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Students' Collaboration Skills through Project-Based Learning Model Using Digital Poster on Virus Reproduction Concepts

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Abstract

This study aimed to improve students' collaboration skills on virus reproduction material by using digital posters to apply the Project Based Learning (PjBL) model. Qualitative methods were used to analyze data collected through observation, interviews, and documentation in class X of one of the public high schools in Serang City, Banten. Students were tasked to create a digital poster due to group work, where they collaborated to identify the stages of the lytic and lysogenic cycles in viral reproduction. The results showed that the PjBL model improved students' collaboration skills, including communication skills, responsibility, and mutual respect for opinions. Most students have shown good collaboration skills, although some are still passive in the discussion. Teachers and students also faced obstacles, such as a lack of commitment from some group members. Thus, implementing PjBL using digital poster media effectively builds collaboration skills, although further support is needed to ensure that all group members are actively involved. This research suggests using innovative media and methods to optimize collaborative learning in the classroom.

Keywords: Collaboration, Project Based Learning, Digital Poster, Virus Reproduction, High School

INTRODUCTION

Rapid advances in technology and fierce competition in the world of work help teach new skills that are needed. Education should be responsive to these changes to equip students with the necessary skills to be skillful in the future. Along with the development of some interesting aspects in daily life, every student should be equipped based on their skills and knowledge of the basics that are relevant today (Parwati *et al*., 2024). New paradigm learning is a profile of Pancasila learning and serves as a guideline in determining policies and reforming the Indonesian education system (Ambarwati & Widodo, 2023).

The characteristics of Pancasila teachers include all consistent aspects, including working together (Ambarwati & Widodo, 2023). One of the key components of the cooperation dimension is collaboration, with several studies showing that collaboration is more than just a type of teamwork. As a result, the relationship is constantly strengthening and developing to achieve the goals that have been set. According to Devi *et al*. (2023), collaboration in the classroom is one of the most important social skills for students in the educational process. In a

collaborative atmosphere, students learn from each other's experiences and knowledge, which improves their critical thinking skills and communication abilities.

The society 5.0 era refers to a time when technology improves human and social welfare. To strengthen students' skills, a teacher must implement an educational program to facilitate and maximize learning. Therefore, technology-based learning media is needed to help foster students' confidence in collaboration and optimize their collaboration skills in learning.

Generally, educators use the lecture method in the teaching and learning process; as a result, students are easily bored and passive, resulting in less interesting learning activities, and many students do not listen to the explanation of the material. Educators should examine and identify field conditions during learning activities, then evaluate finding solutions so that learning becomes interactive and student motivation increases. The PjBL learning model can be an alternative solution to increase student collaboration, which is one of the keys to the P5 project aspect of the independent curriculum (Restyowati *et al*., 2024).

Based on observations made in one of the public high schools in Serang City, Banten, it was found that students still have difficulties in carrying out group-based learning. This learning method requires students to work in groups of seven to ten members per group. However, observations showed that students' group collaboration skills were still suboptimal. Some students tend to be passive and not actively involved in group discussions. Each group had an average of two to four students who did not participate, thus hindering the success of teamwork in completing the assigned tasks. In addition, not all students in the group were fully committed to the tasks they were responsible for, resulting in gaps in understanding of the material. This condition indicates that some students still do not understand the importance of active contribution in group work.

In group work situations, students must have several indicators supporting successful collaboration between individuals. According to Wardani (2021), one of these indicators is an attitude of responsibility, namely the ability and behavior of a person to carry out duties and obligations towards himself, society, nation, and state. Fitriyah (2023) also states that responsibility includes the ability of students to prepare, carry out, and complete various needs independently. This emphasizes that responsibility is an obligation that must be carried out without pressure from other parties, resulting in real action in life. In addition, Jiwa *et al*. (2024) suggested that a positive attitude towards contribution also plays an important role. Students with a good orientation and positive attitude towards learning tend to be more disciplined, supporting optimal learning achievement. Collaboration skills can be defined as

the ability to take part in every activity to establish relationships with others, respect each other's opinions, and work in teams to achieve common goals. Information and knowledge from others can also be obtained when students have good collaboration skills (Mulyani *et al*., 2023). This weak collaboration not only affects the less conducive atmosphere of group work but also harms student learning outcomes, hindering the development of their understanding and skills in working with others.

For these reasons, we chose to implement a cooperative learning model to help foster students' confidence in collaborating and optimize their collaboration skills. Collaboration skills refer to a person's ability to play an active role in various activities, build harmonious relationships with others, respect opinions, and work together in teams to achieve common goals (Nurjanah *et al*., 2020). According to Cahya *et al*. (2023), this ability is crucial to help students improve academic achievement, strengthen social skills, and instill healthy democratic values. Balqist *et al.* (2019) emphasized that good collaboration skills allow students to gain more optimal insights and knowledge from others. Improving students' ability to collaborate by using a project-based learning (PjBL) paradigm in biology classes. During this educational activity, students work together to complete a project to produce a product. Learners are trained to communicate and collaborate effectively, resulting in cohesiveness and teamwork to complete the project successfully. Encouraging students to actively investigate, make decisions, solve problems, and let students work alone, the goal is for students to have skills used in the environment. Students work together to complete the project according to the project-based learning (PjBL) approach that has been instructed. Project-based learning is an approach centered on a field's main principles and concepts. Following the opinion of (Bern and Erickson in Wardah, 2018) it involves learners in solving significant problems and tasks to build learning and ultimately produce real work.

METHOD

The research conducted is Classroom Action Research that aimed to fix real and practical problems in improving the quality of learning in the classroom experienced directly by teachers and students in the classroom. The object of research is students' collaboration skills in learning virus reproduction material through digital posters. The data sources used are teachers and students (Rifai *et al*., 2021). Qualitative research data in Figure 1 is taken from the results of observations, interviews, and documentation during the research process in class X, the results of observations presented in the observation sheet will be processed into descriptions.

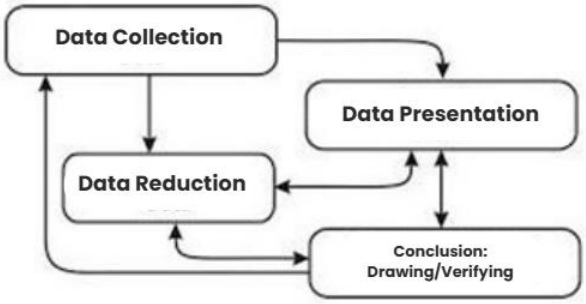

Figure 1. Qualitative Research Data Analysis Process (Source: Millah *et al*., 2023)

This study also used qualitative methods to collect data on student collaboration skills through the Project Based Learning Model using digital posters on virus reproduction material on learning outcomes. Qualitative research is descriptive and analytical research. Description in qualitative research means describing events, phenomena, and social situations under study. Analysis is the process of interpreting, analyzing, and comparing research findings. Qualitative research uses stories or words to explain and describe the meaning of each phenomenon, symptom, and certain social situation. In qualitative research, the researcher is the main tool to understand and explain every phenomenon, symptom, and certain social situation (Patonah *et al*., 2023). Therefore, researchers must master the theory to master the theory to analyze the gaps that arise between theoretical concepts and reality.

This research was conducted on October 10-31, 2024. Data collection was conducted online using Google Forms, facilitating questionnaire distribution and processing. Respondents were contacted via WhatsApp group for participation in the survey. This study focused on grade X students at one of the Senior High Schools in Serang City, Banten.

The subjects of this study were class X students at one of the senior high schools in Serang, Banten, totaling 42 people. The respondents were asked to fill out a questionnaire prepared in a Google Form consisting of 10 questions. The questions contained selfassessment and peer assessment aimed at how successful the collaborative model was in the group and whether the students' skills had met the collaborative indicators themselves (Putri, 2021). This questionnaire collected data on the research topic and provided a comprehensive view of the research subject.

The data used in this research is qualitative data obtained from the Google Form questionnaire. The instruments used in this research are interviews and observation, which use instruments to obtain information about learning activities with the project-based

learning model to see students' collaboration skills. The data collection techniques used in this research are 1) observation technique, 2) interview technique, and 3) documentation technique.

Data collection techniques are the most important step in research because the main purpose of research is to get data. The data collection techniques used include tests, observations, interviews, document reviews, and non-tests in the form of questionnaires. There are four data collection techniques: observation, interview, documentation, and combination/triangulation. Triangulation is often used to verify the authenticity of information and identify authentic objective reality. This method is very suitable if used to analyze certain events, places, and times (Rusandi & Rusli., 2019).

Classroom Action Research uses observation techniques to observe students during the learning process to convey students' understanding of the material better. Observation is a data collection technique involving a process or series of ongoing activities with the human senses. Observation is one of the fundamental foundations of all data collection methods in qualitative research, especially in the social sciences and human behavior. Observation is also understood as "the pillar of ethnographic efforts", meaning that observation is a systematic process of observing human activities and the physical environment where these activities occur continuously from the natural location of the activity to produce events. Observation is the main source of data collection using the triangulation method. The information obtained will later be poured in the form of descriptions (Hasanah, 2017).

In the implementation of this observation activity aimed at teachers and children who are directed at activities (a) lesson plans with project-based learning models (b) steps of projectbased learning models (c) learning gains towards mastery of concepts and (d) children's activities in learning. In this study, the observation carried out by the researcher was the collaboration ability of learning activities with the project-based learning model in class X7 at one of the senior high schools in Serang, Banten.

Interviews are used as a data collection technique when researchers want to conduct an initial study to identify research problems or to explore more in-depth information from respondents. This technique relies on personal reports or self-reports based on individual knowledge and beliefs (Waruwu, 2023). Interviews in this study were conducted with the organizer or principal and included in the category of indirect interviews using

triangulation, which is a method of checking the validity of data by comparing it with information obtained from other sources.

Interviews allow researchers to understand the thoughts and feelings of respondents, which cannot be revealed through observation. Interview guidelines are designed to ensure that the discussion remains focused on the research topic but remains flexible so that it can be adjusted or modified as needed (Sugiyono, 2014). In this study, interviews were conducted directly with the Biology teacher of class X at one of the senior high schools in Serang, Banten.

This study collected data using observation, interview, and documentation techniques to complement the results of observations and interviews. Documentation is used in the form of records of events that have occurred, such as text, images, or works from related parties (Sugiyono, 2014). Data were collected through direct observation and interviews with subjects in the field to obtain in-depth information related to the focus of the research, namely the collaboration skills of class X students at one of the senior high schools in Serang, Banten, through making digital posters on the material of virus reproduction. This data collection process was carried out thoroughly from the beginning to the end of the research.

Observation notes are divided into two parts. The first part is the description, which contains a record of what happened without the researcher's influence or opinion. The second part is commentary, which includes the researcher's reflections, thoughts, and views on what was observed. As the main instrument in this study, researchers used observation sheets, interview guides, and documentation. Documentation includes lesson plans, interview sheets with class X Biology teachers, interviews with class X students, and observation notes related to the learning process of virus reproduction material at one of the senior high schools in Serang, Banten.

Qualitative data analysis in this study was carried out in stages, starting from the problem formulation stage before entering the field, during data collection in the field, until after all data were collected (Nurdewi, 2022). This data analysis continues during collection and is carried out continuously until the data is considered sufficient or reaches a saturation point. Data analysis aims to break down the problem or research focus into several parts to make it easier to understand (Nurdewi, 2022). This study conducted data analysis at each stage, and interpretation was based on relevant theories. Because the data is

in the form of descriptions and not numbers, the data is systematically organized into categories, broken down into units, processed into patterns, and concluded so that the meaning or information is clearer.

This research is expected to produce new findings regarding students' collaboration skills in learning viral reproduction material using digital posters. Data analysis activities include data reduction, data presentation, and conclusion drawing and verification, which are carried out continuously until the data is considered adequate or complete.

RESULTS AND DISCUSSION

Classroom Action Research was conducted using three data collection techniques: observation, interview, and documentation. We took, collected, and analyzed data through test results (pretest and posttest), observation, interviews, documentation, and non-tests in the form of questionnaires/surveys. Before the implementation of the research began, the author diagnosed students' initial ability with a Google form test. The initial ability test questions used were test questions in the form of multiple choice and true or false regarding the basic material of virus reproduction. Based on the results of the initial assessment data analysis, students have mastered the viral reproduction material to be learned because from the results of the initial assessment given, this can be seen from the results of the initial competency assessment. After all, this initial competency assessment shows that not all students have basic knowledge of the reproduction material to be learned.

Based on the results obtained from questionnaires and interviews, the author obtained data on students' collaboration skills through the Project-based learning (PjBL) learning model. The author conducts the following stages of learning continuity: 1) The teacher gives an initial ability test question. The questions from the test are two multiple-choice questions and three true or false questions. 2) The teacher divides the groups into eight, each with five members. 3) The teacher instructs the learners to fill in the group worksheet containing the digital poster design plan that the learners will make. 4) The teacher directs learners to have a group discussion. The discussion that learners discuss in their groups includes viral reproduction material, which consists of the lytic cycle and lysogenic cycle by identifying the stages that occur in each viral reproduction cycle, as well as the differences between the two viral reproduction cycles, namely the lytic cycle and the lysogenic cycle.

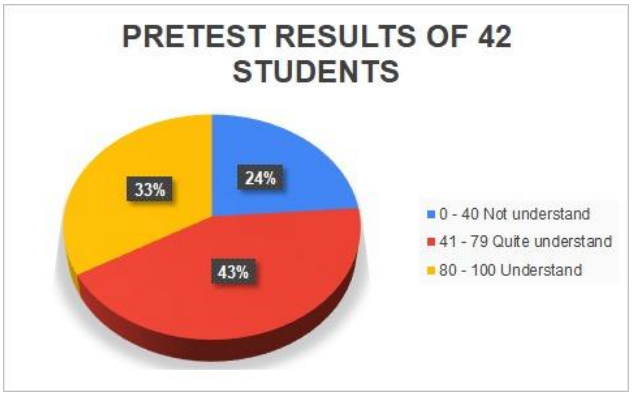

Figure 2. Diagram of Student Pretest Results

Table 1. Frequency Distribution Table of Student Pretest Results

Interval	Category	f	%
0-40	Not understand	10	23.8095
41-79	Quite understand	18	42.8571
80-100	Understand	14	33.3333
Total		42	100

Figure 2 and Table 1 show that the results of the pretest attended by 42 students showed differences in the level of understanding of the material tested. A total of 10 students (23.81%) were in the "Not Understood" category with scores between 0-40, while 18 students (42.86%) were in the "Understood" category with scores 41-79. The other 14 students (33.33%) made it into the "Understand" category, scoring 80-100. This data shows that most students are at the "Fairly Understood" level, meaning they have understood the material in a basic way but still need reinforcement to achieve a deeper understanding. On the other hand, the students in the "Understand" category have shown good results, so they can be given higher learning challenges to expand their abilities. However, more attention needs to be given to students in the "Don't Understand" category, as they need additional help, such as repetition of the material or using more interesting and easy-to-understand learning methods. The repetition method is an approach that aims to ensure that the learning that learners have received is well embedded in their memories. In its application, it is important to ensure that learners do not learn new material without first repeating previously learned material. This method effectively strengthens and maintains memorization, done simply through continuous and serious repetition of the same activity, either under the guidance of a teacher or independently. One of the advantages of this method is that it allows learners to master and develop the expected skills relatively quickly. In addition, this method also helps foster regular, disciplined, and

independent learning habits (Wowo *et al*., 2022).

Information from the pretest results can be used to develop appropriate learning strategies, for example, through special guidance for students who do not understand, more intensive practice for students who understand enough, and enrichment activities for students who have mastered the material. With the right approach, all students are expected to improve their understanding and achieve more optimal learning outcomes.

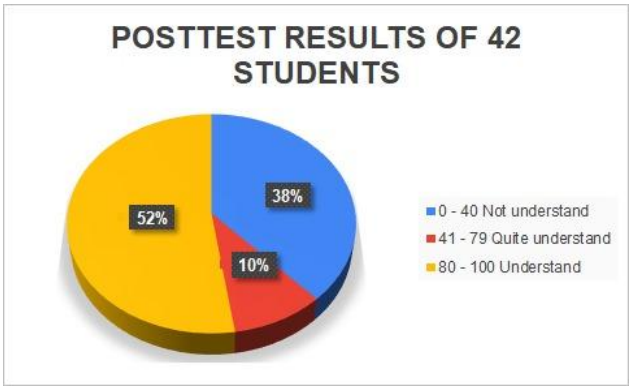

Figure 3. Diagram of Student Posttest

Table 2. Frequency Distribution Table of Student Posttest Results

Interval	Category	f	%
0-40	Not understand	16	38.0952381
41-79	Quite understand	4	9.52380952
80-100	Understand	22	52.3809524
Total		42	100

Figure 3 and Table 2 show the results of the posttest attended by 42 students, providing an overview of the extent to which they understand the material taught. From the results of data analysis, 16 students, or around 38%, were in the "Not Understood" category with scores between 0-40. This shows that almost 40% of students struggle to understand the material and need more attention. Meanwhile, four students, or around 10%, fell into the "Fairly Understood" category with scores between 41-79. Although they have shown sufficient understanding, they still need guidance to improve their knowledge further. As for 22 students, about 52% managed to fall into the "Understand" category with a score of 80-100, reflecting their understanding of the material well.

Although most students have a good grasp of the material, 38% of students are still in the "Not yet understood" category, indicating that challenges must be overcome. Therefore, a more personalized approach, such as individual or small group guidance, can be applied to help struggling students. On the other hand, students who are in the "Fairly Understood" category can be given additional practice or more intense discussion sessions to deepen their

understanding. Meanwhile, students already in the "Understand" category can be given more challenging tasks or enrichment materials to spur deeper understanding.

Although the posttest results show that most students understood the material well, there is still room for improvement. With the implementation of more innovative and targeted learning strategies, it is expected that more students will be able to master the material well. These corrective measures will help students in the low category and encourage all students to reach their best potential in understanding the learning material.

Collaborative learning has been proven effective in improving students' academic understanding. Collaborative learning methods can increase student engagement in the learning process, which ultimately positively impacts their understanding of the material and academic outcomes (Rahmawati & Kurniasih, 2023). In addition, collaborative learning helps students work together, share their thoughts, and take responsibility for their learning outcomes, both individually and in groups (Setiawan *et al*., 2022).

By using collaborative learning methods, it is expected that students who are in the "Don't Understand" and "Understand Enough" categories can improve their understanding through interaction and cooperation with classmates. Meanwhile, students already in the "Understand" category can further deepen their understanding by helping their friends, thus creating a mutually supportive and inclusive learning environment.

Figure 4. Diagram of Student Collaboration

Table 3. Frequency Distribution Table of Student Collaboration Questionnaire Results

Interval	Category	f	%
31-40	Very often	21	42.72727273
21-30	Often	23	52.27272727
11-20	Sometimes	0	0
0-10	Never	0	0
Total		44	100

Based on the analysis of questionnaires and interviews, an overview of the level of

collaboration skills of students in the application of the Project-Based Learning (PjBL) learning model is obtained. The questionnaire measured the intensity of learner collaboration through four categories: very often, often, sometimes, and never. Figure 4 and Table 3 shows that of the total 44 learners who took the survey, 23 people (52.27%) were in the frequent category, while 21 people (47.73%) were in the very frequent category. No learners chose the sometimes or never categories, indicating that the majority of learners showed fairly good participation in group work. This result indicates that most learners know the need to be actively involved in collaborative activities.

However, interviews with subject teachers revealed challenges that contrasted with the questionnaire results. In reality, learners' involvement in group work is uneven. The teacher observed that in each group, only one or two learners consistently contributed and showed initiative in discussions and project completion. Meanwhile, other group members tend to be passive, show no interest in being actively involved, and only rely on the work of more dominant friends. The teacher also stated that this phenomenon often leads to task distribution inequality, so the final result reflects individual work rather than group collaboration. This finding is supported by the questionnaire data, where the names of learners who are considered active match those identified by the teacher in the interview.

The observation results are based on the psychomotor assessment instrument that has been made with five aspects: readability, visibility, legibility, material completeness, and presentation skills. Based on all these aspects, students succeeded in making their digital poster projects. Starting from design, layout, and color contrast. At the beginning of the meeting, it was explained that the topic to be presented was "Lytic and Lysogenic Virus Reproduction Cycles." This topic should not only cover the cycle's stages. However, it should also be developed with a more in-depth discussion, such as the definition, differences between the two cycles, and their biological implications. However, only a few groups could organize the material in a complete, innovative, and developed manner. These groups not only explained the cycle's stages descriptively but also added new insights, such as specific examples of viruses that perform both cycles, the role of the cycle in the spread of disease, and how the cycle can be intervened in medical therapy. In contrast, some other groups only focused on the cycle's stages without broader development, thus lacking the ability to provide a comprehensive picture to the audience. This suggests that material enrichment needs to be re-emphasized so that all participants can produce high-quality

presentations and provide greater benefits for collective learning.

Affective assessment instruments with aspects of learner confidence in conveying ideas in front of their group and classmates during presentations, responsibility for the division of group tasks, and collaborative active involvement in discussions can be seen from the questionnaire and the results of teacher interviews. Affective is related to the emotional development of individual students, such as attitude, appreciation, interest, attention, appreciation, internalization process, and character building. This is indicated by student behavior improvements such as their attention to lessons, discipline, motivation to learn, respect for teachers and friends, study habits, and good social relationships (Primahati *et al*., 2022).

Questionnaire results that contradict teacher observations and interviews may be influenced by learners who find it difficult to understand and interpret questionnaire items, which may lead to results that are inconsistent with interviews or observations (Guttke & Raphaela, 2024). Biased questionnaire results can also occur when learners do not complete the questionnaire objectively. This lack of objectivity is often caused by various factors influencing how learners make judgments or decisions. This kind of bias can arise due to personal preferences, prejudices, or certain conditions that interfere with the accuracy of the data obtained. Some respondents choose answer options at the extremes of the scale (strongly agree or strongly disagree) without considering the middle option. This response style can be influenced by the format of the questionnaire and the individual's interaction with the format (Widhiarso, 2016).

According to Nurwahidah *et al*. (2021), collaboration is an essential skill that enables learners to solve problems through sharing responsibility, organization, and active participation in achieving shared understanding. However, interviews show that many learners still do not understand the importance of this skill. They tend to accept ideas one group member proposes without providing additional input, rarely express opinions, and have no sense of responsibility in managing the project collectively. This contradicts the view of Anggristia *et al*. (2023), who emphasize that collaboration is a key skill that learners must develop to face the world of work in the future.

To measure and hone these collaboration skills, the author implemented several stages in project-based learning. The process begins with an initial proficiency test designed to identify learners' level of understanding before starting the project. Learners were then

divided into eight groups of five people each. Each group was tasked with designing a digital poster that discussed the viral reproductive cycle, specifically the lytic and lysogenic cycles. The project tested learners' academic understanding and encouraged them to discuss, share ideas, and strategize when working on the group project. After the learning sequence was completed, a final proficiency test was conducted to evaluate improving learners' understanding. The results show an improved understanding of the material, which is also reflected in the creativity and innovation of the posters produced.

However, the teacher reiterated that contributions in the poster-making process were uneven. In most groups, only one or two members were fully involved in designing and drafting the posters, while the other members played little or no role. Although the posters produced were of good quality, this fact shows that all learners have not fully honed their collaboration skills.

Various skills that fall into four levels influence students' success in collaborative endeavors. The first level is forming, the basic skill for forming cooperative learning groups. The second level is functioning, a skill that helps students organize group activities, complete tasks, and maintain effective working relationships among group members. The third level is called formulating, where students develop skills in building concepts and understanding the material being taught. At this stage, students are encouraged to use higher-order thinking strategies to master the material optimally. The last level is fermenting, which is related to the ability to stimulate re-understanding of the material, raise cognitive conflicts, seek additional information, and communicate the results or conclusions obtained (Dewi *et al*., 2020).

Some factors influencing students' low collaboration skills include fatigue due to repetitive group activities, less conducive classroom conditions due to limited facilities and infrastructure, and unstable social dynamics between students. This situation leads to a lack of motivation to work together and impacts the final result of the group project. Therefore, a more interactive learning approach and a more structured task distribution are needed to ensure the involvement of all group members. Teachers also need to provide more intensive assistance to less active learners so that each individual can develop collaboration skills.

Collaboration is one of the fundamental skills that not only plays a role in the learning process at school but also determines the success of learners in the professional

world (Nurlaiala *et al*., 2024). With proper guidance, learners are expected to be able to contribute actively in each group project so that the learning process becomes more effective and meaningful. Project-based learning (PjBL) is an educational approach that emphasizes teamwork and 21st-century skills, including creativity and social interaction. PjBL has been proven effective in improving student collaboration at various levels of education and subjects (Yanti *et al*., 2023). Educators need to provide methods and a comfortable environment for children where they are free to express themselves and maximize their potential or verbal communication skills together with friends and teachers at school (Pebrianti *et al*., 2021). PjBL consistently supports the growth of student collaboration. According to research by Pebrianti *et al*. (2021), PjBL learning can improve students' ability to work in groups, interact with colleagues, and remain assertive in handling tasks. In Ritartini's research (2023) at Purwoharjo State Elementary School, applying PjBL increased student cooperation from 79.44% to 86.81%2. In addition, in the study of Hendrawati (2024) at SD N Ledok 01 Salatiga, the percentage of collaboration increased from 0% in the pre-cycle to 81% in the second pre-cycle.

PjBL not only improves teamwork skills but also student learning outcomes. SD Negeri Purwoharjo's application of PjBL increased students' math learning achievement from 60% to 100%, meeting the Minimum Criteria. In addition, PjBL improved the creative thinking skills of SMAN 1 East Kampar students, thus increasing the effectiveness and efficiency of physics education (Ritartini, 2023).

CONCLUSION

Based on the findings and analysis that has been done, it can be concluded that through class action research on biology subjects on virus reproduction material in one of the senior high schools in Serang, Banten, the implementation of PjBL to measure student collaboration has not succeeded in increasing collaboration between students in groups. Learners are still ignorant of their duties, only stick to one idea given by one friend, do not speak or argue much, and rely on each other. The suggestion that can be conveyed is that teachers can apply the friendship grouping technique, as Anggristia's research *et al*. (2023) said that the friendship grouping technique can not only be applied to the same subject but can be applied to other subjects. Adding this technique in PjBL will make learning more interesting; students do not feel tired in groups, which is more effective and encourages students to collaborate with their peers (Anggristia *et al*., 2023).

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