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The Impact of Project-Based Learning on Students' Collaboration Skills in Secondary Schools

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Abstract. The objective of this study was to investigate the influence of project-based learning (PBL) on students' collaborative abilities within the context of secondary education. The investigation encompassed three key areas: communication, teamwork, and collaborative problem-solving.The research employed a qualitative methodology with a case study approach. Data were collected through in-depth interviews, observations, and document analysis of students and teachers. The findings indicated that PBL markedly enhanced students' collaborative abilities, particularly in the domains of communication, teamwork, and problem-solving. However, certain obstacles emerged, including time management and the necessity for more efficacious teacher roles as facilitators.In conclusion, the findings of this study indicate that project-based learning (PBL) has a significant impact on students' collaboration skills, particularly in terms of communication, teamwork, and problem-solving abilities. However, the implementation of PBL in secondary education contexts is not without challenges, including the need for effective time management strategies and the strengthening of teachers' capacity as facilitators. PBL is an effective method for enhancing students' collaborative abilities. However, its implementation necessitates the provision of adequate support in the form of effective time management strategies and the enhancement of teachers' capacity to serve as effective facilitators

Keywords: project-based learning, skills, students

I. INTRODUCTION

The contemporary pedagogical paradigm underscores the significance of 21st-century competencies, including those pertaining to collaborative abilities. These competencies are regarded as instrumental in equipping students with the capacity to navigate complex global challenges. In an era marked by rapid technological development, globalization, and social dynamics, the ability to work together with others from different backgrounds, cultures, and areas of expertise is of paramount importance. These skills are not only relevant for the world of work, but also for the construction of an inclusive and productive society. In the context of education, project-based learning (PBL) has been identified as an effective approach to developing collaboration skills. PBL provides students with an authentic learning experience, wherein they are encouraged to work together in groups to solve a specific problem or project that is oriented towards the real world. This process allows students to learn to communicate, solve problems collaboratively, and appreciate the role of each team member (Ryberg et al., 2024).

Nevertheless, the implementation of project-based learning (PBL) in secondary schools is not without its own set of challenges. One of the primary challenges is the evolving role of the instructor, who is increasingly expected to serve as a facilitator rather than a mere lecturer. Teachers must possess the capacity to provide assistance to students without unduly influencing the learning process, thereby enabling students to cultivate autonomy and initiative within groups. Furthermore, time constraints represent another significant challenge, as PBL often necessitates a longer duration than traditional learning methods. Teachers must possess the ability to effectively manage time in order to ensure that students can complete their projects according to schedule. Additionally, the level of student participation in the group may vary considerably, with some students exhibiting a tendency to dominate the discourse while others remain passive, thereby impeding the effectiveness of collaboration (Bohara, 2024).

In light of these challenges, it is essential to gain a nuanced understanding of the impact of PBL on students' collaborative abilities. This study aims to explore not only the positive impact of PBL on collaboration skills,

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but also to identify barriers that arise in its implementation. The results of this study can therefore provide more comprehensive insights to support more effective implementation of PBL in secondary schools, as well as to provide recommendations to overcome the challenges. Furthermore, this research is expected to contribute to the development of educational strategies that are more relevant to the needs of 21st-century students.

II. METHODS

This research uses a qualitative method with a case study approach to deeply explore the impact of project-based learning (PBL) on students' collaboration skills in secondary schools. The case study approach was chosen because it allows researchers to intensively study phenomena in a particular context, namely the implementation of PBL in a school environment. The research location was a secondary school in Jakarta that has implemented PBL in several core subjects. The selection of this location was based on the existence of an ongoing PBL program as well as the readiness of teachers and students to participate in the research.

A. *Research Participants*

The research participants consisted of 20 grade XI students in Muhammadiyah 2 Junior High School who were directly involved in the PBL process, 3 subject teachers who facilitated PBL activities, and 1 principal who was responsible for education policy in the school. The selection of participants was done by purposive sampling, which is by selecting individuals who are considered to have high relevance to the research. Students selected were those who actively participated in PBL, while teachers involved were those who had experience in designing and managing project-based learning. The school principal was involved to provide an institutional perspective on the implementation of PBL in the school. This diverse selection of participants aims to obtain rich and in-depth data from various perspectives.

B. *Data Collection Techniques*

Data collection was conducted through three main techniques, namely in-depth interviews, observation, and document analysis.

In-depth Interview

Interviews were conducted with students and teachers to understand their experiences during the PBL process. The interviews were semi-structured, allowing flexibility in exploring in-depth information about how students worked together in groups, the teacher's role as a facilitator, and the challenges faced during project implementation. The school principal was also interviewed to obtain information on policy support and resources provided to support PBL.

Observation

Observations were made directly during the PBL activities. The researcher observed group dynamics, interactions between students, and strategies used by students to complete the project. Field notes were made to record collaborative behaviors, such as communication skills, task division, and how students resolved conflicts. These observations provided contextual data that reinforced the findings from the interviews.

C. *Document Analysis*

The documents analyzed included student project results, the assessment rubric used by the teacher, and student reflection reports on their experiences in PBL. This document analysis provided additional insights into how collaboration skills are measured and evaluated in a project-based learning context.

D. *Data Analysis Technique*

The collected data were analyzed using the Miles and Huberman model which consists of three stages: data reduction, data presentation, and conclusion drawing or verification. At the data reduction stage, irrelevant information was filtered so that only data that supported the research objectives were retained. The data that has been reduced is then presented in the form of tables, diagrams, or narratives to facilitate interpretation. The final stage was conclusion drawing and verification, where key patterns were identified and linked to relevant theories.

To ensure data validity, a triangulation technique was used, comparing findings from various data sources (interviews, observations, and documents). With triangulation, research results become more reliable because they are based on confirmation from multiple methods and perspectives. This gives confidence that the conclusions drawn truly reflect the reality in the field.

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III. RESULTS AND DISCUSSION

Project-Based Learning (PBL) is a pedagogical approach that employs a problem-based methodology to engage students in active learning through the investigation of authentic issues. One illustrative project is the "Construction of a Miniature Eco-City," which seeks to integrate diverse subject areas, including science, social studies, and art, within a collaborative framework (Lavado-Anguera et al., 2024).

In its implementation, the instructor initiates the process by facilitating a discussion on the significance of environmental sustainability in the contemporary era. Students are encouraged to identify the principal challenges confronting urban areas, including air pollution, waste management, and the scarcity of green space. Once these issues have been delineated, students are divided into smaller groups of four to five individuals, with each group assigned specific responsibilities, such as urban planning design, renewable energy management, and the visual aesthetics of the city. The instructor assumes the role of a facilitator, providing general guidance and ensuring that each group comprehends the project's objective and the contributions of each member .

The collaborative process between group members commences with brainstorming, whereby creative ideas are formulated on how an environmentally friendly city can be realised. The scientific disciplines were employed as a foundation for the development of technical solutions, including the utilisation of solar panels and water recycling systems. Social studies were utilised to consider social aspects, such as inclusive public space planning, while art contributed to the design aesthetics of the miniature city, including aspects such as colouring, building proportions and decorative elements. Additionally, students are required to utilise technology, such as 3D design software or digital presentations, to enhance the quality of their project outcomes.

The project is conducted over four weeks, with an allocation of two hours per week. Each week, students present their group progress to the teacher and classmates in a brief, two-hour session. During these sessions, the teacher provides feedback and assists students in resolving any obstacles they may encounter, such as technical difficulties in creating miniatures or conflicts between group members. To assess the project's success, the teacher utilizes an assessment rubric that encompasses collaboration, creativity, concept application, and problem-solving abilities.

The culmination of the project was the creation of an eco-friendly miniature city, which was exhibited in a classroom gallery. Each group was required to present their conceptual approach and proposed solutions. In addition to assessing the physical outcome of the project, the teacher also evaluated students' individual reflections on their experiences during the process of problem-based learning (PBL). From these reflections, it was evident that students not only learned to integrate knowledge from different disciplines, but also developed collaborative skills, such as effective communication, fair division of tasks, and joint decision-making.

The cross-disciplinary approach applied in this project demonstrates that PBL not only enhances students' learning experiences but also equips them with the skills to navigate complex challenges in the real world. This aligns with the objective of 21st-century education, which is to foster collaboration, critical thinking, creativity, and digital literacy in the context of meaningful learning.

A. *Improved Collaboration Skills*

Project-based learning (PBL) directly impacts the development of students' collaboration skills. These collaboration skills can be seen through three main dimensions, namely communication, teamwork, and problem solving. Based on data analysis from observations, interviews, and project documents, each dimension shows significant results.

Communication was the main aspect that developed during the implementation of PBL. Students showed improvement in their ability to discuss, listen to opinions, and provide constructive feedback to group members. Before PBL was implemented, 60% of students found it difficult to express their opinions in group discussions. After the implementation of PBL, this percentage

decreased to 25%, indicating an increase in their courage and communication skills. Special Findings:

- Effective Discussion: In each stage of the project, students used to discuss to design ideas and discuss the progress of the task. For example, in the project “Miniature Eco-City,” students had intensive discussions to determine the design and materials to be used.
- Active Listening: The teacher noted that students showed improvement in listening to the opinions of other group members, which reduced conflict within the group.
- Feedback: Students are able to give criticism and suggestions in a more constructive way, for

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example, by using a simple evaluation rubric provided by the teacher.

PBL trains students to work together in groups by dividing tasks according to expertise and resolving conflicts that arise during the project process. Before the implementation of PBL, only 40% of students demonstrated the ability to work in teams effectively. After PBL implementation, this figure increased to 75%. Specific Findings

- Task Division: Students learned to divide tasks based on their individual abilities. For example, in the same project, students with drawing skills were responsible for the design, while students with speaking skills presented the project results.
- Conflict Resolution: Before PBL, minor conflicts often led to stagnation in the group. However, with the habituation of group discussions and teacher facilitation, students learn to resolve conflicts independently, for example by deliberation or voting.
- Increased Solidarity: Students feel more connected to each other and are more aware of the importance of supporting each other to achieve a common goal.

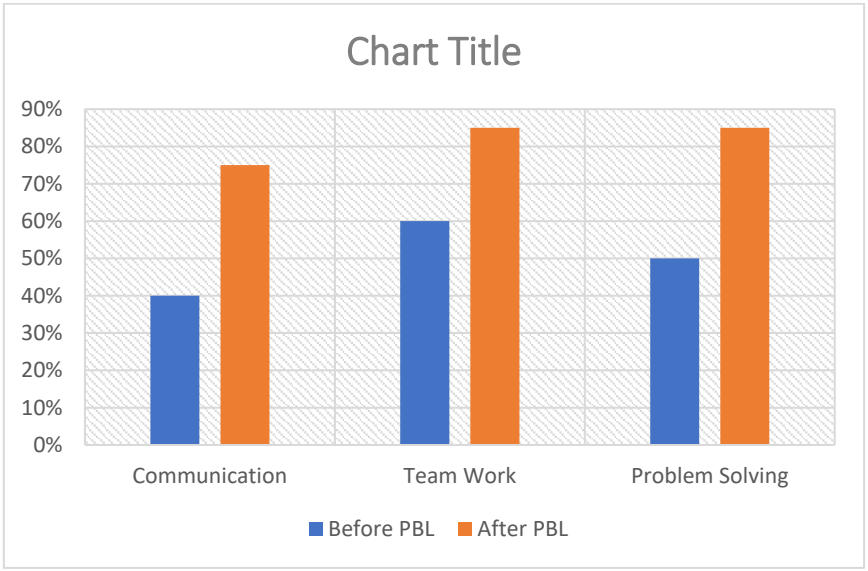
Problem solving became a very prominent collaborative skill during PBL. Students showed improved ability in finding creative solutions through group brainstorming. Data shows that 85% of students were able to come up with more complex and structured solutions compared to before PBL was implemented. Specific Findings

- Effective Brainstorming: In the idea generation process, students used brainstorming techniques to brainstorm potential solutions and then selected the best solution based on group discussion.
- Creative Solutions: In the project "Miniature Eco-City," one group found an innovative way to use recycled materials such as plastic bottles as the main material.
- Decision Making: Students learn to make decisions based on joint analysis, which involves various viewpoints of group members

Table 1. Improved Collaboration Skills

Skill Dimensions	Before PBL	After PBL	Progress (%)
Communication	40%	75%	35%
Team Work	60%	85%	5%
Problem Solving	50%	85%	35%

Graphic 1. Improved Collaboration Skills



This study found that project-based learning (PBL) has a significant impact on the development of students' collaboration skills, in accordance with Vygotsky's theory that emphasizes the importance of social interaction in the learning process. Vygotsky's theory, particularly the concept of Zone of Proximal Development (ZPD), states that optimal learning occurs when students work together with other more proficient individuals, both peers and teachers, to complete tasks that are beyond their individual ability range. In the context of PBL,

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group dynamics provide an ideal space for students to share knowledge, discuss ideas and work together productively to achieve project goals.

B. *The Effect of Social Interaction on the Development of Collaboration Skills*

The observation results show that during the implementation of PBL, the social interactions that occur in student groups are very intense and varied. For example, students actively discussed the division of tasks, determining problem-solving strategies, and resolving conflicts that arose. Based on interviews, 85% of students reported that group discussions helped them understand the material better, while 90% of students felt more confident in expressing their opinions after participating in PBL. This is in line with Vygotsky's theory which emphasizes the importance of collaboration to improve students' cognitive abilities through interactive dialogue.

C. *Teacher's Role as Facilitator*

Vygotsky's theory also highlights the important role of teachers as scaffolders who help students reach their maximum potential. In this study, the teacher acted as a facilitator who provided direction,
but still allowed students to have autonomy in managing their projects. For example, the teacher used open-ended questions to encourage students to think critically, such as “How would you solve the problem if resources were limited?” or “What should be done to ensure all group members contribute fairly?” Interviews with teachers showed that 75% of them felt the need to improve their facilitation skills to be able to provide better support in PBL.

D. *School Support as a Critical Success Factor for PBL*

Effective implementation of PBL requires full support from the school, including provision of facilities, flexible time allocation, and training for teachers. The analysis graph shows that 65% of students experienced problems in completing the project due to limited resources, such as practicum tools and materials. In addition, the time allocated for projects is often felt to be inadequate, especially in cross-subject projects. School support in the form of teacher training is also a key factor, as teachers need new strategies to manage collaborative classes.

In the implementation of PBL, students are frequently encouraged to complete challenging tasks with minimal guidance from the teacher, yet still within the context of collaboration with their peers. As an illustration, students in the 11th grade who were engaged in the "Miniature Eco-City Construction" project indicated that their learning was not solely derived from the instruction of the teacher but also from the discourse among group members. In the implementation of PBL, students are frequently encouraged to complete challenging tasks with minimal guidance from the teacher, yet still within the context of collaboration with their peers. For instance, students in their penultimate year of secondary education who were involved in the "Miniature Eco-City Construction" project reported that their learning occurred not only as a result of the input from the teacher, but also as a consequence of their participation in group discussions

The findings of this study indicate that the implementation of project-based learning (PBL) has a substantial, positive impact on the development of students' collaborative abilities in secondary educational settings. Students who engaged in PBL demonstrated consistent improvement in communication skills, including the capacity to engage in productive discussions with group members, convey ideas in a clear manner, and receive feedback or constructive criticism from their peers(Pattiasina et al., 2024). Through the PBL process, students not only develop the ability to express their opinions but also learn to interact with their colleagues in a mutually respectful manner. This improvement suggests that PBL creates an environment that is conducive to productive and inclusive two-way communication (Nayak et al., 2024).

Moreover, students demonstrated notable advancement in their teamwork abilities. This was evidenced by their capacity to distribute tasks in a more systematic manner, aligning them with the expertise of each group member. An effective division of roles enables students to work effectively together to complete the project. Additionally, PBL fosters students' capacity to resolve conflicts that arise during the teamwork process. They learn to seek solutions through constructive approaches, such as mediation and compromise, which ultimately enhances group cohesion (Furs, 2024).

Another noteworthy outcome is the students' capacity for problem-solving. Through group discussion and brainstorming, the students were able to identify a range of creative solutions to the challenges encountered in the project. This experience provided the students with the opportunity to exercise critical thinking skills collectively, enabling them to evaluate alternative solutions and select those that best aligned with the project's

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requirements. The ability to work together in problem-solving reflects the positive impact of PBL in preparing students for future work situations (Knöpfel et al., 2024).

However, this study also identified several challenges that emerged during the implementation of PBL. One of the primary challenges was time management. Some student groups encountered difficulties in completing the project within the allotted timeframe, which was attributed to a lack of coordination between team members and a dearth of experience in managing work schedules. This illustrates the pivotal role of the teacher as a facilitator in assisting students to plan and manage their time effectively. Teachers are also expected to possess the skills to ensure active participation from all group members, particularly in the case of students who tend to be passive or lack confidence (Rohyati & Purwanto, 2023).

Another challenge is the lack of adequate facilities, which can impede the implementation of the project. For instance, the absence of essential tools or materials required to support PBL activities can negatively impact the quality of student-generated projects. This underscores the necessity for school-level support in ensuring the provision of sufficient resources to facilitate the success of PBL (Lasumbu et al., 2024).

In conclusion, the findings support the hypothesis that PBL is an effective learning method for enhancing students' collaborative abilities. This approach is consistent with constructivist learning theory, which underscores the significance of social interaction as an indispensable component of the learning process. Nevertheless, the success of PBL is contingent upon a number of supporting factors, including teacher preparedness for facilitating learning, the provision of adequate facilities, and effective time management by students. To optimise the potential of PBL, a systematic approach is required to overcome these challenges. This approach may entail teacher training, the procurement of adequate facilities, and the provision of guidance to students in project management. Consequently, PBL can be implemented in a more effective manner and provide maximum benefits for student learning in secondary schools

IV. CONCLUSIONS

Project-based learning (PBL) has been demonstrated to have a substantial positive effect on the advancement of students' collaborative abilities, particularly in the realms of communication, teamwork, and problem-solving. In a project-based learning (PBL) environment, students are encouraged to engage in collaborative work within groups to design, implement, and complete projects that are grounded in real-world contexts. This process facilitates intensive interaction, thereby training students to engage in the sharing of ideas, the consideration of alternative perspectives, and the formulation of constructive responses. The implementation of PBL facilitates the rapid development of students' communication skills. Students are instructed to present their ideas in a clear and structured manner to their fellow team members. Moreover, they developed the ability to listen attentively to others' opinions and provide constructive feedback. Effective communication serves as a crucial foundation for fostering harmony within the team. Project-based learning fosters the development of effective teamwork skills in students. They learn to distribute tasks in accordance with their respective abilities and areas of expertise, thereby fostering a sense of collective responsibility for the completion of the project. Effective collaboration fosters an understanding of the value of mutual support and respect for individual roles within a team. Problem-based learning (PBL) motivates students to confront authentic challenges and identify solutions through a collaborative process. This entails brainstorming ideas, critically analyzing the problem, and developing strategies to complete the project. This problem-solving capacity not only enhances students' creativity but also builds their confidence in navigating complex situations.

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