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Learning Through Projects: A Path to Better Student Collaboration

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Abstract

Collaboration skills are one of the 21st-century skills that are very important for students, especially in facing the challenges of the complex world of work and social life. Students' collaboration skills in the Biology Education Study Program at Universitas Sembilanbelas November (USN), Kolaka, are still relatively low. One approach believed to improve students' collaboration skills is the application of Project-Based Learning (PjBL). Thus, this study aims to determine the effect of the application of Project-Based Learning on the collaboration skills of students in the Biology Education Study Program at USN Kolaka. This study is a pre-experimental type using a one-group pretest-posttest design. The subjects of the study were all active students (16 people) of the biology education study program, even the semester of the 2024/2025 academic year, who took the course "Media dan Sumber Pembelajaran Biologi". Data on students' collaboration skills were obtained using a collaboration skill observation sheet. Data analysis used an inferential test of the paired sample t-test type. The results of the study showed that the average collaboration skill of students before treatment was 30.77, and during treatment was 83.64. From the results of the inferential test, the Sig. The value was obtained. 0.000 < 0.05. This study concludes that there is a positive effect of the implementation of PjBL on students' collaboration skills. These findings indicate that PjBL can create a learning environment that encourages active participation, shared responsibility, effective communication, and constructive teamwork. Therefore, PjBL can be a strategic alternative for improving students' collaborative soft skills sustainably in higher education environments.

Keywords: collaboration, project-based learning

A. Introduction

Collaboration skills are one of the 21st-century skills that are very important for students, especially in facing the challenges of the complex world of work and social life (Dewi et al., 2024). In the context of higher education, collaboration is an essential skill that must be honed early on through a learning process that encourages teamwork, joint problem-solving, and effective communication (Zamhariroh & Thobroni, 2024). Therefore, educational institutions,

including study programs, need to design learning strategies that not only focus on mastering the material but also on developing social skills such as collaboration.

Based on the results of initial observations conducted by researchers on students of the Biology Education Study Program, Universitas Sembilanbelas November (USN), Kolaka, it was found that students' collaboration skills were still relatively low. This can be seen from several phenomena during learning activities, such as low active participation in group discussions, the dominance of several individuals in completing group assignments, and minimal interaction and communication between group members in joint project activities. Even in collaborative assignments, it is not uncommon to find students who hand over the entire workload to only one or two people, while other members do not contribute significantly. For example, in a group presentation assignment, a group consists of three students. However, only one member actively prepares the content and presentation materials. The other two members are merely present during the presentation without making any meaningful contributions throughout the planning and execution of the task. Moreover, when asked to provide input or respond to questions during the discussion, they remain unresponsive or simply read out the group's answers without understanding the content. This reflects an imbalance of roles within the team and a lack of effective collaboration among group members.

Another finding that indicates low collaboration skills is the lack of student initiative in building group work agreements, as well as the weak ability to resolve internal conflicts that arise during the collaboration process. Researchers also found that students tend to be individualistic and show a lack of empathy for the success of the group as a whole. This is certainly a serious problem that must be addressed immediately, considering that future biology teacher students are required to be able to collaborate with various parties in the learning process and other professional activities.

One approach that is believed to be able to improve students' collaboration skills is the application of Project-Based Learning (PjBL). This model places students as active subjects in learning through direct involvement in real projects that require teamwork, planning, implementation, and joint evaluation (Marera & Tendrita, 2024). Through this learning, students not only learn to understand the material conceptually, but also learn to manage roles, complete tasks together, communicate effectively, and be responsible for group results (Nababan et al., 2023).

Several previous studies have shown that the implementation of Project-Based Learning can improve various social skills of students, including collaboration skills (Alfaeni et al., 2022; Suardi, 2024; Amalia et al., 2024). In the context of Biology Education, this approach is very relevant because it allows students to engage in field projects, making learning media, or experimental activities that require teamwork. Nevertheless, studies that specifically examine the effectiveness of Project-Based Learning (PjBL) in improving students' collaboration skills within the Biology Education Study Program at USN Kolaka are still limited in the available scientific publications.

Based on this background, this study aims to determine the effect of the implementation of Project-Based Learning on the collaboration skills of students of the Biology Education Study Program at USN Kolaka. This study is expected to provide an empirical picture of the effectiveness of PjBL in developing students' collaboration skills during the learning process. Thus, the results of this study can be a reference for lecturers in choosing the right learning model to improve students' social skills, especially collaboration.

This study will enrich our understanding of learning models and soft skill development, informing effective, collaborative learning strategies in the Biology Education Study Program at USN Kolaka. The findings will support curriculum development for active, participatory learning, shaping students' collaborative skills and character. By integrating Project-Based Learning, this research ensures graduates possess both scientific knowledge and competent collaborative skills for success in the workforce and community.

B. Literature Review

1. Active Participatory Learning

Participatory active learning is a pedagogical approach that emphasizes the active involvement of students in the learning process, both physically, mentally, and emotionally (Harahap et al., 2025). In this approach, students are not only passive listeners, but are directly involved in the process of thinking, discussing, asking questions, exploring, and solving problems independently or in groups. Participatory active learning aims to create a more meaningful, challenging learning atmosphere and build critical thinking skills and collaboration.

This approach is also believed to be more in line with the characteristics of learning in higher education, which demands student autonomy and responsibility for their learning process.

Participatory involvement in learning encourages students to construct their knowledge, rather than simply receiving information from lecturers. Through interaction and real-life learning experiences, students are better able to understand concepts and relate them to contextual situations. In practice, active participatory learning is often realized through various strategies, such as group discussions, problem-solving, role-playing, simulations, and project-based learning (Syafei, 2025). These strategies encourage the creation of a collaborative and communicative learning environment, which ultimately has a positive impact on the development of students' social skills, including collaboration skills.

In the Biology Education Study Program environment, the active participatory learning approach is very relevant because it is in accordance with the demands of developing prospective teachers who not only master the material but are also able to think critically and work together. With the context of exploratory and investigative biology content, students benefit greatly when the learning process is active and participatory. Activities such as practicums, biology case discussions, to learning media creation projects have great potential to shape 21st-century character and skills, such as communication, collaboration, and responsibility.

However, the implementation of active participatory learning requires readiness from lecturers and students, as well as the support of a flexible and adaptive learning system. Lecturers need to design activities that are not only academically challenging but also activate students' social potential. Meanwhile, students are required to develop a proactive, reflective, and open attitude to various forms of cooperation. In this context, Dananjaya (2023) stated that active participatory learning is not only a method but also an educational paradigm that places students as the main subjects in the learning process.

2. Project-Based Learning Model

PjBL has several main characteristics, including a focus on authentic questions or problems, collaborative activities, real product results, and reflection during the process (Barus et al., 2022). Through projects, students are not only required to master academic content, but also high-level thinking skills such as analysis, synthesis, and evaluation, and social skills such as communication, collaboration, and leadership. This model also provides space for students to develop creativity, responsibility, and managerial skills. Thus, PjBL is very much in line with the goals of higher education, which not only pursue cognitive achievements but also affective and psychomotor aspects.

In the context of biology learning, PjBL can be applied through various projects such as creating learning media, biology experiments, developing teaching modules, and environmental campaigns. All of these projects not only strengthen conceptual understanding but also broaden students' horizons regarding the application of biology in everyday life. In addition, implementing projects in groups can be an effective means of social learning in forming collaborative attitudes, tolerance, and shared responsibility (Junita et al., 2023).

Another advantage of PjBL is its flexibility, which can be adjusted to the local context and student needs (Balkist et al., 2025). In the USN Kolaka Biology Education Study Program environment, the application of this model is a strategic opportunity to improve the learning process, which has so far tended to be lecture-oriented. With the implementation of structured and relevant projects, students can be more actively involved, have a sense of ownership of the learning process, and build collective awareness in completing joint tasks. Therefore, PjBL is a promising alternative to improve students' collaboration skills in a real and measurable way.

3. The Importance of Soft Skills for Students

Soft skills are a set of non-technical skills related to interpersonal skills, communication, work ethics, and self-management. In the world of higher education, soft skills are an important aspect that accompanies the mastery of hard skills or technical skills, according to the field of science. Soft skills cover various dimensions such as leadership, collaboration, critical thinking, responsibility, and adaptability. In the era of globalization and the Industrial Revolution 4.0, college graduates are not enough to rely only on intellectual intelligence, but must also have good social and emotional skills to compete in the world of work (Metan & Handayani, 2023; Utami et al., 2025).

Soft skills play a key role in the career success of graduates. Companies and employment institutions tend to prefer workers who are not only technically proficient but also able to work

in teams, have good communication, and can overcome conflict and work pressure (Widiawati et al., 2024). In the world of education, prospective teachers, for example, are required to have empathy, communication skills, and good leadership in order to be able to foster positive relationships with students, colleagues, and the school community. Therefore, the development of soft skills in higher education must be designed systematically and sustainably.

Biology Education, as a study program that prepares prospective science educators, is also obliged to develop students' soft skills. Mastery of biological concepts is important, but no less important is the ability of students to communicate ideas, work together in teams, and be ethical in conveying scientific information. The learning process that not only focuses on cognitive aspects but also character development and social values is the key to holistically competent graduates. Therefore, learning strategies such as PjBL have great potential to be applied because they facilitate the development of various aspects of soft skills directly in the learning process.

At USN Kolaka, strengthening the soft skills of biology education students can be a priority program to improve the quality of graduates and their competitiveness in the workplace. Soft skills are also important in supporting student success in their studies, such as time management skills, building networks, and solving academic problems collaboratively. In this case, research on the effectiveness of learning soft skills, such as collaboration, is an important step to ensure that the learning process implemented is directed at developing comprehensive competencies for students.

4. Collaboration as a Soft Skill

Collaboration skill is one form of soft skills that is very important in academic and professional life. According to Dewi et al. (2024), collaboration is not just working together in a group, but involves an effective communication process, fair division of tasks, shared responsibility, and collective decision-making. In the context of higher education, collaboration is a skill that supports learning success because, through collaboration, students can complement each other's knowledge, discuss ideas, and develop solutions to problems. Therefore, collaboration needs to be fostered from the start through learning strategies that provide space for interaction and teamwork.

As part of 21st-century skills, collaboration requires individuals to have an open, empathetic attitude and be able to convey and accept opinions wisely (Putri et al., 2022). Effective collaboration will be realized when each member of the group is committed to a common goal and can manage conflicts that may occur. This skill is very important for students who will become teachers in the future, because, in the world of education, teamwork is essential, both in learning planning, extracurricular activities, and professional development. Students who are accustomed to collaborating will be able to adapt more easily to the dynamics of work in the field.

However, based on field observations, many students still have difficulty in building healthy collaboration. They tend to show individualistic behavior, lack communication in groups, or do not take responsibility in teamwork. This shows that collaboration skills have not developed optimally and need to be improved through the right learning approach. Learning that is only lecture-based and has minimal interaction will not be able to foster collaboration, so there needs to be a change in learning strategies that are more participatory and experience-based.

In the context of this study, collaboration skill is an important variable to measure the results of the implementation of Project-Based Learning. Through PjBL, students are directly faced with real collaborative situations, such as designing and completing projects in teams. This situation can create group dynamics that encourage students to learn about communication, compromise, and responsibility. Thus, collaboration skills as the main soft skill will be easier to develop in the context of project-based learning and real interactions between students.

C. Methodology

1. Research Design

This study employed a pre-experimental method with a one-group pretest-posttest design. The research subjects were selected using total sampling, involving all 16 active students of the Biology Education Study Program who were enrolled in the "Media dan Sumber Pembelajaran Biologi" course during the even semester of the 2024/2025 academic year. The research was conducted in the Biology Education Study Program at USN Kolaka during the same semester. The one-group pretest-posttest design was chosen because all research subjects formed a

homogeneous class—namely, all active students enrolled in the "Media dan Sumber Pembelajaran Biologi" course in the even semester of the 2024/2025 academic year. This condition did not allow for the formation of a control group, making the pre-experimental approach the most appropriate to describe the changes occurring before and after the treatment. The total sampling technique was used because the number of students enrolled in the course was relatively small and consisted of a single class, thus making it feasible to include the entire population as the sample.

The PjBL implemented has 6 steps: (a) determining the main project questions, (b) scheduling project stages, (c) designing the project as a whole, (d) monitoring project progress, (e) presenting project results, and (f) evaluating project results (Nuhalizah, 2025). The description of student learning activities based on the components of Project-Based Learning (PjBL) in the “Biology Learning Media and Resources” course is as follows. The learning process began with **Stage 1: Formulating the essential project question**, which was conducted over one day. In this stage, the lecturer oriented students toward general issues related to the use of instructional media in schools. This activity aimed to build students’ initial understanding of the real-world problems to be addressed. Subsequently, students were divided into working groups to design a project for developing instructional media. On the same day, the activity continued to **Stage 2: Planning the project schedule**. In this stage, the lecturer provided a detailed explanation of the project work procedures that students were expected to follow. Together with the lecturer, students developed and agreed on a timeline for the project to ensure that activities proceeded in a systematic and organized manner.

Over the next three weeks, **Stage 3: Developing the project design in detail** was carried out. The activity began with field observations in schools conducted outside regular class hours to identify actual needs related to instructional media. Based on these observations, each group presented its preliminary findings in class. After receiving feedback from the lecturer and peers, each group began designing an initial version of the instructional media tailored to the identified needs and the results of the field analysis. Once the initial design was completed, students proceeded to **Stage 4: Monitoring project progress**, which also lasted for three weeks. In this stage, each group presented their initial instructional media design to receive feedback from the lecturer and fellow students. Based on the feedback received, students revised and refined their media.

Next, students implemented the instructional media directly in schools through collaboration with biology teachers. They observed the teaching and learning process, gathered responses from teachers and students, and analyzed the outcomes of media implementation. This entire process culminated in the systematic preparation of a final project report.

In the final week, students engaged in **Stage 5: Presenting the project results**, where each group gave an oral presentation of their final project report before the lecturer and fellow students. This presentation served as a forum to showcase their work. Finally, students entered **Stage 6: Evaluating the project outcomes**. The lecturer assessed the projects using a predetermined rubric and provided structured feedback covering strengths, weaknesses, and suggestions for improvement. Students then conducted self-reflection on their learning experiences and performed peer evaluations of other groups’ projects to broaden their perspectives and reinforce collaborative learning.

2. Instruments

Data on students' collaboration skills were obtained using a collaboration skill observation sheet consisting of 4 assessment aspects, namely (a) working productively, (b) respecting opinions, (c) compromising, and (d) shared responsibility. To avoid data bias, data collection before treatment (pretest) and during treatment (assumed as posttest) was repeated 3 times each. Before being used, the instrument was first validated by 2 experts, and an average validity value of 0.88 was obtained, which is categorized as valid based on the validity categorization of Mamonto et al. (2021).

3. Technique of Data Analysis

The data were analyzed descriptively and inferentially. The categories of students' collaboration skills were classified based on the score ranges proposed by Saeful (2022). Students who scored less than or equal to 60 were categorized as “low”. Scores ranging from 61 to 70 were classified as “fair”, while scores between 71 and 80 were considered “moderate.” Students who scored between 81 and 90 were categorized as “good,” and those who achieved scores between 91 and 100 fell into the “very good” category. This classification aims to provide

a clear overview of the level of collaboration skills demonstrated by students throughout the project-based learning activities. To determine whether there is an effect of treatment, an inferential statistical test of a paired sample t-test with a significance level of 5% was conducted. Both descriptive and inferential statistical tests were conducted with the help of SPSS software.

D. Findings and Discussion

1. Findings

Learning activities according to the steps set out in the method can be implemented entirely. From 3 repetitions of data collection for each pretest and posttest, 2 groups of average data were obtained, the results of which are presented in Table 1.

Table 1. Analysis of Students' Collaboration Skills in General

Value	Collaboration Skill	
	Pretest	Posttest
Highest	56,25	91,79
Lowest	19,03	57,86
Median	31,44	75,63
Average	30,77	83,64
Category	Low	Good

Based on the analysis in Table 1, there was a significant improvement in students' collaboration skills following the implementation of the project-based learning model. The highest score increased from 56.25 in the pretest to 91.79 in the posttest. The lowest score also rose from 19.03 to 57.86. The median increased from 31.44 to 75.63, and the average score sharply rose from 30.77 to 83.64, indicating a shift in category from "low" to "good." This suggests that the applied learning model had a positive impact on enhancing students' collaboration skills. The distribution of students' collaboration ability levels from the results of individual data analysis is shown in Table 2. The results of the analysis of each assessment aspect are presented in Figure 1.

Table 2. Analysis of Student Collaboration Ability Per Individual

Value	Category	Collaboration Skill			
		Pretest		Posttest	
		Frequency	%	Frequency	%
≤ 60	Low	15	93,75	0	0
61 - 70	Fair	1	6,25	1	6,25
71 - 80	Moderate	0	0	1	6,25
81 - 90	Good	0	0	4	25,00
91 - 100	Very Good	0	0	10	62,50
	Total	16	100	16	100

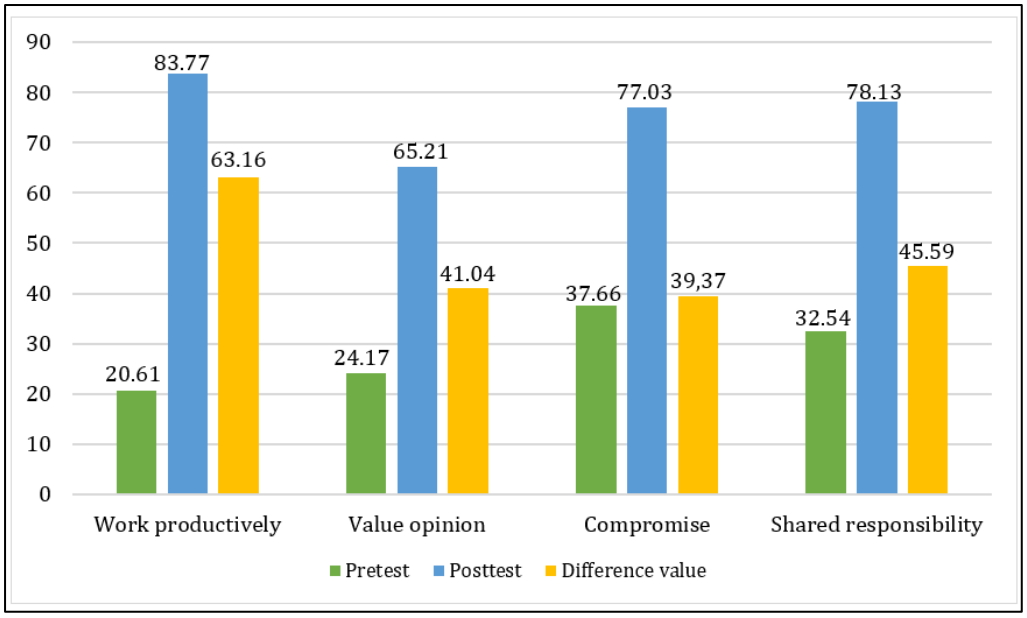

Figure 1. Results of Analysis of Each Aspect of Student Collaboration Ability Assessment

The information in Table 2 indicates that, prior to the treatment, the majority of students' collaboration skills fell into the "low" category, accounting for 93.75% of the total number of students. After the treatment, the "very good" category became the most dominant, with 62.50% of students falling into this category. Moreover, there were no longer any students in the "low" category. Additionally, Figure 1 shows that the indicator “work productively” experienced the most significant improvement as a result of the treatment. This is evident from the initial average score of 20.61, which increased to a final average score of 83.77, with a score difference of 63.16. The next step, an inferential test, is carried out by first testing the normality of the data. The results of the normality test and paired sample t-test are presented in Table 3.

Table 3. Results of Normality Test and Paired Sample T-Test

Variable	Data Group	Normality test (Saphiro Wilk)	Paired Sample T-Test
Collaboration skill	Pretest	0,071	Sig. 0,000
	Posttest	0,066	

Table 3 shows that all research data are normally distributed (Sig. ≥ 0.05). Therefore, data analysis was continued by conducting a parametric paired sample t-test, and the results of Sig. < 0.05, which means that there is a positive influence of the implementation of PjBL on students' collaboration skills.

2. Discussion

The results of the study showed that the collaboration ability of Biology Education students at USN Kolaka experienced a significant increase after the implementation of the Project-Based Learning (PjBL) model. Before the treatment, the highest score was only 56.25 with an average score of 30.77, which was categorized as “low”. Most students (93.75%) were in this category. After the implementation of PjBL, the average collaboration ability increased to 83.64, with the highest score of 91.79, and most students (62.50%) were in the “very good” category. The results of the inferential test also showed a significant influence of the PjBL model on students’ collaboration ability.

One aspect of collaboration that has seen the most significant improvement is the ability to work productively. Students are able to complete project tasks by dividing roles efficiently, demonstrating good planning and implementation of teamwork. The project undertaken by students in this study involved the design and implementation of biology learning media, carried out collaboratively. Each group was responsible for every stage of the project, from field observation and media design to school-based trials and the preparation of the final report. Roles within the groups were assigned in a structured manner based on each member's interests and abilities, including team coordinator, media designer, data analyst, documenter, and report writer. All group members were actively involved in every phase of the project, ensuring a participatory process that reflected balanced engagement among members. The findings of Islawati & Samsuddin (2024) indicate that the PjBL model encourages students to be more active, independent, and productive in completing group tasks. Project-based activities motivate students to manage time and resources more effectively, thereby improving work efficiency. Students’ active involvement throughout the project reflects progress in collaborative productivity.

In addition, students' ability to appreciate the opinions of their peers also increased after the implementation of PjBL. Students learned to listen, consider, and respond to the ideas of other group members openly and constructively. Before the treatment, passive attitudes and one-party dominance often emerged, but this condition changed when students were trained to work together to complete the project. This is in line with research by Sintia & Safitri (2025), which states that PjBL strengthens interpersonal communication skills and openness in group discussions. This improvement is an important foundation for building healthy team dynamics.

The ability to compromise also showed an increase after students were involved in PjBL. The project development process requires students to face differences of opinion, set shared priorities, and reach collective decisions. Before the implementation of PjBL, students tended to maintain their own opinions or follow the direction of only one person. However, after implementing PjBL, students were more flexible and able to accept mutually agreed-upon alternatives. Rozana et al. (2023) stated that PjBL teaches students to be open to different views and find common ground for group success.

The aspect of shared responsibility also experienced significant strengthening. Before the treatment, some students still depended on one or two people in the group to complete the task. However, with the PjBL approach, all members felt they had the same responsibility for the success of the project. Students demonstrated improvements in attendance consistency, engagement in discussions, and contributions to project completion by sharing roles based on mutual agreement—for example, as team coordinator, media designer, data analyst, documenter, and report writer. Research by Buda et al. (2022) also showed that the PjBL model increased students' sense of collective responsibility because the success of the project depended heavily on the contribution of all members.

The changes in the distribution of collaboration ability categories before and during the implementation of PjBL showed very positive results. Initially, the majority of students (93.75%) were in the "low" category, and none reached the "moderate", "good", or "very good" categories. After the treatment, no students were in the "low" category, and most (62.50%) were in the "very good" category. This proves that PjBL can increase collaboration ability from a low level to a very high level. This distribution confirms that PjBL has an even impact on increasing the collaborative ability of all students.

This finding strengthens the results of previous studies that state the effectiveness of PjBL in improving collaborative skills. Research by Ilma et al. (2024) states that PjBL not only improves cognitive learning outcomes but also improves cooperation and coordination between group members. In addition, Retno (2022) in her research stated that PjBL is very suitable for application in science education because it requires teamwork, observation, and collaborative synthesis of information. This suitability is evidence that the project-based learning model supports the development of students' soft skills as a whole.

Collaboration skills are an essential competency in today's workplace. By increasing the ability to work productively, respect opinions, compromise, and take shared responsibility, students are prepared to face the challenges of collaborative work in the future. According to the World Economic Forum (2020), teamwork skills are one of the 10 main competencies needed to face the industrial era 4.0 and 5.0. PjBL is one of the relevant learning strategies to bridge the world of education with the real world of work.

The implementation of PjBL not only increases collaboration but also has the potential to develop other skills such as critical thinking, creativity, and communication. Students are not only invited to complete assignments but are also challenged to find solutions to real problems together. This experience provides opportunities for broader personal and social development. Riskayanti (2021) stated that PjBL encourages 21st-century skills, including communication, collaboration, critical thinking, and creativity.

Based on the results of this study, it is recommended that the PjBL model be implemented more widely in the Biology Education curriculum, especially in courses that emphasize teamwork. Lecturers need to design challenging and meaningful projects that allow students to work together, discuss, and solve problems collectively. Evaluation of the collaborative aspect should be carried out continuously to ensure the development of these skills. The integration of PjBL in the learning process can be one strategy to improve the quality of graduates who are not only academically capable but also have strong social competence.

E. Conclusion

Based on the results of the study, it can be concluded that the implementation of Project-Based Learning (PjBL) has a significant effect on improving the collaboration skills of Biology Education students at USN Kolaka. Before the implementation of PjBL, the majority of students were in the "low" collaboration ability category, but after the implementation, there was a significant increase, and most students were in the "good" and "very good" categories. These findings indicate that PjBL is able to create a learning environment that encourages active participation, shared responsibility, effective communication, and constructive teamwork. Therefore, PjBL can be a strategic alternative in improving students' collaborative soft skills sustainably in higher education environments. PjBL is not only effective in building solid teamwork, but it is also relevant to developing 21st-century skills that are important for students' readiness to face the world of work.

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