Bioeducа: Journal of Biology Education
http://journal.walisongo.ac.id/index.php/bioeduca
ISSN 2714-8009 (print), 2715-7490 (online)

Volume 5, Nomor 2, Tahun 2023
Hal. 155 – 168

The Effect of a Project-Based Learning Model on Learning Outcomes and Collaboration Skills

Andi Mulyadi*, Romy Faisal Mustofa, Dea Diella
Program Studi Pendidikan Biologi, Fakultas Keguruan dan Ilmu Pendidikan, Universitas Siliwangi
*Email: mulyadiandi250501@gmail.com

Article Information
Submited: 09 – 07 – 2023
Accepted: 28 – 09 – 2023
Published: 29 – 09 – 2023

Publisher
Program Studi Pendidikan Biologi, Fakultas Sains dan Teknologi, UIN Walisongo Semarang

ABSTRAK

Penelitian ini dilatarbelakangi oleh belum optimalnya hasil belajar dan keterampilan kolaborasi peserta didik. Tujuan penelitian ini untuk mengetahui pengaruh *model project based learning* terhadap hasil belajar dan keterampilan kolaborasi peserta didik pada materi ekosistem. Metode penelitian yang digunakan yaitu *Quasi Experimen* dengan desain *the matching-only posttest-only control group design*. Populasi penelitian adalah kelas X MIPA SMA Negeri 8 Tasikmalaya. Sampel diambil menggunakan *purposive sampling* dan didapatkan kelas X MIPA 1 sebagai kelas kontrol dan X MIPA 4 sebagai kelas eksperimen. Proses pembelajaran di kelas kontrol menggunakan model *discovery learning*. Teknik pengumpulan data berupa tes hasil belajar dan non-tes menggunakan *angket Collaboration Self-Asessment Tool* (CSAT). Analisis data menggunakan Uji *One Way Anova.* Hasil penelitian menunjukkan bahwa ada pengaruh model *project based learning* terhadap hasil belajar dan keterampilan kolaborasi peserta didik pada materi ekosistem di kelas X MIPA SMA Negeri 8 Tasikmalaya.
Kata kunci: Hasil Belajar; Keterampilan Kolaborasi; *Project Based Learning*.

ABSTRACT

This research was motivated by the lack of optimal learning outcomes and collaboration skills of students. The purpose of this study is to determine the effect of the project-based learning model on learning outcomes and student collaboration skills on ecosystem material. The research method used is Quasi Experiment with the matching-only posttest-only control group design. The study population is class X MIPA SMA Negeri 8 Tasikmalaya. Samples were taken using purposive sampling and obtained class X MIPA 1 as a control class and X MIPA 4 as an experimental class. The learning process in the control classroom uses the discovery learning model. Data collection techniques in the form of learning outcomes tests and non-tests using the Collaboration Self-Assessment Tool (CSAT) questionnaire. Data analysis using One Way Anova Test. The results of data analysis show that there is an influence of the project based learning model on students' learning outcomes and collaboration skills on ecosystem material in class X MIPA SMA Negeri 8 Tasikmalaya.
Keywords: *Collaboration Skill; Learning Outcomes; Project Based Learning.*

INTRODUCTION

The 2013 curriculum is one of the curricula used in the education system in Indonesia, especially when this research was conducted. Siregar & Amrizal (2018) stated that the 2013 Curriculum has several characteristics, including learning activities using a scientific approach, emphasizing more on developing attitudes, knowledge, and training skills in an integrated manner. In this curriculum, students are required to be active in the learning process, and teachers act as facilitators. Furthermore, Herawati (2018) in her research on teacher perceptions of the 2013 curriculum, 100% of participants agreed with and recognized the advantages of the 2013 curriculum, but only 50% were able to apply it consistently in learning activities. Mukminin (2022) stated that there is a significant influence of the implementation of the 2013 curriculum and teacher performance on the learning outcomes of didi participants.

Learning outcomes are obtained by students after following the learning process, which is divided into cognitive, affective, and psychomotor aspects. This is in line with Alamsyah (2021)explaining learning outcomes as an assessment of the results that have been achieved by students obtained from the efforts of learning activities assessed over a certain period. Education today does not only focus on learning outcomes; it must also pay attention to skills that support the progress of human resources in accordance with the development of science and technology that occurs in the 21st century.

The development of science and technology in the 21st century is growing so rapidly that it affects human life, especially in the field of education. The US-based Apollo Education Group identifies 21st century skills that include critical thinking, communication, leadership, collaboration, adaptability, productivity and accountability, innovation, global citizenship, entrepreneurial ability and spirit, and the ability to access, analyze, and synthesize information (Zubaidah, 2016). One of the 21st century skills that needs to be developed is collaboration. Collaboration skills are part of the 4C skills (critical thinking, creative thinking, communication, and collaborative skills) that need to be trained and developed (Kurniahtunnisa & Wowor, 2022).

Collaboration skills are crucial in the learning process because they aim to enable students to work together in groups to solve problems together (Pramudiyanti et al., 2020). Then, collaboration involves the division of tasks, and everyone has responsibility for doing the work to achieve a common goal. According to Greenstein (in Cahyati, 2019) collaboration skills are the ability to work together effectively, show respect to different team members, train skills, and have the willingness to make decisions necessary to achieve common goals.

Based on the results of observations that have been made at SMA Negeri 8 Tasikmalaya through interviews with biology class X MIPA teachers on November 15, 2022 and direct observation of the learning process in classes X MIPA 1 and 2, the following results were obtained: The average scores of students in each biology teaching material have different averages. One of them is in the ecosystem material for the 2021/2022 school year, which has an average value of learning outcomes of 70, while the KKM (Minimum Completeness Criteria) value that must be achieved by

students is 75. So that participants who have scores below KKM (Minimum Completeness Criteria) are given a remedial opportunity. As for the learning process in the classroom, teachers have used direct instruction and discovery learning models, but the implementation has not been optimal. The learning process has carried out learning in groups but has not optimally led to collaboration skills, which is shown by the presence of students who have difficulty conveying arguments, communicating discussion results, asking questions, and answering questions.

One concept in biology that can give rise to collaboration skills is ecosystem material. Ecosystem material in the discussion is related to everyday life, which includes biotic and abiotic components, interactions between organisms, and biogeochemical cycles. Through the Project-Based Learning (PjBL) model, ecosystem materials allow project-based learning to be carried out, which will make it easier for students to be able to understand it collaboratively. This is in accordance with KD. 4.10 in the 2013 Curriculum applied at SMA Negeri 8 Tasikmalaya, which requires students to create works that show interactions between ecosystem components and are done in groups (collaboratively).

Several studies related to the project-based learning (PjBL) model have had a positive impact on the learning process. Hamidah (2021) conducted research on the effectiveness of the project-based learning (PjBL) model on learning outcomes. The results of her research stated that the project-based learning model was effective in improving student learning outcomes. Saenab (2019) in his research on the influence of the project-based learning (PjBL) model on the collaboration skills of science education students, found that the results of the inferential test show the influence of the project-based learning (PjBL) model on student collaboration skills. Some previous research has focused on the effect of the project-based learning (PjBL) model on learning outcomes and collaboration skills separately. This study focuses on the influence of the project-based learning (PjBL) model on the learning outcomes and collaboration skills of students.

In line with the background of the problem, researchers tried to conduct research by applying the project-based learning (PjBL) model to determine the effect of the PjBL model on the learning outcomes and collaboration skills of students. The existence of this research is expected to improve the learning outcomes and collaboration skills of students and be useful for readers in improving the quality of education.

METHOD

The method used in the study, namely the Quasi experiment with the design of the matching-only posttest-only control group design from Fraenkel *et al* (2012) can be seen in Table 1.

Table 1. Research Design

M_1	X	O_1
M_2	C	O_2

(Source: Fraenkel et al., 2012)

Information:
M_1 : Experimental class group
M_2 : Control class group
X : Experimental class using the Project-Based Learning (PjBL) model
C : Control class using the Discovery Learning model
O_1 : Post-test experimental class
O_2 : Post-test control class

The population in the study is the entire class X MIPA SMA Negeri 8 Tasikmalaya Academic Year 2022/2023. The study population amounted to 186 students, consisting of 5 classes of X MIPA, namely X MIPA 1 to X MIPA 5. The sampling technique uses purposive sampling, which is based on teachers of the same subjects with the same learning activity and learning outcomes that are not much different, so they have the same characteristics. The selection of control classes and experimental classes is carried out randomly. The sampling results were declared X MIPA 4 as an experimental class with a total of 37 people and X MIPA 1 as a control class with a total of 35 people. The learning control class uses the discovery learning model, while the experimental class uses the project-based learning (PjBL) model. Data collection from post-test scores using learning outcomes tests (which are limited to cognitive processes) and non-tests in the form of Collaboration Self-Assessment Tool (CSAT) questionnaires

The test instrument is in the form of multiple-choice questions—as many as 30 questions—that are limited to the cognitive processes of remembering (C1), understanding (C2), applying (C3), analyzing (C4), and evaluating (C5) and dimensions of factual (K1), conceptual (K2), and procedural (K3) knowledge. Meanwhile, the non-test used the Collaboration Self-Assessment Tool (CSAT) questionnaire with a total of 44 statements, which were validated by experts (expert judgment) and readability validated by 3 students of grade X MIPA 1 SMA Negeri 8 Tasikmalaya. As for the 44 statements, there were improvements in sentence structure on indicators of contribution, quality of work, time management, problem solving, group dynamics, flexibility, and reflection. The research data were analyzed with the help of IBM SPSS 26 software. The prerequisite analysis tests included normality tests with the Kolmogorov-Smirnov test and homogeneity tests with the Levene test at significance level (α) 0.05. Test the hypothesis using the one-way ANOVA test at a significance level (α) of 0.05, both partially and simultaneously. The anova test is used to determine the average difference between the two groups. The hypotheses in this study are as follows:

Ho : There is no influence of the project based learning (PjBL) model on learning outcomes and student collaboration skills on ecosystem materials;
Ha : There is an influence of the project-based learning (PjBL) model on learning outcomes and student collaboration skills in ecosystem materials.;

RESULTS AND DISCUSSION

The Effect of a Project-Based Learning Model on Learning Outcomes and Collaboration Skills

Project-Based Learning (PjBL) is a teaching and learning strategy in which students engage in productive projects to solve community or environmental problems (Putri & Zulyusri, 2022). The results prove that the project-based learning (PjBL) model has an influence on the learning outcomes and collaboration skills of students. Based on the results of simultaneous data analysis, sig values are obtained. 0.000 (0.000< 0.05) with a calculated F value of 14.475 > F table 3.12, which means that Ho is rejected and Ha is accepted, or simultaneously, there is an influence of the project-based learning (PjBL) model on learning outcomes and student collaboration skills on ecosystem material in class X MIPA SMA Negeri 8 Tasikmalaya Academic Year 2022/2023. The average learning outcomes and collaboration skills of the experimental class and the control class are stated in Figure 1.

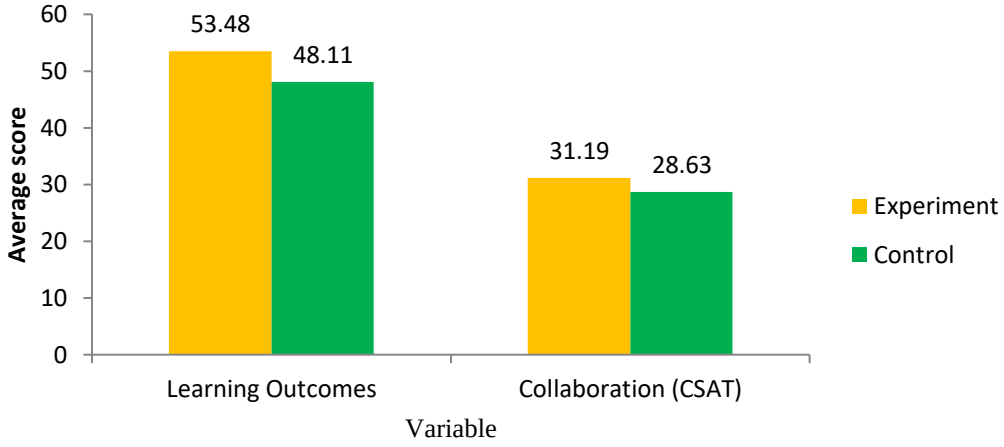

Figure 1. Average scores of learning outcomes and collaboration skills in experimental and control classes

Based on Figure 1, it is known that the average difference in learning outcomes and collaboration of students in experimental classes whose learning uses the project-based learning (PjBL) model has a higher average score of 16.06 for learning outcomes and 31.19 for collaboration skills compared to the average score of the control class using the discovery learning model of 14.46 for learning outcomes and 28.63 for collaboration skills. The difference in average scores indicates that there is an influence of the project-based learning (PjBL) model on student learning outcomes and collaboration skills.

The existence of this influence is because, in using the project-based learning (PjBL) model, students are given the opportunity to actively participate in learning through projects, thus affecting learning outcomes and student collaboration skills. In line with Na'imah (in Roziqin et al., 2018) the project-based learning (PjBL) model provides opportunities for students to actively participate in learning so as to give a pleasant impression and can improve learning outcomes and collaboration skills. According to Aini (2018) the project-based learning (PjBL) model can create an

interesting and fun learning atmosphere because students determine the project to be made and take responsibility for completing it.

The results of this study are in line with Khanifah's research (2019) which states that the use of the project-based learning (PjBL) model affects learning outcomes and collaboration skills, as shown by the results of hypothesis testing. The calculated f value is greater than the table f value (7,259 > 2,920), and the significance value is smaller than the a value (0.002 < 0.05), because with project-based learning (PjBL), students are given the opportunity to find concepts or understanding through examples encountered in everyday life. Apriliani (2018) stated that learning using the project-based learning (PjBL) model affects learning outcomes because it is able to stimulate students to work together with other group members through projects made so that students gain knowledge from others. Saenab (2019) suggests that there is an influence of the project-based learning (PjBL) model on improving collaboration skills because activities in the PjBL model are able to make students respect each other, agree, find solutions, and achieve the goals of project implementation.

As for the implementation of research, it has been carried out in accordance with research procedures. However, the average difference in learning outcomes was 2.14, and the average difference in collaboration skills was 2.56. This means that the difference in average scores has a small difference, so learning outcomes and collaboration skills can still be improved again considering the project-based learning (PjBL) model has several weaknesses in terms of time, cost, and other supporting facilities. Zulhana (2017) project-based learning (PjBL) model has several disadvantages, namely requiring a lot of time to solve problems and produce products, requiring sufficient costs, requiring skilled and willing teachers to learn, and requiring adequate facilities, equipment, and materials.

Based on this description, it can be concluded that the project-based learning (PjBL) model can be one of the learning models that can be used to train and improve the learning outcomes and collaboration skills of students. This is shown by the Anova test, and the average score obtained on learning outcomes and collaboration skills for the experimental class is higher than that of the control class. Learning outcomes and collaboration skills still need to be improved, considering that the project-based learning model has several weaknesses.

The Effect of a Project-Based Learning Model on Learning Outcomes

Learning outcomes are essentially obtained by students after going through learning experiences. This study used a test instrument in the form of a compound choice of 30 questions to measure learning outcomes. The data tested were the posttest scores for the experimental class and the control class. Based on the results of data analysis using the one-way anova test with the help of IBM SPSS 26 software, a significance value of 0.020 (0.020<0.05) was obtained, meaning that H0 was rejected and Ha was accepted, or there was an influence of the project-based learning (PjBL) model on student learning outcomes on ecosystem material in class X MIPA SMA Negeri 8 Tasikmalaya for the 2022/2023 academic year.

The existence of this influence is because students whose learning process uses the project-based learning (PjBL) model have the ability to construct knowledge and apply it through the projects they make. In line with Panjaitan (2019) which suggests that the project-based learning model allows students to carry out learning activities that support the knowledge construction process. Hamidah (2021) With project-based learning, students are given the opportunity to explore and discover through investigation and project creation. So that students have meaningful experiences that can increase their understanding of the material learned. Therefore, learning outcomes become better. The following is the score obtained from the learning outcomes of the experimental class and the control class (Fig. 2).

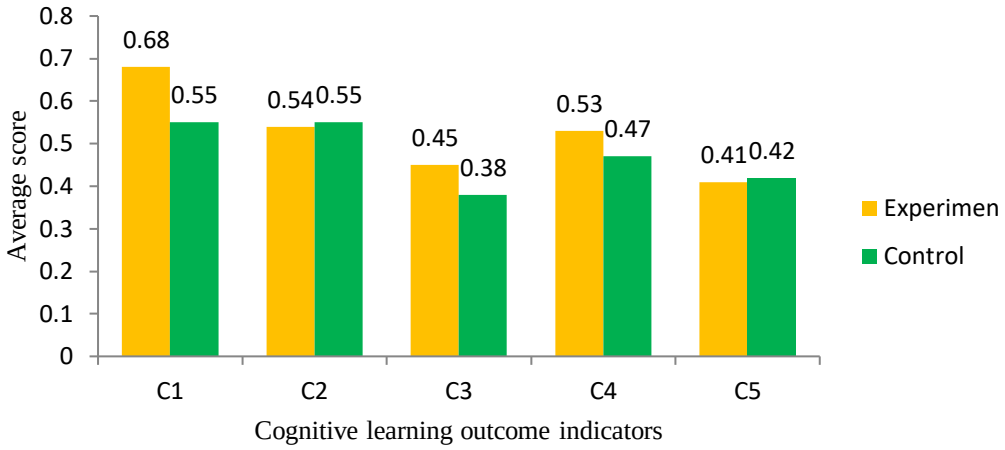

Figure 2. Bar chart of average learning outcomes score

Figure 2 shows the average posttest score of experimental and control class learning outcomes, with an ideal score of 1. It is known that the highest score of the experimental class and the highest score of the control class are found on the same indicator, namely remembering (C1). The experimental class obtained a recall score (C1) of 0.68, and the control class obtained a recall score (C1) of 0.55. Meanwhile, the lowest score of the experimental class was found in the evaluating indicator (C5) at 0.41. While the lowest score of the control class is found in the applying indicator (C3) of 0.38, As for the indicators of understanding (C2) and evaluating (C5), the control class is superior to the experimental class. The control class's understanding indicator (C2) obtained a score of 0.55, and the evaluating indicator (C5) obtained a score of 0.42.

Based on this, posttest learning outcomes conducted in the experimental class and control class obtained the highest average score on the recall indicator (C1). This shows that the use of project-based learning (PjBL) and discovery learning models has an impact on the ability of cognitive processes to remember (C1). Anderson & Kratwohl (2017) the ability to remember (C1) is a cognitive process in the category LOTS (Lower Order Thinking Skill). Recall indicators include the processes of remembering (recalling) and recognizing (recognizing). Nabilah (2020) some mistakes students make in answering questions on the remembering indicator (C1) because students do

not understand the concept and they forget the material tested because it has been far passed.

The indicator with the lowest average score on the experimental class posttest was the evaluating indicator (C5) at 0.41. A low ability to evaluate can be caused by the inability of students to assess a statement. In addition, it can be caused because students are accustomed to obtaining knowledge from teachers and are not used to being independent in finding knowledge. Rochman (2018) students who are not used to acquiring knowledge independently affect their ability to assess a statement. Afriani (2022) students are said to have the skill to evaluate if they are able to understand the meaning of the statement and provide the right reasons for choosing answers.

The lowest average score in the control class was found in the applying indicator (C3) at 0.38. This shows that students are not used to using a procedure and carrying it out when solving problems. Anderson & Kratwohl (2017) argue that applying includes the process of executing and explaining. According to Nabilah et al. (2020), there are several mistakes that occur in students when working on applying questions (C3), including misunderstanding and translating problems so that students go through the stages of solving, errors in using concepts, and errors in calculating problem solving.

The other learning outcome indicators are the understanding indicator (C2) of the control class, which is superior to the experimental class with a score of 0.55. Higher comprehension scores (C2) indicate the ability of students to construct meaning (understanding). Anderson & Kratwohl (2017) Understanding indicators include the cognitive processes of interpreting, giving examples, classifying, comparing, and explaining. As for the implementation of learning in the control classroom using the discovery learning model, students are accustomed to working on LKPD (student worksheets), which stimulate students to interpret, give examples, compare, and explain the material. According to Nabilah(2020), student errors in the understanding indicator (C2) can be caused by students forgetting the material that has been learned.

The evaluating indicator (C5) in the control class obtained a higher average score compared to the experimental class of 0.41. Higher evaluation scores indicate the ability of students to determine a consideration and assess a statement. Anderson & Kratwohl (2017) evaluate indicators, which include cognitive processes of examining and critiquing. In the learning process in the control class, students are accustomed to examining and assessing a statement. In discovery learning, students look for various sources of information and check them to answer questions in LKPD (Student Worksheets).

Based on data obtained from the results of learning outcomes research, it is known that the project-based learning (PjBL) model has an influence on student learning outcomes. The highest score in the experiment and control classes was found on the recall indicator (C1). Meanwhile, the lowest score of the experimental class is found in the evaluating indicator (C5). While the lowest score of the control class is found in the applying indicator (C3), when viewed as a whole, the experimental class that uses a project-based learning model is superior to three indicators, namely remembering (C1), applying (C3), and analyzing (C4). Meanwhile, the indicators of

understanding (C2) and evaluating (C5) in the experimental class tend to be lower than those in the control class.

The Effect of a Project-Based Learning Model on Collaboration Skills

This research shows that the project-based learning (PjBL) model influences student collaboration skills. Based on the results of the hypothesis test data analysis using One Way Anova with the help of IBM SPSS 26, a significance value of 0.046 was obtained, so the conclusion of the hypothesis obtained was that Ho was rejected and Ha was accepted because 0.046 < 0.05. This means that there is an influence of the project-based learning (PjBL) model on the collaboration skills of students in class X MIPA SMA Negeri 8 Tasikmalaya for the 2022/2023 academic year.

This influence is because students whose learning process uses the project-based learning (PjBL) model are accustomed to collaborating on projects and are actively involved in learning. This is in line with the George Lucas Educational Foundation (in Nurohman, 2015) that project-based learning Project-based learning provides opportunities for students to collaborate in exploring content (material) in various meaningful ways. Meilinawati (in Alfaeni et al., 2022), namely the application of the project-based learning (PjBL) model, can improve collaboration skills and the quality of learning carried out by students. The acquisition of questionnaires on the collaboration skills of the experimental class and the control class can be seen in Figure 3.

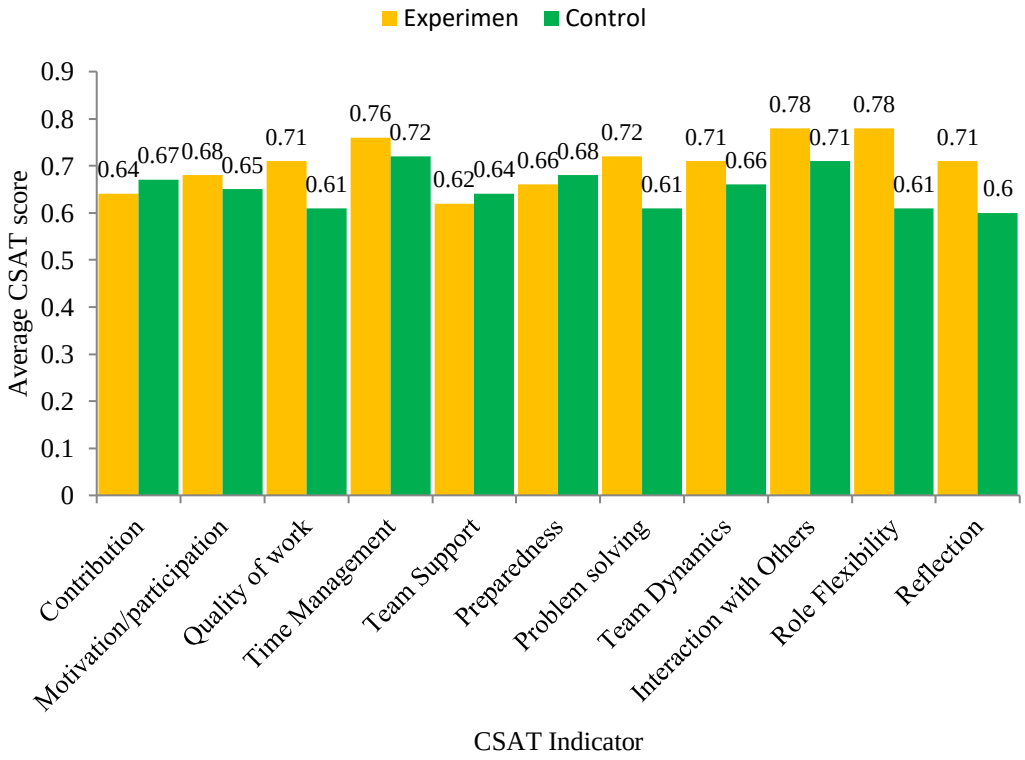

Figure 3. Average bar chart of collaboration skills

Figure 3 is the average score of the CSAT (Collaboration Self-Assessment Tool) experimental class and control class, with an ideal score of 1. It is known that the highest score of the experimental class is found in the interaction and flexibility indicator, with a score of 0.78. While the highest score of the control class was found in the time management indicator with a score of 0.72, meanwhile, the lowest score of the experimental class was found in the group support indicator, with a score of 0.62. While the lowest score of the control class was found in the reflection indicator with a score of 0.60, as for the indicators of contribution, group support, and preparation, it was seen that the control class obtained higher scores than the experimental class. The contribution indicator of the control class obtained a score of 0.67. The support indicator of the control class group obtained a score of 0.64. The control class preparation indicator obtained a score of 0.68.

The highest average achievement of the experimental class was found in the interaction and flexibility indicator, with the same average score of 0.78. This is because experimental classes using the project-based learning (PjBL) model can stimulate students to interact with each other in making projects and train students' adaptability (flexibility) in leading and being led during project work. Ofstedal (2009) flexibility leads to the ability or flexibility of learners in the role of leaders or followers when in a group. Interaction is the ability to respect, listen, acknowledge, and support colleagues in a group. Nasehudin (in Qisthi & Diella, 2021) says that to form good interactions between teachers and students, students with students, and students with material, elements of communication are needed.

Meanwhile, in the control class, the highest average collaboration score was found in the time management indicator of 0.72. This is because the control class uses a discovery learning model so that the learning stages and phases are more structured and students are accustomed to completing tasks on time. Ofstedal (2009) defines time management as the ability of learners to manage their time and be responsible for completing tasks on time. The high ability to collaborate on time management indicators is related to the ability of students to function. Dewi (2020) defines functioning as the ability of students to manage group activities when doing tasks and establish effective working relationships because it can be done on the same day.

Furthermore, the lowest average score of the experimental class was found in the group support indicator, with a score of 0.62. Ofstedal (2009) says group support relates to the ability of learners to support efforts made by colleagues in a group. Low group support can be caused because students are not used to creating cooperative groups, so the support from group colleagues is not so good. According to Dewi (2020), the ability of students to create cooperative groups affects their collaboration skills. As for the learning process, group formation is carried out randomly by counting.

Meanwhile, the control class's lowest average collaboration score was on the reflection indicator, with a score of 0.60. Low reflection scores are related to the ability of students to evaluate the sustainability of group work and group work results. Sandars (2009) says that reflection in the context of education has a meaning as a process of rethinking so that it can be interpreted or analyzed. Rahman (2014) says

that reflection has the potential to stimulate one's emotional self-awareness in a good way. As a result, a person is more likely to enter feelings. Emotions, needs, and values that reside in him so that he becomes a better self.

The results of other collaboration skill indicators, such as contribution indicators, in the experimental class obtained a score of 0.64, while the control class obtained a score of 0.67. This means that the contribution indicator of the control class is superior to that of the experimental class. The low contribution to experimental classes can be caused by students not being accustomed to sharing ideas, information resources, and resources that are owned through project-based learning. Ofstedal (2009) Contribution indicators lead to the ability to share ideas, information, and resources with colleagues in a group. Suciani (2018) is one of the reasons students are less active in contributing because they have difficulty sharing ideas, information sources, and resources they have. In addition, contributions can be influenced by the ability of students to function in groups, which includes dividing tasks and completing them.

The experimental class preparation indicator obtained a score of 0.66, while the control class obtained a score of 0.68. This means that control class students have good preparation before starting learning. In the learning process using discovery learning, students are easier to prepare because what needs to be prepared is more than the tools and materials commonly used in learning activities. This is different from the learning process using project-based learning, which is more complex, so often the tools that will be used are not brought in (left behind). This affects students in choosing statements on the preparation indicators. Ofstedal (2009) argues that preparatory indicators lead to the ability of learners to prepare the tools and materials needed. Apriono (in Dewi, 2022)preparation can be influenced by the ability of learners to manage group activities.

The control class learner group support indicator was superior to the experimental class by 0.64. Higher scores on the group support indicator indicate that control-class learners have the ability to support other colleagues in the group. This can be caused because in the learning process using discovery learning, the division of tasks is more in the context of how to complete the LKPD (student worksheet) and present the answers from the LKPD that have been completed, in contrast to the experimental class learning process, which uses a project-based learning model whose activities are more complex and continuous, and sometimes students feel the absence of group support. This affects the answers to student questionnaires on group support indicators. Dewi (2020) suggests that group support can be influenced by the ability of learners to function or manage groups, which includes effective division of tasks and work relationships. In addition, group support can be influenced by group formation that is carried out randomly (by counting), so that group formation is not in accordance with the wishes of students.

Based on the data obtained from the results of the study, it shows that there is an influence of the project-based learning (PjBL) model on collaboration skills. The highest score of the experimental class was found on the indicators of interaction and flexibility. The highest score of the control class is found on the time management

indicator. Meanwhile, the lowest score of the experimental class was found on the group support indicator. The lowest score of the control class is found on the reflection indicator. When viewed as a whole, the experimental class is superior to eight indicators, namely motivation/participation, work quality, time management, problem solving, group dynamics, interaction, flexibility, and reflection. Meanwhile, the indicators of contribution, group support, and preparation of experimental class students tend to be lower.

CONCLUSION AND RECOMENDATION

Based on the results of research, data processing, and hypothesis testing, partially and simultaneously, Reject Ho and Accept Ha or there is an influence of the project-based learning (PjBL) model on the learning outcomes and collaboration skills of students in class X MIPA SMA Negeri 8 Tasikmalaya Academic Year 2022/2023.

For future researchers, it is expected to continue research on the use of project-based learning models on other materials, combined with the use of other media/ applications, to be more optimal. In addition, there needs to be further development of products made by students so that the projects made are not wasted and can be used further.

ACKNOWLEDGMENT

The author gives thanks to all parties who contributed to this research. This gratitude is given to the Dean of FKIP Universitas Siliwangi, family, friends, and comrades in arms who also provided prayers and support in the preparation of this research.

REFERENCES

Aini, Q., Lesmono, A. D., & Wahyuni, S. (2018). Hasil Belajar, Minat Dan Kreativitas Siswa Sma Pada Pembelajaran Fisika Menggunakan Model Project Based Learning Dengan Memanfaatkan Bahan Bekas. *Jurnal Pembelajaran Fisika*, *7*(1), 1. https://doi.org/10.19184/jpf.v7i1.7218

Alamsyah, A., Rumanta, M., & Widiasih, W. (2021). Pengaruh model pembelajaran Project Based Learning dan keterampilan kolaborasi terhadap Hasil Belajar IPA Siswa. *Jurnal Elementaria Edukasia*, *4*(2), 179–188. https://doi.org/10.31949/jee.v4i2.3147

Alfaeni, D., Nurkanti, M., & Halimah, M. (2022). Kemampuan Kolaborasi Siswa melalui model Project Based Learning menggunakan Zoom pada materi Ekosistem. *BIOEDUKASI (Jurnal Pendidikan Biologi)*, *13*(2), 143. https://doi.org/10.24127/bioedukasi.v13i2.6330

Anderson, L. W., & Kratwohl, D. R. (2017). *Kerangka Landasan Untuk Pembelajaran, Pengajaran dan Asesmen*. Pustaka Pelajar.

Apriliani, D. N. ;Vertika P. (2018). Model Pembelajaran berbasis Project Based Learning (Pjbl) terhadap Minat Belajar dan Hasil Belajar Siswa kelas X RPL di SMK Negeri 1 Boyolangu. *JoEICT (Journal of Education Jurnal and Information Communication Technology) and Information Communication Technology)*, *2*(20), 19–26. http://www.jurnal.stkippgritulungagung.ac.id/index.php/joeict/article/view/691

Cahyati, D. s. (2019). Kemampuan Literasi Sains Aspek Proses Sains dan

Keterampilan Collaborative calon Guru Biologi pada pembelajaran Free-Inquiry. *Jurnal Bio Educatio*, *4*, 35–46.

Dewi, A. P., Putri, A., Anfira, D. K., & Prayitno, B. A. (2020). Profil keterampilan kolaborasi mahasiswa pada rumpun pendidikan MIPA. *Pedagogia Jurnal Ilmu Pendidikan*, *18*(01), 229–238.

Dewi, M. R. (2022). Kelebihan dan Kekurangan Project-based Learning untuk Penguatan Profil Pelajar Pancasila Kurikulum Merdeka. *Ejournal UPI*, *19*(2), 213–226.

Fraenkel, J., Wallen, N. E., & Hyun, H. H. (2012). How to design and Evaluate reseach in Education. In *McGraw-Hill* (8th ed.).

Hamidah, I., & Citra, S. Y. (2021). Efektivitas model pembelajaran Project Based Learning (PjBL) terhadap Minat dan Hasil Belajar Siswa. *BIOEDUSAINS:Jurnal Pendidikan Biologi Dan Sains*, *4*(2), 307–314. https://doi.org/10.31539/bioedusains.v4i2.2870

Herawati, D., Latifah, S. S., & Munandar, R. R. (2018). Persepsi Guru terhadap Implementasi Kurikulum 2013 dalam pembelajaran Biologi. *Pedagonal : Jurnal Ilmiah Pendidikan*, *2*(2), 01–06. https://doi.org/10.33751/pedagog.v2i2.847

Khanifah, L. N. (2019). Pengaruh penggunaan model Project Based Learning dan keterampilan kolaborasi terhadap Hasil Belajar Siswa kelas IV Sekolah Dasar pada tema cita-citaku. *Jurnal Review Pendidikan Dasar : Jurnal Kajian Pendidikan Dan Hasil Penelitian*, *5*(1), 900–908. https://doi.org/10.26740/jrpd.v5n1.p900-908

Kurniahtunnisa, & Wowor, E. C. (2022). Development of STEM - Project Based Learning Devices to Train 4C Skills of Studentsf Biology Education. *Bioeduca: Journal of Biology Education*, *4*(2), 1–11.

Mukminin, A., Fitria, H., & Fitriani, Y. (2022). Pengaruh Kurikulum 2013 dan kinerja Guru terhadap Hasil Belajar Siswa. *Jurnal Pendidikan Tambusai*, *6*(3), 14009–14017. https://doi.org/10.31004/jptam.v6i3.4929

Nabilah, M., Sitompul, S. S., & Hamdani, H. (2020). Analisis Kemampuan Kognitif Peserta Didik Dalam Menyelesaikan Soal Momentum Dan Impuls. *Jurnal Inovasi Penelitian Dan Pembelajaran Fisika*, *1*(1), 1. https://doi.org/10.26418/jippf.v1i1.41876

Nurohman, S. (2015). Pendekatan Project Based Learning. *Pendidikan Matematika*, *1*(1), 1–20.

Ofstedal, K., & Dahlberg, K. (2009). Collaboration in student teaching: Introducing the collaboration self-assessment tool. *Journal of Early Childhood Teacher Education*, *30*(1), 37–48. https://doi.org/10.1080/10901020802668043

Panjaitan, E. U., Adam, J. H., & Lingkar, M. (2019). Pengaruh Model Pembelajaran Project Based Learning terhadap hasil belajar biologi siswa SMAN 1 Aeksongsongan. *Jurnal Edu-Bio*, *1*(1), 2019.

Pramudiyanti, Nabilla, I. O., & Maulina, D. (2020). Pengaruh model pembelajaran Discovery Learning terhadap keterampilan kolaborasi Pencemaran Lingkungan. *Jurnal Bioterdidik*, *8*(2), 66–75. https://doi.org/10.23960/jbt.v8.i2.08

Putri, Y. A., & Zulyusri. (2022). Meta-Analisis Pengaruh Model Project Based Learning Terhadap. *Bioeduca: Journal of Biology Education*, *4*, 1–11. http://journal.walisongo.ac.id/index.php/bioeduca

Qisthi, N., & Diella, D. (2021). *Efektivitas pembelajaran daring berbasis Google Docs terhadap keterampilan kolaborasi Peserta Didik pada konsep Perubahan Lingkungan*. 277–294.

Rahman, B. (2014). Refleksi Diri dan Peningkatan Profesionalisme Guru. *Paedagogia*, *17*(1), 1–12. http://jurnal.fkip.uns.ac.id/index.php/paedagogia

Rochman, S., & Hartoyo, Z. (2018). Analisis High Order Thinking Skills (HOTS) Taksonomi menganalisis permasalahan Fisika. *Science and Physics Education Journal (SPEJ)*, *1*(2), 78–88. https://doi.org/10.31539/spej.v1i2.268

Roziqin, M. K., Lesmono, A. D., & Bachtiar, R. W. (2018). Pengaruh Model Pembelajaran Berbasis Proyek (Project Based Learning) Terhadap Minat Belajar Dan Keterampilan Proses Sains Siswa Pada Pembelajaran Fisika Di Sman Balung. *Jurnal Pembelajaran Fisika*, *7*(1), 108. https://doi.org/10.19184/jpf.v7i1.7232

Saenab, S., Yunus, S. R., & Husain, H. (2019). Pengaruh penggunaan model Project Based Learning terhadap keterampilan kolaborasi Mahasiswa pendidikan IPA. *Biosel: Biology Science and Education*, *8*(1), 29. https://doi.org/10.33477/bs.v8i1.844

Sandars, J. (2009). The use of reflection in medical education: AMEE Guide No. 44. *Medical Teacher*, *31*(8), 685–695. https://doi.org/10.1080/01421590903050374

Siregar, M. K., & Amrizal, A. (2018). Implementasi Kurikulum 2013 dengan pendekatan Saintifik (Scientific Approach) pada mata pelajaran Biologi. *Jurnal Pelita Pendidikan*, *6*(4), 238–246. https://doi.org/10.24114/jpp.v6i4.11068

Suciani, T., Lasmanawati, E., & Rahmawati, Y. (2018). Pemahaman Model Pembelajaran Sebagai Kesiapan Praktik Pengalaman Lapangan (Ppl) Mahasiswa Program Studi Pendidikan Tata Boga. *Media Pendidikan, Gizi, Dan Kuliner*, *7*(1), 76–81.

Zubaidah, S. (2016). Keterampilan abad ke-21: Keterampilan yang diajarkan melalui Pembelajaran. *Researchgate*, *December 2016*.

Zulhana, Z., & Usman, M. (2017). Keefektifan Model Pembelajaran Berbasis Proyek Dalam Keterampilan Berbicara Bahasa Jerman Siswa Kelas X Mia Sma Negeri 2 Sungguminasa. *Eralingua: Jurnal Pendidikan Bahasa Asing Dan Sastra*, *1*(1), 1–11. https://doi.org/10.26858/eralingua.v1i1.2984