

# THE IMPLEMENTATION OF PROJECT-BASED LEARNING ON STUDENTS SCIENCE PROCESS SKILLS AND LEARNING MOTIVATION IN IPAS LEARNING

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## ABSTRACT

The purpose of this study was to determine the effect of the project-based learning model on the science process skills and learning motivation of students at SMPIT Insan Mandiri Jagakarsa in the IPAS subject regarding environmental change. The method used was a quasi-experiment with a pretest-posttest nonequivalent control group design. Data analysis techniques employed descriptive statistical analysis and hypothesis testing using either the Independent Sample T Test or Mann Whitney U Test at a significance level of 0.05. The results showed that the average posttest score of the control class was 51.35, while that of the experimental class was 79.15. This indicates that the average posttest score of the experimental class was higher than that of the control class. Furthermore, the hypothesis test using the Mann Whitney U Test yielded a significance value of  $<0.001$  (sig.  $< 0.05$ ), meaning that  $H_a$  is accepted, or there is a significant difference in science process skills between the experimental and control classes. Subsequently, descriptive analysis of student learning motivation data revealed an average final score of 77.85 for the control class and 82.40 for the experimental class. These results indicate that the final average of the experimental class is higher than that of the control class. In addition, the hypothesis test using the Independent Sample T Test obtained a significance value of 0.017 (sig.  $< 0.05$ ), which means that  $H_a$  is accepted, or there is a significant difference in learning motivation between the experimental and control classes. Therefore, it is concluded that the project-based learning model has an effect on the science process skills and learning motivation of SMPIT Insan Mandiri Jagakarsa students in IPAS learning on the topic of environmental change.

**Keywords:** Project-Based Learning, Science Process Skills, Learning Motivation, Social and Science Learning

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## INTRODUCTION

The changing times have also driven ongoing transformations in the national curriculum, as seen in the replacement of the 2013 Curriculum with the Merdeka Curriculum. Implemented starting in the 2021/2022 academic year, this curriculum focuses on core material and competency development tailored to students' learning phases (Usman et al., 2022). According to (Rahmadayanti & Hartoyo, 2002), phases are defined as learning targets formulated based on students' character, potential, and needs. Learning outcomes are the minimum basic competencies that students must meet for a subject (Usman et al., 2022)

Based on the Decree of the Ministry of Education and Culture Number 008/H/KR/2022, IPAS learning outcomes consist of two main components: understanding science material and process skills. In the process skills component, students are expected to master several skills, such as making observations, formulating questions, making predictions, designing and carrying out investigations, processing and analyzing data, evaluating, reflecting, and communicating findings. These various skills are collectively known as science process skills. Therefore, it can be concluded that learning outcomes for the process skills element in Biology refer to mastery of science process skills.

Science process skills are defined as students' competencies to independently explore and discover scientific principles or knowledge through scientific methods and work steps (Mardianti et al., 2020). Mastery of these skills is crucial. (Wahyuni, 2016) states that science process skills help students understand and discover learning concepts. Furthermore, (Lestari & Diana, 2018) adds that through the science process, students can solve problems with a logical approach, which ultimately impacts their readiness for life in the present and the future. Results of international assessments show that the science process competency of Indonesian students remains at a worrying level. In the 2015 TIMSS study, Indonesia ranked 45th out of 48 countries in the field of science with a score of 297. Meanwhile, in the 2018 PISA assessment for science ability, Indonesia ranked 70th out of 78 countries with a score of 369. This achievement is significantly below the international average. Considering that the test items in TIMSS and PISA are mostly designed to measure science process skills (Rosyida & Nurita, 2018), it can be concluded that Indonesian students' mastery of this aspect is really weak.

This weakness is thought to be closely related to the implementation of a classroom learning model that places minimal emphasis on the process dimension, a finding also raised by (Qomariyah, 2015). Observational findings at SMPIT Insan Mandiri Jagakarsa reinforce this suspicion, indicating that the school's IPAS learning process is not geared toward honing science process skills. Although practical activities have been carried out, several key stages of scientific work—such as making predictions, interpreting data, and designing investigations—are often not implemented. According to (Himmah, 2021), the dominance of lecture methods that focus solely on the knowledge aspect further exacerbates the situation by under-motivating students during learning. Furthermore, the level of student motivation at the school is also suboptimal. The science teaching and learning process in eighth grade takes place in an unsupportive atmosphere, as evidenced by students' passivity, drowsiness, and lack of enthusiasm. The lack of innovation and engaging learning activities is suspected to be the underlying cause, given that (Siswanti, 2019) states that monotonous presentation of material has a high potential to reduce students' enthusiasm for learning. To address these issues and meet the needs of students at SMPIT Insan Mandiri Jagakarsa, an effective learning model is needed to improve science process skills and learning motivation. The project-based learning model is one recommended solution because it gives students the freedom to plan, implement, and produce learning products (Mahendra, 2017). Empirically, this model has been shown to influence junior high school students' science process skills (Anggriani et al., 2019) and contribute significantly to learning motivation (Nurrahman, 2017).

This model is considered to have the potential to develop science process skills because it is designed to achieve competencies encompassing skills, knowledge, and attitudes (Fathurrohman, 2015). During its implementation, students will engage in activities such as observation, problem formulation, project planning, concept application, tool use, data interpretation, and presentation of results (Rahmadayanti & Hartoyo, 2022), all of which are direct manifestations of science process skills. Furthermore, project-based learning also has the potential to increase learning motivation through two main mechanisms. First, this model opens up space for self-exploration (Insyasiska et al., 2017), which encourages students to be more active and proactive in building understanding (Yani, 2021). Second, this approach creates an engaging and enjoyable learning environment (Insyasiska et al., 2017), which directly correlates with increased learning motivation (Afrilia et al., 2022).

## LITERATURE REVIEWS

One key element of the education system is the curriculum. The Independent Curriculum initiative, initiated by Minister of Education and Culture Nadiem Anwar Makarim, is considered a progressive breakthrough to address today's educational challenges (Rahmadayanti & Hartoyo, 2022). This curriculum implements a new approach by combining science and social studies into a single integrated subject called Natural and Social Sciences (IPAS). This integration is based on the consideration that elementary school students generally view events holistically and comprehensively (Astuti, 2022) This view aligns with the developmental stage of children's thinking, which is still concrete, simple, holistic, and not yet focused on details (Purnawanto, 2022). Learning IPAS is one effort to improve students' abilities to understand and manage the natural and social environment in an integrated manner. The IPAS material is designed with the principles of ease of understanding, integration, and direct student involvement in the learning experience (Marwa et al., 2023). This T aims to encourage student activeness in exploring the social and scientific world. Through this integrated approach, it is hoped that students will be able to interact with and manage their social and natural environments wisely. As an integrated subject, science plays a crucial role in forming the foundation of students' understanding of various natural phenomena and social dynamics in their environment.

In the context of IPAS learning, a number of materials need to be presented using a combination of approaches, such as oral explanations, observations, experiments, and hands-on practical activities (Budiwati et al., 2023). This indicates the importance of using engaging learning models and media that encourage student activeness. Interactive learning models can increase student engagement, stimulate creativity, and foster their curiosity about the material being taught. However, in practice, IPAS learning is often dominated by the teacher and is text-based, leaving little room for active student participation. As a result, students easily become bored with monotonous and conventional teaching methods. A learning model to be implemented must be designed with two main aspects in mind: student needs and alignment with the material and learning objectives (Panjaitan, 2021). Observations show that the practice of IPAS learning at SMPIT Insan Mandiri Jagakarsa emphasizes theoretical aspects and provides less contextual support. However, some science material—for example, environmental change—is concrete in nature (Nimpun, 2016). This material raises current environmental issues that require solutions (Nirwana & Puspitawati, 2021). Official competency requirements also require students to be able to formulate solutions based on environmental issues at the local and global levels (Kemendikbud, 2022). With these characteristics, the project-based learning model is a relevant choice because of its ability to guide students to solve environmental problems around them (Lette & Kuntjoro, 2019).

## RESEARCH METHODOLOGY

### Type and Design

This study adopted a quantitative approach utilizing a quasi-experimental design with a pretest-posttest nonequivalent control group structure. The research population encompassed all eighth-grade students at SMPIT Insan Mandiri Jagakarsa for the 2025/2026 academic year. The sample comprised two intact classes: Class VIII-A (23 students) was assigned as the control group, and Class VIII-B (20 students) as the experimental group. Data on science process skills were collected using a written test instrument and an observation sheet, while data on learning motivation were gathered via a questionnaire. Data analysis involved both descriptive statistics and hypothesis testing. Hypothesis testing was conducted using the Independent Sample T-Test for parametric data or the Mann-Whitney U test for non-parametric data, with a significance level set at  $\alpha = 0.05$ . The influence of the project-based learning model on science process skills and learning motivation was considered statistically significant if the mean score of the experimental group was substantially higher than that of the control group.

### Data and Data Sources

The data for this investigation was drawn from the population of eighth-grade students at SMPIT Insan Mandiri Jagakarsa during the 2025/2026 academic year. The sampling process was conducted in the first semester of 2025, involving students enrolled in the IPAS (Ilmu Pengetahuan Alam dan Sosial/Science and Social Studies) subject. The study employed a purposive sampling technique, selecting two intact classes as the sample: Class VIII-A, consisting of 23 students, was designated as the control group, and Class VIII-B, with 20 students, served as the experimental group.

The initial sample consisted of 43 students. These participants were subsequently screened based on the study's design and methodological requirements. The core criterion for inclusion was their enrollment in the parallel eighth-grade classes following the standard school curriculum, ensuring group comparability. Students with extensive prior experience in specialized project-based learning programs or those with prolonged absences during the intervention period were considered for exclusion to maintain the integrity of the treatment effect. Following this procedure and accounting for the pre-established group assignments, a final sample of 43 students was confirmed for the quasi-experimental intervention and subsequent data analysis on science process skills and learning motivation.

### Data collection technique

This study employed a mixed-methods approach that integrated quantitative analysis of a quasi-experiment with qualitative analysis of students' science process skills and learning motivation. The primary objective of this methodology was to measure and explain the effect of implementing a project-based learning model on improving seventh-grade students' science process skills and learning motivation at SMPIT Insan Mandiri Jagakarsa in IPAS learning, using a constructivist theoretical framework and project-based learning (PBL) principles (Krajcik & Blumenfeld, 2006)

The initial stage involved instrument preparation and research design. The research instruments consisted of a science process skills test, a learning motivation questionnaire based on ARCS (Attention, Relevance, Confidence, Satisfaction) theory, and an observation guide. All of these instruments underwent expert validation and reliability testing (Cronbach's Alpha > 0.70) (Keller, 2010). The experimental class implemented a project-based learning model with the stages of driving questions, design and planning, artifact creation, and presentation, while the control class used conventional learning. This rigorous research protocol was designed to ensure that measurable impacts resulted from the learning model intervention, while controlling for confounding variables as much as possible (Creswell & Creswell, 2018). All research data, encompassing pre-test and post-test scores for science process skills, observation sheet results, and questionnaire responses for learning motivation, were compiled and

organized using Microsoft Excel for initial data management and compatibility across analysis platforms. The data was then processed utilizing IBM SPSS Statistics software for conducting descriptive statistical analysis and hypothesis testing. The Independent Sample T-Test and the Mann-Whitney U Test were employed to analyze the differences in outcomes between the experimental and control groups. The process and workflow of the study are systematically depicted through the research framework (see Figure 1), which illustrates the stages from sample selection and group assignment to intervention, data collection, analysis, and conclusion drawing regarding the influence of the project-based learning model.

### **Data analysis**

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- 1) Normality and Homogeneity Tests: A prerequisite for selecting appropriate inferential statistical tests (Pallant, 2020).
- 2) Paired Sample t-test and Independent Sample t-test: To test for significant gains in the experimental group and differences in final results between the experimental and control groups (Field, 2018).
- 3) Effect Size Analysis (Cohen's d): To measure the magnitude of the project-based learning model implementation on the dependent variable (Sullivan & Feinn, 2012).

The third stage involved a qualitative analysis of student activity observation data and semi-structured interview results, which were analyzed thematically, following (Braun & Clarke, 2006) framework. The purpose of this qualitative synthesis was to deepen our understanding of how the project-based learning process facilitates the development of observation, hypothesis-making, experimentation, and data interpretation skills, as well as the factors that influence students' intrinsic and extrinsic motivation (Bell, 2010; Llewellyn, 2013).

The results were visualized using score gain graphs, statistical comparison tables, and thematic analysis diagrams. Further analysis was conducted by mapping the relationships between emerging qualitative themes (such as collaboration, project challenge, and sense of ownership) and quantitative improvements in each indicator of science process skills and motivation (Miles

et al., 2014). This combined approach enabled data convergence and triangulation, providing a holistic and contextualized understanding of the impact of project-based learning.

Furthermore, descriptive analysis was conducted to group the findings based on the evolution of motivation and skill acquisition across project phases. This approach allows tracking the shift in student engagement from initial motivation driven by curiosity (attention) to sustained motivation driven by confidence and satisfaction with the results (confidence & satisfaction) (Krajcik & Czerniak, 2018). This combined methodology provides in-depth insights into the developmental pathways of both science competencies and students' affective states in project-oriented IPAS learning.

Overall, the results of this analysis are expected to provide empirical evidence regarding the effectiveness of project-based learning models within the context of the science curriculum at the junior high school level, as well as serve as an academic foundation for designing IPAS learning that simultaneously develops students' scientific skills and learning motivation (Han et al., 2015).

## RESEARCH RESULTS

The science process skills data in this study were measured through pretest and posttest results given to students in the control and experimental classes. A summary of descriptive statistics for the science process skills data from both groups is presented in Table 1.

Statistically, the pretest results for students' science process skills in the control and experimental classes showed a relatively small difference in average scores. The control class's pretest mean score was 48.12, while the experimental class's score was 44.85. On the other hand, the posttest results showed that the experimental class's science process skills mean was significantly higher than the control class. The control class's posttest mean was 51.35, while the experimental class's score was 79.15.

**Table 1** Descriptive Statistics Results of Process Skills Data

Statistic	Science Process Skill			
	Control Class		Experiment Class	
	Pretest	Posttest	Pretest	Posttest
N (Number of Sample)	23	23	20	20
Mean	48.12	51.35	44.85	79.15
Median	46.50	52.00	45.00	80.50
Modus	48	54	45	81
Deviation Standard	12.415	11.728	11.902	7.842
Variation	154.136	137.550	141.661	61.488
Minimum Score	26	29	21	63
Maximum Score	74	80	70	94

To test the significance of these differences, this study conducted a hypothesis test. Because the science process skills data were not normally distributed, the analysis used the nonparametric Mann-Whitney U test. In this test, the null hypothesis ( $H_0$ ) is accepted if the significance value is greater than 0.05 and rejected if it is less than 0.05. The complete results of the hypothesis test for the science process skills data can be seen in Table 2.

**Tabel 2** Result of Mann Whitney U Test of Science Process Skill Data

<b>Statistik</b>	<b>Pretest</b>	<b>Posttest</b>
<i>Sig. (2-Tailed)</i>	0,315	< 0,001
Result	H <sub>0</sub> accepted	H <sub>0</sub> rejected

Based on the analysis using the Mann-Whitney U test, the significance value for the science process skills data at the initial stage of learning was 0.315. Because this value exceeds 0.05, the null hypothesis (H<sub>0</sub>) is accepted. This indicates that there is no significant difference in science process skills between students in the control and experimental classes before the intervention is administered.

On the other hand, the significance value at the end of the learning period is less than 0.001 (<0.001). Because this value is less than 0.05, H<sub>0</sub> is rejected and the alternative hypothesis (H<sub>a</sub>) is accepted. Thus, it can be concluded that there is a significant difference in science process skills between the two groups after the intervention is implemented.

In addition to tests, the science process skills data in this study were also strengthened by observations. Observations were conducted by two observers using a structured observation sheet to increase measurement accuracy. The results were then converted to a score scale of 1-100. The complete observation data for the science process skills of students in the control and experimental classes can be seen in Table 3.

**Tabel 3** Observation Result of Student' Science Process Skill

<b>No</b>	<b>Science Process Skills Indicator</b>	<b>Average Observation Score of Control Class</b>	<b>Average Observation Score of Experimental Class</b>
1	Observing	60	86
2	Classifying	86	96
3	Questioning	35	100
4	Predicting	64	80
5	Designing an Experiment/ Investigation	20	86
6	Using Tools/Materials	49	97
7	Interpreting	48	87
8	Communicating	48	96
<b>Overall Average</b>		51	91

Analysis of Table 3 reveals a disparity in achievement between the two groups. The experimental class' average observation score of 91 was significantly higher than the control class' score of 51. These results provide empirical evidence that the intervention in the experimental class was more effective in improving students' science process skills.

Data on learning motivation was collected by distributing questionnaires before and after the learning process. The results of the descriptive statistical analysis of the questionnaire data for both sample groups are presented in Table 4.

**Table 4** Descriptive Statistics Results of Learning Motivation Data

Statistic	Motivasi Belajar			
	Control Class		Experiment Class	
	Initial	End	Initial	End
N (Number of Sample)	23	23	20	20
Mean	75.70	77.85	76.00	82.40
Median	79.00	78.00	78.50	82.00
Modus	80	70	77	83
Deviation Standard	5.842	5.123	6.215	4.318
Variation	34.131	26.249	38.621	18.642
Minimum Score	65	68	64	74
Maximum Score	89	88	90	92

At the beginning of the learning phase, the average learning motivation between the control class (75.70) and the experimental class (76.00) did not show a significant difference. However, at the end of the learning phase, the experimental class' learning motivation increased to 82.40, while the control class only reached 77.85. The distribution pattern of learning motivation scores for both classes is visualized in the attached figure.

Hypothesis testing was conducted to analyze the significance of these differences. Assuming the data were normally distributed, the Independent Sample T-Test method was applied. The decision-making criteria were based on the significance value:  $H_0$  was accepted if  $\text{sig.} > 0.05$  and rejected if  $\text{sig.} < 0.05$ . The complete analysis results are listed in Table 5.

**Table 5** Independent Sample T-Test Results for Learning Motivation Data

Statistic	Initial	End
<i>Sig. (2-Tailed)</i>	0,742	0,017
Result	$H_0$ accepted	$H_0$ rejected

Based on the results of the Independent Sample T-Test, the significance value for learning motivation data at the beginning of the lesson was 0.742. Because this value is greater than 0.05, the null hypothesis ( $H_0$ ) is accepted, meaning there was no significant difference in learning motivation between students in the control and experimental classes before the intervention was implemented.

On the other hand, the significance value at the end of the lesson was 0.017. This value is less than 0.05, so  $H_0$  is rejected and the alternative hypothesis ( $H_a$ ) is accepted. This indicates a significant difference in learning motivation between the two groups after the learning process was completed.

The project-based learning model is effective in developing science process skills because it integrates scientific activities into the learning steps. According to (Rahmadani & Albeta, 2018), students engage in observation, planning, application of concepts, and communication during project work. Its influence on science process skills can be analyzed through six learning syntaxes (The George Lucas Educational Foundation, 2005): defining a fundamental question, designing a project, developing a schedule, monitoring progress, testing results, and evaluating. In the first syntax (determining basic questions), students in the experimental class honed their observation, classification, and questioning skills through observation activities, which were then developed into research questions. This was not optimal in the control class, so the observation results for these three aspects were higher in the experimental class. Observation skills are known to be the most easily developed ability (Zeidan & Jayosi, 2015) and serve as the foundation for developing classification and questioning skills (Bahriah et al., 2017).

The second syntax, project design, involves two science process skills: experiment/investigation planning and prediction. In this study, students in the experimental class were directed to design a project by gathering information related to the topic, materials, and procedures, and were asked to predict possible outcomes. Prediction activities were intentionally integrated to develop students' predictive skills. This aligns with the view (The George Lucas Educational Foundation, 2005), which states that the design stage focuses on selecting activities that support the resolution of fundamental questions. (Bahriah et al., 2017) also emphasized that prediction skills can be developed in this syntax. On the other hand, students in the control class did not systematically engage in experiment planning or prediction activities. Therefore, the observed results for both skills in the experimental class were significantly higher than in the control class. This finding is consistent with the results of research (Okta Fitriyani, 2018), which concluded that the prediction and experiment planning skills scores in classes using project-based learning models were superior to those in classes using conventional learning. In the third syntax, namely scheduling, students in the experimental class collaborated with the instructor to develop a project implementation schedule. This scheduling aimed to ensure the project's implementation was effective and efficient. Through this syntax, students' skills in planning experiments or investigations improved. As stated by (Irwansyah, 2019), the scheduling stage provided students with experience in organizing projects, particularly in allocating time and determining the equipment and procedures needed to complete a task. This syntax was only applied to the experimental class, resulting in superior experimental planning skills in this group compared to the control class. This was demonstrated through the observation results presented in Table 3. These findings align with research (Okta Fitriyani, 2018), which showed that the average observation score for experimental planning skills in classes using the project-based learning model was higher than in classes using conventional learning.

In the fourth syntax, namely project progress monitoring, students in the experimental class were responsible for implementing the project according to the established plan. During implementation, students actively used various tools and materials. This is in line with the opinion (Bahriah et al., 2017) who stated that in project implementation, students are required to be able to use tools and materials according to the correct functions and procedures. Thus, this syntax can improve students' skills in using tools and materials. Strengthening of this finding was obtained from the results of observations of science process skills conducted. Based on Table 3, the ability to use tools and materials of students in the experimental class was proven to be better than the control class.

In the fifth syntax, namely testing the results, students in the experimental class communicated the project results through presentation activities. After completing the project, they were directed to systematically present their findings, while students in the control class did not engage in optimal communication activities. Communicating results is part of science process skills (Rustaman, 2007). Therefore, the average observational communication skills of students in the experimental class were higher than those in the control class. These results align with research (Okta Fitriyani, 2018), which also found that the average observational communication skills in project-based classes were superior to those in conventional classes.

In the sixth syntax, namely evaluating experiences, students in the experimental class were guided to connect data, identify patterns in observations, and draw conclusions based on the project activities they had completed. These activities are part of the interpretation sub-indicator within science process skills (Rustaman, 2007). Observations showed that the interpretation skills of students in the experimental class were better than those in the control class. This finding is supported by research (Okta Fitriyani, 2018), which also stated that interpretation ability scores in classes using a project-based learning model were superior to those using conventional learning.

The implementation of a project-based learning model has a dual impact on students, both internally and externally, thereby stimulating intrinsic and extrinsic motivation. According to (Ernata, 2017), learning motivation is divided into two types: intrinsic and extrinsic. Therefore, this model can increase students' overall learning motivation, which aligns with the statement (Istianah & Sy, 2022) that one of the advantages of project-based learning is increased learning motivation.

The project-based learning model can stimulate students' intrinsic motivation. The first syntax in this study encourages students to observe and formulate questions. These two activities stimulate curiosity, which, according to (Azis, 2017), is a source of intrinsic motivation. During the project design stage, students are also given the freedom to design projects independently. According to (Ernata, 2017), an atmosphere of freedom and responsibility is more effective in fostering intrinsic motivation than an atmosphere full of coercion.

On the other hand, this model is also capable of building extrinsic motivation. From the first sentence to the last, students are given the freedom to take initiative and engage in interesting and enjoyable activities, in line with the opinion (Istianah & Sy, 2022), who stated that PjBL can create a pleasant learning atmosphere. Engaging and enjoyable learning can increase student motivation (Afrilia et al., 2022). Specifically, in the project progress monitoring syntax, students are encouraged to complete the project successfully because good results will result in good grades, thus fostering extrinsic motivation. (Azis, 2017) explains that extrinsic motivation focuses on achieving good grades to receive awards or praise. During the results testing phase, students are responsible for presenting project results, while the instructor provides feedback and praise. Timely praise can be an effective motivational trigger (Azis, 2017).

## DISCUSSION & CONCLUSION

Based on data analysis, it can be concluded that the project-based learning model has an influence on the science process skills of students of SMPIT Insan Mandiri Jagakarsa on environmental change material. This is evidenced by the higher average posttest score of the experimental class compared to the control class, as well as the Mann Whitney U hypothesis test which shows a significance of 0.000 (sig. <0.05), indicating a significant difference between the two groups. In addition, the project-based learning model also has an influence on student learning motivation, which can be seen from the higher final average of the experimental class and the results of the Independent Sample T-Test with a significance of 0.742 (sig. <0.05), confirming a significant difference in learning motivation between the experimental and control classes.

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