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Improving Students' Science Process Skills Through PjBL Learning Assisted by Collaborative Project LKPD

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Abstract

This research aims to enhance students' science process skills in static electricity through the implementation of Project-Based Learning (PjBL) model aided by Collaborative Project Worksheets. The research method employed is Classroom Action Research. The research subject comprises 24 ninth-grade students from SMP Negeri 1 Jereweh. The results indicate a significant improvement in students' science process skills from the first cycle to the second cycle, with an average increase of 30.6%. The implementation of the PjBL model with LKPD has also proven effective in enhancing student engagement in learning and facilitating the development of social skills. Recommendations for further research include expanding the scope of study, deepening understanding of factors influencing the implementation of the model, and exploring its effects on other aspects of learning such as student motivation and mastery of concepts. This research provides valuable insights into the potential and benefits of the PjBL approach with LKPD in enhancing the effectiveness of learning in schools. Thus, through this approach, it is hoped to create a more dynamic learning environment focused on comprehensive student skill development..

Keywords: Science Process Skills, PjBL, LKPD, Collaborative Projects

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INTRODUCTION

The importance of science process skills plays a crucial role in enhancing students' abilities across various aspects such as observation, hypothesis formation, data collection, information analysis, and inference based on empirical evidence. Studies by (Asmawati et al. 2017;Hunaepi et al. 2021) underscore the significance of these skills in the context of learning. Science process skills not only confine to the realm of science education but also contribute to the development of students' critical thinking, logic, and problem-solving abilities (Huliadi, 2021; Purnawati et al., 2020). Through observation, hypothesis formation, data collection, information analysis, and inference based on empirical evidence, students cultivate critical thinking, logic, and essential problem-solving skills (Çakiroğlu et al., 2020; González-Pérez & Ramírez-Montoya, 2022). Therefore, it's imperative for education to adequately address the development of these skills within the curriculum and instructional practices.

Asyari elucidates that Science Process Skills (SPS) manifest science as a process (Asy'ari et al., 2019). This implies that in science education, the focus should not solely be on the end result or the knowledge students acquire but also emphasizes the process through which students obtain that knowledge.

Observations across various educational landscapes indicate that science process skills are often taught separately from core content, resulting in shallow understanding and difficulty in applying knowledge contextually. Hence, a comprehensive approach is required to integrate these skills into student learning. A similar situation exists at SMP Negeri 1 Jereweh, where students' science process skills are still relatively low. This is attributed to teaching processes that haven't prioritized science process skills as a main component of learning outcomes. Additionally, instructional materials, especially in formulating learning objectives, have not explicitly formulated indicators of science process skills. Therefore, there is a need to enhance the integration of science process skills into learning so that students can develop a deeper understanding and apply knowledge contextually in various situations.

The Project-Based Learning (PjBL) model has emerged as a robust strategy for teaching science process skills (Firdaus & Asmali, 2021; Milla et al., 2019; Nurhidayah et al., 2021; Safaruddin et al., 2020; Wijanarko et al., 2017). PjBL immerses students in real-life projects, requiring the application of these skills in substantial contexts. Although promising, practical implementation of PjBL requires structured guidance for optimal results.

Previous research on PjBL has identified its effectiveness in enhancing science process skills. However, integrating Collaborative Project Worksheets within PjBL can further sharpen students' acquisition of these skills. The innovative approach proposed in this article combines PjBL with LKPD designed through collaborative projects, aiming to provide clearer guidance for educators and learners in developing science process skills. This combination introduces a more contextual aspect to PjBL, potentially enhancing its effectiveness.

This research aims to improve students' science process skills in static electricity material by implementing the Project Based Learning (PjBL) model assisted by Collaborative Project Student Worksheets. indicators of goal achievement are improving students' Science Process Skills (KPS), increasing teacher and student activity during the learning process. By examining the approach design, implementation results, and its impact on skills development, this research aims to contribute to enriching a more integrated and holistic educational methodology..

Drawing insights from various studies, it is evident that instructional strategies such as inquiry, experiments, project-based learning, and models such as guided inquiry and cooperative learning significantly enhance science process skills. These skills not only improve cognitive development but also motivate learning and can be enhanced through active learning models such as guided inquiry. The use of scientific-based learning modules and the integration of STEAM projects have also been highlighted as effective in improving skills. The synergy between STEM/STEAM methodologies and PjBL has been proven to enhance critical thinking, creativity, and cognitive outcomes. Focused research shows the potential of PjBL in improving not only academic achievement but also collaborative work, active engagement, and practical knowledge application. Customized LKPD, such as those on renewable energy, play a crucial role in effectively mastering science process skills.

Collective findings from studies conducted by Alawi & Soh (2019); Bhakti et al. (2020); Mulyani et al. (2020); Pitaloka et al. (2021); Syukri et al. (2021) provide strong support for the positive impact of Project-Based Learning (PjBL) on students' science process skills, creative thinking, learning motivation, and educational achievement. Through PjBL integration, students engage in authentic projects that strengthen their science literacy and problem-solving abilities, marking a significant step towards comprehensive educational experiences.

Based on these findings, the objective of this research is to enhance students' science process skills through the implementation of Project-Based Learning (PjBL) aided by Collaborative Project Worksheets. It is hoped that through this approach, students will be able to develop their science process skills holistically while enhancing creative thinking, learning motivation, and overall academic achievement.

METHOD

This study employs Classroom Action Research (CAR) by implementing the Project-Based Learning (PjBL) model aided by Collaborative Project Worksheets. The aim is to enhance students' Science Process Skills in the topic of Static Electricity. The research subjects consist of 24 ninth-grade students from SMP Negeri 1 Jereweh. The topic utilized is Static Electricity within the Science subject.

The CAR in this study follows a spiral model developed by (Stephen et al., 2013). Kemmis's planning involves a reflective spiral system starting with action planning, action, observation, and reflection. This cycle is referred to as problem-solving activities. If no improvement is observed after one cycle, the research proceeds to the second cycle and beyond. However, if the targets in the first cycle are achieved, the research can be concluded.

Data sources include teachers, students, classroom events, documents, and assessment of SPS projects. Data collection employs both test and non-test techniques. Science process skills are evaluated using project assessment rubrics, while teachers and students observe activities using observation sheets. SPS assessments are conducted at the end of cycles I and II to assess the teaching actions' impact on SPS.

Analysis in CAR begins after cycle I. Field research data are analyzed qualitatively, utilizing descriptive analysis to calculate the percentage of correct answers to each question and provide a clear overview of the learning process, implementation, and student performance. Qualitative analysis techniques include data reduction, presentation, conclusion drawing, and verification. Success indicators include increased student activity and SPS.

RESULTS AND DISCUSSION

The overall results of the study indicate success, based on several indicators. Firstly, there was an increase in teacher activity from cycle I to cycle II, as well as an improvement in student activity during the learning process. Another indicator is the students' science process skills, where in cycle I, the average score reached 55.4 with the category "enough", while in cycle II it reached 86 with the category "lofty", showing an increase of 30.6%. This improvement demonstrates that the PjBL learning model supported by project-based CPWs can enhance students' science process skills.

A. Results of Teacher Activity Observation during the Learning Process

In the initial phase of the cycle process, there was an observation sheet for teacher activity consisting of 13 observation aspects, with each aspect having three assessment criteria. In this evaluation, two observers observed teacher activities during the learning process adopting the Project-Based Learning (PjBL) model with collaborative Project Participant Worksheets (CPWs) support.

Table 1. Results of Teacher Observation Data Analysis

Cycle	Observer I	Observer 2
I	29	30
II	30	31
Amount	59	61
average	29.5	30.5
Amount	**60**	
Average value	**30**	
Assessment Category	**Enough**	

The data from Table 1 reflects the observations made during cycle I, conducted by two observers in two sessions on teacher activities. In the first meeting of cycle I, the first observer gave a score of 29, and the second observer gave a score of 30, while in the second meeting, the scores given were 30 and 31 respectively. Thus, the average score for cycle I is 30 for the first observer and 30.5 for the second observer, which falls into the "Sufficient" category with a score range between 22 to 30. Based on these observation results, several aspects demonstrated good performance in cycle I. These include effective implementation of preconception by providing relevant questions based on students' experiences to enhance motivation and understanding, as well as the formation of groups that consider student diversity.

The distribution of collaborative Project Participant Worksheets (CPWs) to each group was also done clearly. Furthermore, the evaluation of the learning process has been applied using performance evaluation rubrics on the CPWs. However, there are still some aspects that require improvement. One of them is the lack of clarity in conveying the learning objectives using the PjBL model aided by collaborative CPWs. Additionally, the lack of opportunities for students to express opinions or responses in solving problems within the group is also a concern that needs to be addressed.

B. Results of Student Activity Observation during the Learning Process

In the first cycle, the student activity observation sheet covered 13 observation aspects, with each aspect having three assessment criteria. The learning process was evaluated through observations conducted by two observers on student activities during the implementation of learning using the PjBL model with the support of Collaborative Project Participant Worksheets (CPWs).

Table 2. Results of Student Observation Data Analysis

Cycle	**Observer I**	**Observer 2**
I	29	29
II	30	30
Amount	59	59
average	29.5	29.5
Amount	**59**	
Average value	**29.5**	
Assessment Category	**Enough**	

Based on the data presented in Table 2, the observation results of student activities in Cycle I were conducted by two observers across two sessions. In the first session, the first observer gave a score of 29, and the second observer gave a score of 29. In the second session, the first observer's score was 30, while the second observer's score was also 30. The average score for Cycle I by the first observer was 29.5, and by the second observer was 29.5. Thus, the average score for Cycle I was 29.5, falling within the "Sufficient" category.

From the observations conducted by two observers, several aspects of student activities in Cycle I appeared to proceed well. These aspects included student responses to the teacher's introductory activity, grouping of students for learning purposes, group work presentations, and student responses to individual tests administered by the teacher. However, there were some aspects that could be improved. For instance, there was a lack of student understanding of the learning objectives, low motivation in engaging with the learning material, and limited participation in completing Student Activity Sheets (SAS) and listening to teacher explanations. There were also challenges in verbally summarizing lesson materials and insufficient student responsiveness to the teacher's messages. Therefore, there is still a need for improvement in several areas to enhance the effectiveness of student learning. The implementation of learning activities proceeded according to the developed scenario, both during material presentation and group project practice.

C. Results of Science Process Skills Analysis

The analysis of science process skills indicates a significant improvement from Cycle I to Cycle II. In Cycle I, the average science process skills of students reached 55.4, categorized as "enough," whereas in Cycle II, it increased to 86, categorized as "lofty," indicating a 30.6% improvement. This demonstrates that the implementation of the PjBL learning model supported by project-based LKPD effectively enhanced students' science process skills. The improvement is evident in students' abilities to observe, formulate questions, plan and conduct experiments, utilize tools and materials effectively, as well as analyze and draw conclusions based on empirical evidence. Thus, it can be concluded that this learning approach has a significantly positive impact on the development of students' science process skills.

Table 3. Results of Science Process Skills Analysis

Aspects of Science Process Skills	**Cycle**		**Enhancement %**
	I	**II**	
Observe	54	89	35
Asking question	55	89	34
Planning an Experiment	56	80	24
Using Tools and Materials	57	90	33
Communicate	55	82	27
Average	**55,4**	**86**	**30,6**
Qualification	**Enough**	**Lofty**	

The data illustrate the development of various aspects of science process skills from Cycle I to Cycle II. There is a significant improvement in each aspect, such as observation, questioning, experiment planning, using tools and materials, and communication. For example, the improvement in observation skills increased from 54% in Cycle I to 89% in Cycle II, indicating a significant increase of 35%. This increasing trend consistently occurs in all dimensions, albeit with varying rates of improvement.

The percentage increase averages across all aspects, reaching 30.6%. This average signifies an overall positive trend in the enhancement of observed science process skills throughout the cycles. The implementation of the PjBL model supported by Collaborative Worksheets proves effective in enhancing student engagement in the learning process. This approach ensures not only active student participation but also fosters cooperation among group peers during project work, contributing to social and collaborative skill development.

As students engage in the learning process (Figure 1), they demonstrate increased confidence in presenting their projects. This indicates that an instructional approach involving active student participation in project creation can enhance their confidence. By providing students with opportunities to present their work, they can refine their public speaking skills and evaluate their understanding of the material.

Figure 1. Completing Collaborative Projects

The inclusive teaching approach is among the other benefits of the PjBL model with Collaborative Worksheets. By acknowledging differences in students' abilities, intelligence, and backgrounds, teachers can create an inclusive learning environment. This ensures that every student has an equal opportunity to learn and develop according to their individual potential (Eksi, 2004; Maulana, 2020)

Based on the cited research findings, it can be concluded that the PjBL model with Collaborative Worksheets has a positive impact on developing students' science process skills. These findings indicate that the implementation of this model can improve student learning outcomes and significantly stimulate and develop their science process skills. Therefore, the PjBL model with Collaborative Worksheets emerges as a promising instructional approach to enhance learning effectiveness in schools (Kurniawati et al., 2021).

The implementation of Project-Based Learning (PBL) oriented towards Character and Professional Ethics Development (CEP) with the assistance of Electronic Student Worksheets (e-LKPD) has a positive impact on students' science process skills. Through this approach, students are not only encouraged to understand scientific concepts but also guided to develop the character and professional ethics necessary in the field of science and technology. Meanwhile, the application of the Project-Based Learning model has a significant influence on the development of science process skills in the topic of force and motion among students. Through this approach, students not only gain a deeper understanding of force and motion concepts but also actively engage in the process of exploration, observation, experimentation, and scientific communication (Baho et al., 2022).

The implementation of the PjBL model allows students to learn through direct and contextual experiences, where they have the opportunity to apply their knowledge in real-life situations. In this regard, students not only become passive information receivers but also active knowledge creators involved in creating projects relevant to the subject matter. Thus, through the PjBL model, students can develop science process skills such as observation, formulating research questions, planning and conducting experiments, using tools and materials effectively, and communicating their research findings clearly and systematically.

Furthermore, through collaboration in learning projects, students can also develop important social and teamwork skills in a scientific context. They learn to work in teams, share ideas, solve problems, and achieve goals together, all of which are essential aspects of science process skills. This PjBL model not only helps students better understand scientific concepts but also equips them with relevant skills and knowledge to face challenges in the fields of science and technology in the future.

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CONCLUSION

The conclusion of this study is as follows: the results of observing teacher activities in cycle I, conducted by two observers in two sessions, showed that the average score for cycle I was 30 for the first observer and 30.5 for the second observer, categorized as "Fair". Although some aspects of student activities in cycle I showed good performance, there were still several aspects that needed improvement, such as clarity in conveying learning objectives and student involvement in completing Student Worksheets (LKS). Data analysis also indicated a significant improvement in science process skills from Cycle I to Cycle II, with an average increase of 30.6%. The implementation of the PjBL model with Collaborative LKPD proved effective in increasing student engagement in learning science, specifically static electricity topics, and helping students develop science process skills holistically. Therefore, this approach not only aids students in understanding scientific concepts but also prepares them to face challenges in the fields of science and technology in the future.

RECOMMENDATIONS

Recommendations for future research include expanding the scope of the study by involving more schools and classes. This would provide a broader understanding of the effectiveness of the Project-Based Learning (PjBL) model using Collaborative Student Worksheets (LKPD) in improving students' science process skills. Additionally, future research could delve deeper into understanding the factors influencing the implementation and effectiveness of the model, including the influence of school context and teacher characteristics. Furthermore, future studies could broaden their focus to explore the impact of the PjBL model with Collaborative Project Worksheets on other aspects of learning, such as student motivation, conceptual mastery, and character development. Thus, future research is expected to provide a more comprehensive and in-depth insight into the potential and benefits of this instructional approach in the current educational context.

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