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IMPROVING LEARNING OUTCOMES AND STUDENT RESPONSES THROUGH PROJECT BASED LEARNING MODEL ON LIGHT AND OPTICAL INSTRUMENTS

Galang Sasmito Aji[1], *Darmadi*[2], *Yulida Isro'in Rohmawati*[3]
[1]Teacher Professional Education, Faculty of Teacher Training and Education, PGRI Madiun University, Indonesia
[2]Mathematics Education, Faculty of Teacher Training and Education, PGRI Madiun University, Indonesia
[3]Public Junior High School 1 Ngasem, Bojonegoro, Indonesia

Abstract

This study aims to improve the results and learning responses of class VIII-F students of SMPN 1 Ngasem through the application of the Project Based Learning (PjBL) learning model. The subjects in this study were class VIII-F students of SMPN 1 Ngasem with a total of 21 students. The type of research conducted was Classroom Action Research (PTK) which was conducted in two learning cycles. There are four stages in classroom action research, namely: (1) planning, (2) implementation, (3) observation, and (4) reflection. The data collection technique used in this study was the learning achievement test and student response questionnaires. The results of the study show that applying the project based learning model is quite effective in improving student learning outcomes. Based on the learning outcomes of the cognitive domain on science learning outcomes, it was found that the mastery learning conditions before the action (observation), cycle I, and cycle II showed a percentage of completeness of 28%, 57% and 76%. Besides that, through this learning model, a positive response was obtained from students who obtained an increase in the percentage of responses from cycle I and cycle II, which obtained a percentage of 67.5% which was included in the good criteria, and 83% which was included in the very good criteria. So, it can be concluded that learning science by applying the Project Based Learning (PjBL) model is able to improve the learning outcomes and responses of class VIII students.

Keywords: Project Based Learning, Learning Outcomes, Responses, Action Research

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[1]Corresspondence Address:
Teacher Professional Education, Faculty of Teacher Training and Education, PGRI Madiun University,Indonesia
E-mail: ppg.galangsasmitoaji01@program.belajar.id

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INTRODUCTION

Learning is one of a series of activities that involve sending and receiving information that is carried out in a planned manner to make it easier for students to achieve learning goals. Learning Natural Sciences (IPA) is one of the sciences that studies concepts, facts, laws, and theoretical forms. In science learning activities students will be able to relate existing facts, so that students are able to build their own knowledge and are able to think scientifically (Ramadhani, 2020). Science learning basically emphasizes student process activities, so that in science learning an emphasis is needed on direct experience, so as to provide space for students to grow and develop the ability to think, work, and act scientifically in an integrated manner (Yulianti et al., 2023). To achieve the goals of learning science at school, science teachers must understand its nature, act as a learning facilitator, and adjust teaching to the abilities and needs of students as specified in the curriculum (Al-Busaidi & Al-Seyabi, 2021). However, due to the change in curriculum from K13 to an independent curriculum, many teachers are still unable to adjust their teaching to science learning. So that it causes problems in learning science, namely the low learning outcomes and responses from students when implementing learning in class. Many factors influence the success of student learning and things that often hinder the achievement of science learning goals.

One of these factors is that learning is still teacher-centered so that it does not involve students actively to interact in class, the lack of teacher mastery in using more fun learning models and the minimal use of learning media assistance for students (Rusmini et al., 2021). Project-based learning is one a learning model that uses problems as a basis for acquiring new knowledge based on experience to integrate concepts into real-life activities (Anwar et al., 2021). Project-based learning is able to encourage students to carry out investigative activities carried out collaboratively with group members to identify and create a product to solve an existing problem, while being able to encourage students to achieve the minimum completeness criteria (KKM). (Zuhaida & Mubtasyiroh, 2022). KKM is a minimum completeness criterion that must be achieved by students both in cognitive, psychomotor, and affective aspects (Iswatun et al., 2017). The learning model will be used more effectively with the right learning media, one of which is the student worksheet (LKPD). LKPD is a tool used in learning to make it easier for students to understand the material and improve learning activities. LKPD-assisted learning activities make students discover concepts independently (Fadilah, 2018). LKPD can help students construct their understanding to be poured into a new creative product. The stages in learning Project Based Learning includes basic questions, designing project plans, compiling project production schedules, designing project plans, compiling production schedules, monitoring project progress, testing product results, and evaluating learning experiences (Partjuma et al., 2022).

Based on the results of the pre-research response questionnaire analysis conducted by the researcher, it was stated that class VIII students at SMPN 1 Ngasem obtained the results of the pretest conducted by the researcher to obtain the percentage of student completeness, which obtained a percentage of 28% or 6 students who were able to obtain the above scores. KKM 75, while 72% or as many as 15 students have not reached KKM. Based on the results of observations made by researchers, this occurs because the learning process is still conventional. Where in learning activities teachers tend to be more active in learning so that students are mostly passive, resulting in student learning outcomes that are still lacking or have not been able to achieve the expected KKM. Based on the problems that have been described, a strategic step is needed by utilizing appropriate and appropriate learning models in order to be able to improve learning outcomes and student responses. Project-Based Learning (PjBL) is a learning model that organizes a group in a class in a project. The PjBL learning model involves students to create a product that requires students to solve real problems and be actively involved in learning. By defining key points during the project, clearly demonstrate that they have learned key concepts and skills. The existence of this PjBL Model is expected to be able to improve student learning outcomes, and increase students' positive responses in making projects (science learning media), increase collaboration or the role of group collaboration, and develop students' planning abilities (Susanti et al., 2020). The goal in implementing the Project Based Learning model is to enable students to collaboratively solve problems and produce projects while they are learning. In this learning process, the teacher only acts as facilitator because learning will be boring if it is a lecture. The lecture learning system is where the teacher does not develop teaching materials and tends to be sober (watching), especially if students tend to be passive and only recipients of knowledge or it can be said that they are just listening (Hamidah & Citra, 2021).

Based on the description described above, the researcher conducted a study with the aim of

applying the model Project Based Learning (PjBL) in science learning to improve science learning outcomes and the response of class VIII students.

METHOD

Research Method

The research used in this research is classroom action research (PTK) which aims to improve the learning outcomes and responses of class VIII students by applying the model Project Based Learning (PjBL) on IPA learning

Research Subject

This research was conducted in the even semester of the 2022/2023 school year at SMP Negeri 1 Ngasem, Bojonegoro Regency. The subjects of this study were class VIII-F students with a total of 21 students. The selection of this subject was based on the results of the analysis of the researcher's observations and the learning outcomes and responses of the students tended to be low.

Data Collection Technique

The source of the data obtained is through questionnaires and evaluation tests. While the instruments used were lesson plans, worksheets, assessments, and student response questionnaires. Data collection techniques in this study used written tests and student response questionnaires. Data analysis was carried out by data reduction, data presentation, conclusions, and reflection. Data on the results of student responses were obtained through student response questionnaires which were carried out in each learning cycle. Then, data for students' cognitive learning outcomes is obtained through written test scores. Tests carried out before learning (pretest) then at the end of each learning cycle students are given a written test sheet (posttest). So from the comparison of the values obtained, it can be seen that the increase in student learning outcomes. The classroom action research used in the research consisted of two cycles. In cycle I, if the specified indicators have not been reached, then cycle II is carried out. Each cycle is carried out in 2 meetings. Based on the research method, each CAR research cycle has four stages, namely planning (plan), execution (action), observation (observe), and reflection (reflect) (Arikunto, 2017). The design of the activities carried out in this study is shown in Figure 1.

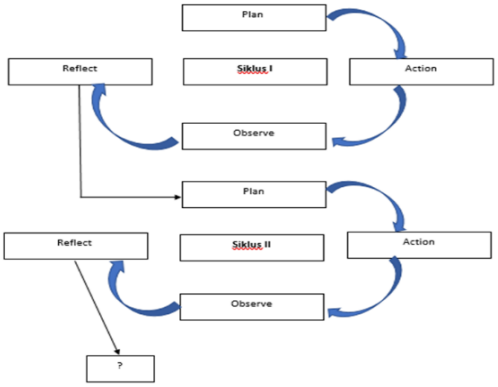

Figure 1. Scheme of research implementation

Data Analysis

The indicator of the success of this study was marked by an increase in student responses with a percentage of 88% with very good criteria, while for student learning outcomes the average score was 78, so that students had fulfilled the school's KKM of 75.

RESULTS AND DISCUSSION

Results of Data Analysis of Student Learning Outcomes with the Application of the model *Project Based Learning* (PjBL)

Student learning outcomes seen from the results pretest (pre-cycle) and posttest carried out at the end of each cycle of learning. With gift sports it can be seen that there is an increase in student learning outcomes in science learning. Comparison of student learning outcomes using models Project Based Learning (PjBL) can be seen in Table 1.

Table 1. Student learning outcome data

No	Indicator	Learning Cycle			Improvement from Pre-cycle to Cycle II
		Pre-cycle	Cycle I	Cycle II	
1	Number of Students	21	21	21	-
2	Average value	61	73	78	17
3	Mark 75	6	13	16	10
4	Value < 75	15	8	5	10
5	%success	29%	57%	76%	47%

Based on the learning outcomes of students starting from the pre-cycle, 6 students who complete the class or with a percentage of 29% achieve scores above the KKM. Then, the learning outcomes of students in cycle I, students who passed were 13 students or with a percentage of 57% who achieved scores above the KKM. Whereas in cycle II, 16 students who passed or with a percentage of 76% achieved a score above the KKM. Based on these results, from pre-cycle to cycle II, there was an increase of 47%. This shows that by using the learning model Project

Based Learning (PjBL) is able to improve student learning outcomes in science learning

Results of Data Analysis of Student Responses to the Application of the Model *Project Based Learning* (PjBL)

The results of the student response questionnaire while participating in learning activities with the learning model *Project Based Learning* (PjBL) filled out by students shows an increase in students' positive responses to the application of this learning model starting from cycle I to cycle II. The results of student responses in each cycle can be shown in table 2.

Table 2. Comparison of the percentage of student responses

Cycle	Meeting I		Meeting II	
	Percentage	Criteria	Percentage	Criteria
Cycle I	60%	Enough	75%	Good
Cycle II	78%	Good	88 %	Very good

From table 2 it can be compared to the percentage of student responses from meeting I in cycle I from 60% which increased to 75% at the second meeting with good criteria. In cycle II, the first meeting of the students' responses showed an increase from 78% to 88% at the second meeting with very good criteria. Then, the comparison of the average student activity in cycle I and cycle II can be seen in Table 3.

Table 3. Comparison of average student responses

Cycle	Percentage	Criteria
I	67,5 %	Good
II	83%	Very good

Based on table 3 above, it can be seen that in cycle I, the average positive response of students obtained a percentage of 67.5% with good criteria. While cycle II obtained an average positive response of students of 83% very well. This shows an increase in the average positive response of students in learning science by using the modelProject Based Learning (PjBL) from cycle I to cycle II.

Discussion

This classroom action research was conducted in two learning cycles. Where each cycle includes the stages of planning, implementation, observation and reflection. The discussion in each cycle is explained as follows.

Cycle I

In learning cycle I, implementation of science learning using the Project Based Learning learning model as follows.

Planning (Plan).

In the planning stage the basic thing to do is to determine the subject matter of learning material that will be applied in the science learning process. Then, determine the basic competencies in the science learning material to be taught. Then determine and formulate learning objectives in accordance with the basic competencies that have been determined. At the planning stage there are several activities carried out, namely: 1) Developing a learning implementation plan (RPP) that is adapted to the learning stepsProject Based Learning (PjBL), 2) Preparing learning media to support learning activities such as LKPD, teaching materials, and trigger videos, 3) Preparing student response questionnaires to learning activities, 4) Preparing test instruments that will be used to obtain data on student learning outcomes.

Execution (Action)

This implementation phase was carried out for 2 meetings. Implementation in accordance with the RPP that has been prepared, there are 3 activities including preliminary, core, and closing activities. In the preliminary activities, there are several activities such as 1) The teacher greets and prays, 2) The teacher focuses the attention of students through activities Ice breaking, 3) Students carry out cognitive diagnostic assessments in the form of pretests. This is done to find out and obtain data on students' initial abilities, 4) Students are given apperception in the form of video playback as material for triggering questions by the teacher, 5) Submission of learning objectives, and 6) Participants students are divided into several groups by the teacher.

In the core learning activities, the first meeting carries out the stages according to the syntax of the learning model Project Based Learning (PjBL), namely providing basic questions, designing product plans, and compiling schedules for product manufacturing activities. In the first phase of the fundamental question stage, students receive the LKPD given by the teacher, then students read the instructions on the LKPD with the teacher's guidance. Then, students together with the group collect information through observational activities that will be used as information material in making products. Phase 2. Designing a product plan, students together with the group identify the tools and materials needed in making the product. Then, students design the desired product plan. Phase 3. Arranging a project work schedule, students together with the group develop a product manufacturing schedule with guidance and direction from the teacher, so that students are able to determine product completion deadlines. Then each group submits a planning schedule for the manufacture and completion of the product.

Then at the second meeting, continuing the stages of the learning model Project Based Learning namely monitoring product responses and developments, testing results, and evaluating learning products. Phase 4. Monitoring students' responses to learning and project development, where students make products according to the planning schedule they have prepared together with the group, besides that students discuss problems that arise during the project completion process. Then students complete the product as a whole. Phase 5. Testing the results, students are instructed to present the results of the products they have made together with the group and other group members are given the opportunity to provide responses or questions to the group that is carrying out the presentation. Phase 6. Evaluation of learning experiences, students together with the teacher reflect on learning experiences such as what difficulties are faced and what are the strategies for overcoming these problems.

In the closing activity, students fill out a learning response questionnaire to find out how students respond to learningProject Based Learning (PjBL). Besides that, in this activity, students worked on posttest sheets to find out how far students' understanding of material concepts had increased after participating in learning activities. Then, students hear and pay attention to information about learning activities at the next meeting. Then, students pray together and the teacher closes the learning activity by giving closing greetings.

Observation

The observation stage is carried out during a series of learning activities. The object under observation in this case is the student's response to the learning model. The results of observations of students' responses in the first cycle of the first meeting of the students mostly heard and paid attention when the teacher gave an explanation of the concept of learning material, besides that there were some students who asked questions that they felt they did not understand in the material. In addition, some students responded quite well, every time the teacher gave a trigger question the students were able to respond to the questions given by the teacher. However, there are some students who have not recorded the learning material delivered by the teacher. When discussing project implementation planning activities, some students are actively and effectively able to discuss with their group members to design and design the expected product. So with the results of the questionnaire analysis of students' responses to learning, it was obtained that the percentage was 60% with sufficient criteria.

Then, at the second meeting the students paid attention to the teacher's explanation and direction, the students responded to each question the teacher gave, and the students asked the teacher about the systematic process of product presentation activities produced. However, at this second meeting, there were still some students who had not recorded the learning material during the learning activities. There were some students who were not very active in carrying out discussion activities with their group members. At the second meeting, students reported the results of the progress of the projects they had carried out, as well as presented and tested the results of the products they had produced. Based on the results of the response questionnaire given at the second meeting, a percentage of 75% was obtained which was included in the good criteria in responding to learning activities project based learning. So based on the results of the student response questionnaire, the average percentage in cycle 1 at meetings 1 and 2 was 67.5% which was included in the good criteria.

The learning outcomes carried out at the end of learning in the first cycle in the second meeting, where the average value based on table 1 is 73. This does not meet the predetermined success indicators where the average student score that must be achieved is 75 according to KKM.

Reflection

Reflection activities carried out at the end of cycle 1 activities have been completed. This is done as an evaluation of the learning carried out, so that through this evaluation material it can later be used as material for future improvements in designing and implementing learning activities. The obstacles or obstacles in the first cycle are: 1) Students do not fully understand the project work instructions/instructions in LKPD, 2) Students do not record important material in learning activities, 3) There are some students who are not very active in group discussion activities , this is because they feel they are not in the group they want, 4) Some students do not fully understand the learning material so that this becomes a factor that influences their learning outcomes.

Based on the problems encountered in the first cycle, a strategic step or follow-up plan is needed to improve learning in the second cycle. The teacher's follow-up plans in future learning are 1) The teacher needs to guide and explain work instructions or instructions to students in making projects and filling out worksheets so that students are able to fill in and carry out work instructions correctly. 2) Teachers need to be more active and intense in guiding students so that they have motivation in recording the learning material delivered by the teacher. 3) The teacher needs to

monitor students so that they participate actively in group discussion activities, so that the group is able to complete the project according to the planned schedule. 4) The teacher should provide explanations and reinforcement of the material to students, so that they are really able to understand the material well.

Cycle II

Planning

The planning stage begins with determining the subject matter that will be carried out in the science learning process. Then, look for basic competencies on the topics to be discussed. Then, determine the learning objectives in accordance with these basic competencies. The planning phase includes: 1) Creating a Learning Implementation Plan (RPP) with model learning stagesProject Based Learning (PjBL), 2) Prepare learning resources and media such as LKPD and teaching materials. LKPD made more detailed work instructions along with the addition of examples of projects that can be made by students. The teacher also prepares learning media in the form of powerpoint and examples of product-making videos to explain material and provide reinforcement of understanding of the material to students, 3) Prepare student response questionnaires, 4) Prepare tests that will be used to collect data on student learning outcomes.

Implementation (Action)

Not much different from the implementation of cycle I, in cycle II the implementation stage was carried out for 2 meetings. The implementation is in accordance with the learning implementation plan that has been prepared, which includes 3 activities, namely preliminary, core and closing activities. In the preliminary activity the teacher gives an apperception video, this is done to give a trigger question to the students, besides that the teacher gives an example of a product video, so that students have an idea of what kind of product they want. The core activities include the stages of the model Project Based Learning (PjBL) which includes basic questions, designing project plans, compiling production schedules, monitoring project activity and progress, testing results, and evaluating learning experiences. In the project development phase, the teacher is more active in providing direction so that each group member can work together and discuss well. Then, in the closing activity, the teacher provides material reinforcement to students with the help of the media point. The teacher also provides motivation and asks students to record important points of explanation of the material provided. This is done so that students can better understand the material being taught.

Observation

The results of the student response questionnaire in cycle II meeting 1 were the same as cycle I meeting 1 except that students at this meeting were more active, namely students paying attention to the teacher's explanation, responding to questions from the teacher, and asking questions to the teacher. Students also noted the material presented by the teacher and looked enthusiastic in participating in learning. However, students have not done a report on the progress of the project. During the discussion process, students and their group members discuss the project plan and then they present the project planning schedule. So that the results of the percentage of students' responses to learning were 78% with good criteria.

Then, at meeting 2 the students were more enthusiastic, it was seen that the students paid attention to the teacher's explanation, responded to the teacher's questions, and the students also asked questions to the teacher and the students had recorded material during the learning activities. However, there were 3 students who did not carry out discussion activities with their group members. At meeting 2, students reported on the progress of the project, which they then made presentations to test the results of the products they produced. Based on the results of the response questionnaire filled in by students, the percentage of student responses was 88% with very good criteria.

So based on the response questionnaire data that has been given, the average response to learning in cycle II is 83% with very good criteria for student responses to Project Based Learning (PjBL) learning. This is in accordance with the indicator of success to be achieved, namely achieving very well. Meanwhile, learning outcomes are carried out at the end of cycle II by giving a posttest to students. The average student score is in accordance with table 1, namely 78. This has fulfilled the indicator of success, namely the average student score has reached a value above 75 or achieved KKM.

Reflection

Based on observations of the learning process carried out by teachers and observers in cycle II, learning outcomes and student responses have increased from the previous cycle. The existence of reflection and improvement from the first cycle is able to provide an increase in the quality of learning. Reflection in cycle II showed that students began to understand and get used to learning using models Project Based Learning (PjBL). The interaction between teachers and students is actively communicative, so that aspects of student activity can increase. Students are also given material reinforcement so as to make

students better understand the material being taught and at the end of cycle II experience an increase in learning outcomes.

Discussion of Improving Learning Outcomes and Student Responses

Application of learning models Project Based Learning (PjBL) which has been carried out on class VIII students of SMPN 1 Ngasem has achieved the expected results. Where the indicators of the success of learning outcomes have met the minimum standards of KKM and students' responses to learning get responses with very good criteria. This means that every meeting in the cycle there is an increase. Based on the results that have been obtained, the learning cycle is dismissed in the second cycle.

Increasing student learning outcomes can occur, because through the learning modelProject Based Learning provides space and opportunities for students to participate actively in learning activities. This is in line with (Hamidah & Citra, 2021) which states that the learning model Project Based Learning is one of the innovative learning models that is able to train and develop students' critical thinking skills, improve the ability to solve a problem, involve students in discussion, observation, and manufacture of a product that is able to help students' understanding in understanding a learning material. Besides that, through the learning process Project Based Learning trains students in identifying problem solving and meaningful task activities, providing opportunities for students to work together autonomously in constructing their own knowledge and ultimately being able to produce real products (Fini et al., 2018). This is in line with Yuniasih et al. (2022) research, which shows that the application of PjBL learning can improve science learning outcomes in each learning cycle. By applying the PjBL learning model, students will get experience that is able to provide learning meaning for them so that they are able to build a good understanding of concepts (Made,et al.,2022). This is confirmed by Nagarajan (2019), who state that the PjBL model is able to assist educators in creating a pleasant learning environment so that students are able to connect their ideas and skills. Besides being able to improve student learning outcomes, through this learning activity students give a positive response to learning, this is because during learning activities students are actively involved in learning activities.

The positive response of students was able to increase this because of the motivation of students in constructing their knowledge into a learning product. This is in accordance with the statement put forward by (Opita Sitompul et al., 2020) which states that students are easily motivated if they are facilitated in building their understanding through experimental activities or project activities, so that the understanding they build will be more meaningful to them. In line with research (Choi et al., 2019) which states that exploration, experimentation, discovery, and problem solving activities in small groups are able to train students' critical thinking skills, thereby influencing students' positive responses to the learning activities that have been carried out.

CONCLUSIONS AND SUGGESTIONS

Conclusions

Based on the results of the analysis and discussion it can be concluded that by applying the model Project Based Learning (PjBL) in science learning is able to improve learning outcomes and student responses with an average pre-cycle score of 61 then increase in cycle I to 73 then increase again in cycle II of 78 so that student learning outcomes meet the KKM standard criteria that have been determined. The results of the average student response to learning have increased, where in the cycle I obtained an average percentage of 67.5% which is included in the good criteria. Then in cycle II, an average percentage of 83% was obtained which was included in the very good criteria, so that the students' responses met the predetermined criterion indicators. This research implies that if a teacher wants to improve student learning outcomes, the teacher can apply student-centered learning models, one of which is the learning model.Project Based Learning (PjBL). The limitation of the results of this study is only in science lessons which are carried out in class VIII-F at SMPN 1 Ngasem.

Suggestions

Based on research that has been done regarding improving learning outcomes and student responses through project-based learning models on mirror material and optical devices, suggestions that can be given by researchers are: (1) Researchers should be able to innovate in creating learning models according to the characteristics of the participants educated. (2) If possible, learning products can be adapted to the characteristics of students.

REFERENCES

Al-Busaidi, S., & Al-Seyabi, F. (2021). Project-based learning as a tool for student-teachers' professional development: A study in an Omani EFL teacher education program. *International Journal of Learning, Teaching and Educational*

Research, *20*(4), 116–136. https://doi.org/10.26803/ijlter.20.4.7

Anwar, Y., Fadillah, A., & Syam, M. (2021). Pengaruh Model Pembelajaran Project Based Learning Terhadap Hasil Belajar Siswa Kelas X di SMA Negeri 11 Samarinda. *Jurnal Pendidikan*, 30(3), 399. https://doi.org/10.32585/jp.v30i3.1753

Arikunto, S. (2017). Penelitian Tindakan Kelas. Jakarta: PT. Bumi Aksara.

Choi, J., Lee, J. H., & Kim, B. (2019). How does learner-centered education affect teacher self-efficacy?The case of project-based learning in Korea. *Teaching and Teacher Education*, 85,45–57. https://doi.org/10.1016/j.tate.2019.05.005

Fadilah, A. U. (2018). Peningkatan pemahaman konsep peserta didik pada materi pesawat sederhana setelah penerapan model learning cycle 5E. Pensa E-Jurnal, 179-184.

Fini, E. H., Awadallah, F., Parast, M. M., & Abu-Lebdeh, T. (2018). The impact of project-based learning on improving student learning outcomes of sustainability concepts in transportation engineering courses. *European Journal of Engineering Education*, 43(3), 473–488. https://doi.org/10.1080/03043797.2017.1393045

Hamidah, I., & Citra, S. Y. (2021a). 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

Iswatun, I., Mosik, M., & Subali, B. (2017). Penerapan model pembelajaran inkuiri terbimbing untuk meningkatkan KPS dan hasil belajar siswa SMP kelas VIII. *Jurnal Inovasi Pendidikan IPA*, *3*(2), 150. https://doi.org/10.21831/jipi.v3i2.14871

Nagarajan, S. (2019). Promoting Systems Thinking Using Project- And Problem-Based Learning. *Journal of Chemical Education*, 2901–2909. https://doi.org/10.1021/acs.jchemed.9b00358

Opita Sitompul, N., Agus, S., Syahputra, A., Dan, S., & Manurung, S. (2020). Penerapan Model Pembelajaran Project Based Learning (pjbl) Terhadap Hasil Belajar IPA Siswa SMP. http://jurnal.unimed.ac.id/2012/index.ph

Partjuma, A. H., Roini, C., Nasichah, A. Z., Pascasarjana, P., Khairun, U., Jusuf, J., Kampus, A., Unkhair, I. I., Kota, G., Selatan, T., & Utara 97728 Indonesia, M. (2022). Pengaruh Model Project Based Learning (PjBL) Berpendekatan Jelajah Alam Sekitar (JAS) Terhadap Hasil Belajar Kognitif Siswa Kelas VII SMP Islam Jailolo (Vol. 5, Issue 2).

Ramadhani, F. (2020). Penerapan Model Pembelajaran Project Based Learning untuk Meningkatkan Hasil Belajar IPA Dalam Pembelajaran Daring di Kelas IX SMP. *Jurnal Pelita Pendidikan* (Vol. 8, Issue 4). https://jurnal.unimed.ac.id/2012/index.php/pelita/index

Rusmini, Suyono, & Agustini, R. (2021). Analysis of science process skills of chemical education students through self-project based learning (sjbl) in the covid-19 pandemic era. *Journal of Technology and Science Education*, *11* (2) ,371–387. https://doi.org/10.3926/jotse.1288

Subiki, S., Elika, E. T. P., & Anggraeni, F. K. A. (2023). Effect of the Project-Based Learning Model with the STEAM Approach on Learning Outcomes of High School Students the Subject of Material Elasticity. *Jurnal Penelitian Pendidikan IPA*, *9*(2), 745–751. https://doi.org/10.29303/jppipa.v9i2.2926

Susanti, D., Sari, L. Y., & Fitriani, V. (2020). Curriculum Analysis of Biological Learning Media Module Development Based on Project Based Learning (PjBL). *Jurnal Penelitian Pendidikan IPA*, 6(2), 157. https://doi.org/10.29303/jppipa.v6i2.302

Yulianti, N., Putra Raharja, E., & Nidiasari, Y. (2023). Pengaruh Model Pembelajaran PjBL (Project Based Learning) Dengan Pendekatan Saintifik Berbasis Local Wisdom Papua Terhadap Hasil Belajar IPA Pada Materi Pesawat Sederhana Siswa Kelas VIII SMP Muhammadiyah 2 Mariyai. *Jurnal Pendidikan*, 11(1).

Yuniasih, E., Hadiyanti, A., & E.Zain. (2022). Penerapan Model Project Based Learning untuk Meningkatkan Keterampilan Proses dan Hasil Belajar IPA Siswa. Edukatif: Jurnal Ilmu Pendidikan, 4(5), 6670-6677.

Zuhaida, A., & Mubtasyiroh, Z. (2022). Efektivitas Model Project Based Learning dengan Pendekatan Inkuiri Berbasis Lingkungan terhadap Hasil Belajar IPA. *Jurnal IPA & Pembelajaran IPA*, 6(2), 119–129. https://doi.org/10.24815/jipi.v6i2.24440