and previous research results, PjBL is significant for learning outcomes and collaboration skills and one of the advantages of PjBL is that it is able to develop students' social interaction skills, teamwork and collaboration skills in the learning process.

Based on this explanation, it appears that there is a discrepancy between theory and the results of research on the implementation of PjBL, so it is interesting to test it again in more depth on other aspects of learning outcomes, namely student collaboration skills, which are still limited in secondary schools. Testing was carried out on class VII middle school science subjects, temperature, and heat material by paying attention to the instructional impact of PjBL, namely student cognitive learning outcomes, and the impact of MPBP accompaniment, namely collaboration skills, which also develop 21st century skills.

Method

This type of research is quasi-experimental, with a pretest-posttest, non-equivalent control group design. This design can be noticed in the Table 1.

Tabel 1. Pretest-Posttest Non-Equivalent Control Group

O1	X1	O3
O2	X2	O4

(Sugiyono, 2017)

Descriptions :

O1, O2 = Pre observation, pre test

X1, X2 = treatment with conventional model and PjBL

O3, O4 = Post observation, post test

The population was 320 students from class VII at SMP Negeri 2 Gerokgak, consisting of eleven classes, and the research sample used was four classes. The sampling technique used was nonprobability sampling, with a total sample of 128 students distributed in classes VII B1 and VII C1 as the experimental group and classes VII C3 and VII D1 as the control group. This research consists of independent variables, namely project-based learning models and conventional learning models, and dependent variables, namely collaboration skills and learning outcomes.

The research was conducted at SMPN 2 Gerokgak, Buleleng Regency, Bali Province. The research implementation time is in the odd semester of the 2023–2024 academic year, during October–November 2023. The research procedure consists of preparation, implementation, and follow-up stages. The instruments used to collect data were a collaboration skills observation sheet with 15 statements and a multiple-choice learning outcomes test with 15

questions. The instrument is first validated by expert judges and tested to obtain content validity, reliability, item internal consistency, item difficulty index, and item discrimination index.

The data obtained is in the form of collaboration skills scores and pretest and posttest scores on temperature and heat material. The score criteria are shown in Table 2 and Table 3. Next, the percentage of normalized gain scores (N-Gain) from (Hake, 1999) is carried out for hypothesis testing purposes. The criteria are shown in Table 4. Data were analyzed using descriptive analysis techniques and inferential analysis using one-way MANOVA at a significance level of 5%. Descriptive analysis is used to describe data on collaboration skills and student cognitive learning outcomes in the form of average values, frequencies, percentages, and standard deviations after treatment. Meanwhile, multivariate analysis of variances (MANOVA) is a multivariate analysis that is used to test mean differences simultaneously between two or more dependent variables. The Manova test describes the effect of treatment on two dependent variables at once. Before testing the hypothesis, prerequisite tests are carried out, which include normality tests, homogeneity of the variance-covariance matrix, linearity, and correlation between variables. The research method flow diagram is presented in Figure 1.

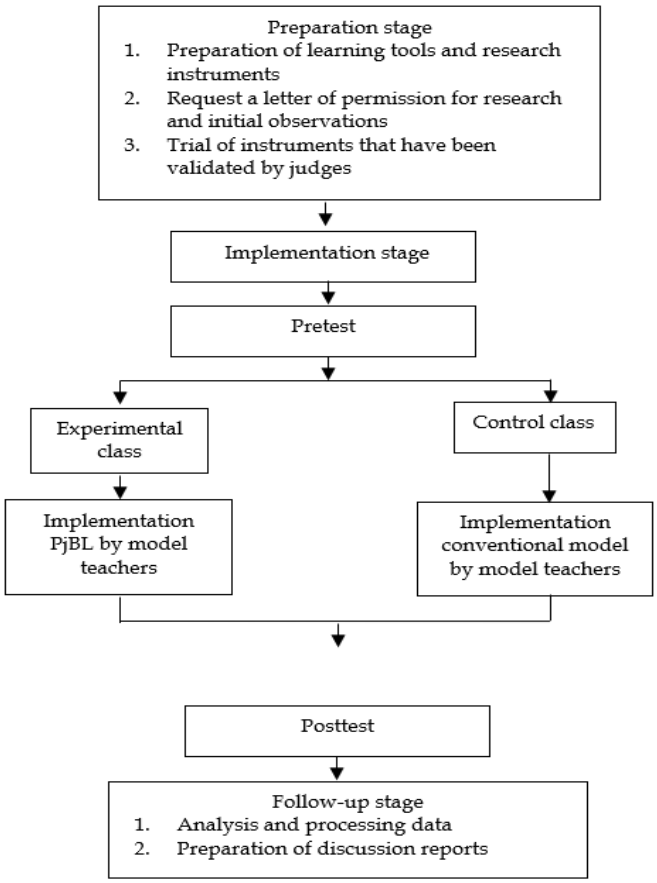

Figure 1. Research Flow

Tabel 2. Normalized Score Gain Criteria

Gain score	Criteria
n-gain > 0.7	High
0.7 ≤ n-gain < 0.3	Medium
n-gain < 0.3	Low

Tabel 3. Collaboration Skills Criteria

Percentage	Criteria
85-100	Very High
65-84	High
45-64	Medium
25-44	Low

Tabel 4. Learning Outcome Criteria

Interval	Criteria
85-100	Very High
70-84	High
55-69	Medium
40-54	Low
0-39	Very Low

Result and Discussion

The results of the descriptive analysis of collaboration skills and learning outcomes of class VII students at SMP Negeri 2 Gerokgak for the 2023–2024 academic year who were taught using project models and conventional models can be shown in Table 5 and Table 6.

Table 5. Results of Analysis of Student Collaboration Skills Scores

Results of Analysis	Pre observation experiment	Post observation experiment	Pre obseva tion control	Post observa tion control
Average	69.35	78.55	68.67	73.63
Standard Deviation	4.83	8.26	6.18	7.32
N-Gain Score		0.28		0.13
Category		Low		Low

Table 6. Results of Analysis of Student Learning Outcome Scores

Results of Analysis	Pretest experiment	Posttest experiment	Pretest control	Posttest control
Minimum Value	20.00	26.67	13.33	13.33
Maximum Value	73.33	80.00	66.67	80.00
Average	41.35	57.60	41.04	48.96
Standard Deviation	11.97	14.83	12.92	14.30
N-Gain Score		0.27		0.13
Category		Low		Low

Inferential analysis begins with prerequisite tests, namely normality tests, homogeneity of the variance covariance matrix, linearity, and correlation between variables. The test results show that the data is normal, homogeneous, linear, and has a correlation in the low category, so it can be continued with the one-way MANOVA test. The results of hypothesis testing are shown in Table 7, Table 8, and Table 9.

Table 7. Results of Manova Hypothesis Testing

	Effect	Sig.
Class	Pillai's Trace	0.001
	Wilks'Lamda	0.001
	Hotelling's Trace	0.001
	Roy's Largest Root	0.001

Table 8. Hypothesis Testing Results for Student Collaboration Skills

Source	Dependent Variable	Sig.
Class	Collaboration Skill	0.002

Table 9. Hypothesis Testing Results for Student Learning Outcomes

Source	Dependent Variable	Sig.
Class	Learning Outcome	0.001

Referring to the results of this research, it is known that the p value is <0.05, so H0 is rejected and H1, H2, and H3 are accepted. So, there are differences in collaboration skills and science learning outcomes for students who are taught using project models and conventional models, either simultaneously or together and separately.

There are several theoretical foundations as the basis for differences in collaboration skills in groups of students taught with the project-based learning model compared to the conventional model. Students who study with the project model show collaboration skills and higher learning outcomes compared to students who study with the conventional model. Collaboration skills allow each group to make decisions together that are better than making decisions alone. Apart from that, collaboration in groups provides the opportunity to work constructively with peers and improve understanding by explaining other concepts, so that learning outcomes are also better. This group interaction is able to develop cognitive concepts by revealing differences in knowledge between one another, thereby increasing students' understanding of a concept. Collaboration skills are a group learning process in which each member contributes information, experience, ideas, attitudes, opinions, abilities, and skills to jointly improve the understanding of all members (Nuraini et al., 2023).

The project-based learning model requires students to actively participate and collaborate in groups in the problem-solving investigation process so that they are able to construct the core of the lesson from the findings (N. L. I. M. Yanti et al., 2023). According to Sumarni et al. (2016) activities through project assignments are also able to train self-confidence, critical thinking skills, creativity, analytical skills, collaboration, communication, problem solving, and independent learning.

Based on descriptive analysis, the average initial observation of the collaboration skills of the two groups, namely the experimental group and the control group, had scores that were not much different. The average initial observation score in the experimental group was 69.35, and the control group was 68.67. During group discussion activities in the experimental group, it was observed that each group showed an attitude of flexibility and mutual respect. However, weak indicators appear to be working productively, responsible attitudes, and active contributions. In this indicator, not all group members are able to demonstrate productive work and contribute actively. Students do not show a responsible attitude and use group work time to tell stories, and there is no teamwork. Most students do not understand the assignment, so it is only done by one or two students. The same thing also happened in the initial observation activities of the control group. Indicators showing mutual respect and flexibility are well visible in all groups. However, indicators of working productively and responsibly are still less than optimal, and the lowest is the students' ability to contribute actively.

The low average indicator of collaboration skills is because some students are still not active in groups. Therefore, students who are active will tend to dominate the group, so passive students will depend on active students. This condition also occurs because the steps of the conventional learning model do not give rise to activities that require student creativity and activeness. This is supported by the opinion of (Ashriah et al., 2020) that the conventional learning model is characterized by lectures from teachers accompanied by explanations, the distribution of tasks, and practice questions, so that student activity is limited.

After being given treatment, the final observation results showed that there was a difference in the average collaboration skills in the experimental group and the control group. Referring to Table 1 and Table 2, the average of the experimental group is higher than the control group in each indicator. The average indicator of productive work and active contribution in the experimental group experienced an increase in the score for the indicator of productive work from 63.28 to 79.12, while the average indicator of active contribution was from 66.02 to 74.05. The control group mean for the indicator of working productively is 76.65 and 67.36 for the indicator of actively contributing. Overall, there was an increase in collaboration skills on five indicators in

the experimental group compared to the control group after being given treatment. The total average result in the experimental group was higher compared to the control group. This result is in accordance with the statement (Nurhidayah et al., 2021), that project-based learning is a learning model designed to develop desired student characteristics such as research skills, self-confidence, responsibility and cooperation, through activities where students work individually or in groups to design plans.

The increase in collaboration skills after being given PjBL treatment was influenced by the learning steps in this model involving the cooperation of each team member, starting from the basic question stimulation stage, project planning, and creation to the presentation stage. As a result, each team member will indirectly be responsible for and actively involved in project work. This condition is supported by the statement of (Saenab et al., 2019), which states that through the activities of project-based learning students, they are able to work together, agree with each other, and respect each other's different opinions from each group member to reach a solution to the problem that will be resolved by implementing the project. The research from (Dharin et al., 2023) that learning to be creative and fun because students and teachers are used to establishing good communication and collaboration. The use of PjBL also has a positive influence on improving students' collaboration skills because, with this model, the learning process conditions students to be involved in problem-solving projects, implementing problem-solving activities with new knowledge obtained during concrete activities from project-learning activities (Mariamah et al., 2021).

Project-based learning has a positive effect on students who are active in doing group assignments, giving opinions, actively presenting the results obtained by the group, actively involved in solving problems, and always accepting the opinions of other group members. The activeness of students in the experiment class occurs because of the implementation of the project based learning directs students to create a project related to the concept being studied (Aprida & Mayarni, 2023; Mursalim et al., 2023). PjBL provides opportunities for students to think critically and innovatively to solve problems or produce new products, requires students to think independently, analyze information, and generate new ideas. In addition, PBL also encourages students to think outside the box and not be afraid to try new things (Yanti et al., 2023). Project-based learning positively influences students in honing their skills in carrying out projects to create mind maps of topics (Rasyid & Khoirunnisa, 2021). When discussing each stage of the project and its results, students can become familiar with ideas and arguments in front of other students with confidence and accuracy (Bulu & Tanggur, 2021; Jasmi et al., 2023). Project-based learning is applicable because it can improve students' collaboration skills so that it influences communication skills, creativity, and critical thinking skills in various teaching fields (Kurniawati et al., 2019).

The results of descriptive analysis and hypothesis testing, as presented previously, show that PjBL has a significant effect on learning outcomes. The results of the initial test (pretest), which measured the initial abilities of students in the two research groups, showed an average of 41.35 in the experimental group and 41.04 in the control group. After being given different treatment, the average of the group of students who studied with project-based learning showed an increase with an average score of 57.60, higher than the group of students who studied with the conventional learning model, namely 48.96. There are several theoretical foundations as the basis for differences in collaboration skills and learning outcomes in groups of students taught with the project-based learning model compared to the conventional model. Students who study with the project-based learning model show collaboration skills and higher learning outcomes than students who study with the conventional model. Project-based learning has learning steps that condition students to work together, gather a lot of information, divide tasks, and solve problems in the form of projects. Project-based learning is able to make students very enthusiastic and active in participating in learning, student-centered, teamwork, and contextual learning activities (Kristanti et al., 2016; Munawaroh et al., 2013).

Project-based learning is project-based and applicative and positively influences students in honing their skills when carrying out projects. Students can get used to ideas and arguments in front of their friends with confidence while developing communication skills, creativity, and critical thinking skills (Bulu & Tanggur, 2021; Kurniawati et al., 2019; Rasyid & Khoirunnisa, 2021). This condition can affect student learning outcomes in the experimental group and the control group, which shows significant differences. Through the project model, students learn to evaluate experiences, express opinions, cooperation of group members, difficulties faced, and benefits obtained from the learning that has been followed.

The increase in learning outcomes from the cognitive aspect has achieved an increase in moderate to high criteria of 50.56% from the initial test, which was only 12.5%. This happens because project-based learning invites students to take a more active role in meaningful learning activities (Atika et al., 2023; Mahulae et al., 2023). Through these meaningful learning activities, students can further improve their understanding of concepts, learn to be responsible and gain direct experience that they also experience in everyday life. Project-based learning develop students' abilities to

investigate, collect information, interpret, create projects in their respective groups, practice directly making products from environmental problems and train them to evaluate and communicate the results of their projects (Arlian et al., 2023; Azmi & Festiyed, 2023),. This will also increase their understanding of certain concepts. PBL can have a positive long-term impact on students even after they have graduated and can therefore be considered as a solution towards building real-life competencies such as proper communication, collaboration, emotional intelligence, and problem solving (Bytyqi, 2021; Ngereja et al., 2020).

Based on the results of interviews conducted by researchers with model teachers, science learning outcomes in the classes he teaches are still low due to several things, including: the implementation of learning models that are still not varied, especially innovative learning models, so that they do not provide enough conditions for activities that require thinking skills. high level in the student learning process, limited implementation of learning models has implications for the lack of practice on high order thinking skills (HOTS) questions in daily learning activities such as quizzes and formative or summative exercises so that when students are faced with questions with cognitive level C4 and above, they are less careful in giving the best answers, and low literacy and numeracy abilities of students. This is shown by the results of the school quality report card, with students' abilities in the literacy and numeracy sections still in the red.

Student learning outcomes in this study have improved, but if you look at the achievement scores, students are still in the low to medium category, and few have reached the high category. Several factors can influence students' interest in participating in learning. Student interest can increase students' motivation and curiosity to participate in learning. Factors that influence learning outcomes are not only collaboration abilities. However, learning outcomes are also influenced by other factors. Isnaeni et al. (2022), explained that student independence, responsibility, and discipline can consistently influence learning outcomes for the better. In line with this research, Wahab & Rosnawat (2021)stated that the factors that influence learning outcomes are factors from within the student (internal factors) and from outside the student's environment (external factors). Internal factors include physiological factors and psychological factors. Physiological factors relate to an individual's physical condition. Meanwhile, psychological factors are the psychological state of students; this condition can influence the student's learning process, including intelligence, interests, attitudes, motivation, and talents. As for external factors, namely factors from outside the student that also have an influence on student learning activities, consisting of support from parents, school, and the community.

Implementation of activities, including : the project-based learning model requires more thorough planning and preparation than the conventional learning model. Planning starts with discussing the distribution of total learning time in the chapters to be studied, planning each learning step in the teaching module, compiling project student worksheets, and planning materials that are affordable for students. While the preparation includes conditioning the readiness of teachers and students to understand each step of project learning, preparing students to be able to respond to the stimulation given, and preparing project tools and materials, implementing the project-based learning model requires more energy and costs compared to the conventional learning model, so it is quite tiring for teachers who teach many classes. In the implementation of the project-based learning model, not all students are able to participate in the activities well; there are still a small number of students who are not focused and do not follow every step in the model, which is good; and the project-based learning model requires more implementation time compared to the conventional learning model to prepare, implement, and present the results of the project. However, behind several obstacles that arise in the implementation of project-based learning, there are many positive things that students and teachers gain through meaningful experiences and learning, such as training critical thinking and creativity skills, practicing communication and problem solving, and developing team collaboration skills, which are indeed the advantages of project based learning.

Conclusion

Referring to the results and discussion, it can be concluded that there are differences in collaboration skills between students who are taught using the project-based learning model (MPBP) compared to students who are taught using the conventional learning model (MPK). The research results show significant differences in collaboration skills and science learning outcomes both simultaneously and separately between students taught using the project-based learning model and students taught using the conventional learning model with a p value <0.05. Based on the findings, several suggestions are made, as follows: student learning outcomes in this research are still low, so teachers are advised to use innovative models to condition collaborative active learning and develop high-level thinking abilities. The project model requires careful preparation but is able to improve collaboration skills and student learning outcomes, so school principals should encourage teachers in other fields to also start trying to implement the project model. Other researchers who want to carry out similar research are

advised to choose different materials at different levels and add other aspects of learning outcomes as well as review the quality of the products produced.

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Conceptualization, methodology, investigation, writing, L.P.W.S. Review, criticism and suggestions that build and improve the quality of writing in the concept section, results of data analysis, interpretation of results and discussion, , I.W.S and I.W.S. All authors have read and agreed to the published version of the manuscript.

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