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PjBL online in ecological learning to improve student's problem-solving skills

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Abstract

Implementation of PjBL will be more flexible and efficient if implemented online. Students develop ecological problem-solving projects around where students live and students can also report on the progress of their projects in their respective homes. Online learning is sought so that students can improve their skills to solve real problems in the surrounding environment. This type of research is classroom action research using the Kemmis and McTaggart model which consists of 3 cycles. This research was conducted at the Tadris IPA Study Program, IAIN Kudus for four months from February to June with the research subjects being 38 B class students. The data in this study were collected using observation guidelines for the implementation of learning and student's problem-solving skills. The results of observations of problem-solving skills were 66.58% in cycle I, 80.72% in cycle II, and 92.44% in cycle III. This indicates an increase in problem-solving skills in students through the application of the PjBL online in ecological learning. In addition, student activity also increases in the application of this learning. The activeness of students in the first cycle was 48.63%, in the second cycle it was 77.53% and in the third cycle, it was 87.6%. In addition, 82% of students gave a positive response to learning for each question item. Enthusiastic students are actively involved in developing PjBL online in ecological learning to solve real environmental problems.

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Introduction

The ecology course is a course offered in semester 5 of the Tadris IPA IAIN Kudus study program. Implementation of the ecology course is intended so that students are able to understand the interaction of organisms with the biotic and abiotic environment so that they are able to describe the order of organisms with their environmental factors. Through this course, students are expected to be able to analyze and solve ecological problems that exist in real life.

Achieving the above goals can be done by designing learning that encourages students to develop problem-solving skills in the field of ecology. Problem-solving skills are the ability to identify problems, search for and select various alternative solutions and determine decisions in solving all problems faced (Bariyyah, 2021). This skill provides students with the opportunity to develop thinking skills in solving problems through constructing knowledge that students have independently by utilizing various learning resources so that understanding of the material becomes deeper and learning becomes more meaningful (Andayani et al., 2022; Redhana, 2019). Several indicators of problem-solving skills include students' skills in understanding problems, defining problems, formulating/planning alternative problem-solving, implementing solving strategies/solutions, and evaluating the results of problem-solving (Aisyah et al., 2021; Anugraheni, 2020; Riyani & Hadi, 2023; Siregar, 2024). Thus, developing problem-solving skills in students can help students understand and overcome various challenges related to ecosystems and the environment, and students can be better prepared to face ecological challenges in the future and contribute to environmental sustainability.

PjBL is a learning model that can be applied to develop ecological problem-solving skills (Niemiller et al., 2021). The application of PjBL in learning can provide meaningful experiences through real projects that require them to think critically, creatively, and collaboratively in solving ecological problems (Ayuningrum et al., 2024; Sopiani et al., 2019; Ardianti et al., 2017). Students can develop projects as solutions to real-life problems by applying several stages in the PjBL model. The stages in the PjBL model include formulating basic questions related to a problem, preparing a project plan, creating a project development schedule, monitoring project implementation and progress, testing and providing an assessment of the project being created, evaluating experience (Istiqomah et al., 2023).

Implementation of project activities will be more flexible and efficient if implemented online (Anggraini et al., 2022; Kim, 2021; Uyen et al., 2023; Alfarimba et al, 2021). Students develop an ecological problem-solving projects around where students live and students can also report on the progress of their projects in their respective homes. Lecturers can still monitor the progress of projects carried out by students to solve ecological problems in the environment around students. Lecturers and students can interact easily via IT. Lecturers can guide and control the implementation of each stage in the PjBL model. Furthermore, students can use IT to report scientific steps and project results that have been carried out.

Several previous studies have shown success in improving student learning outcomes through implementing PjBL in online learning (Uyen et al., 2023). Kim (2021) stated that the success of PjBL in online learning can be used as a guide in further learning, but it needs to be focused on certain subjects and reviewing the project process and resulting products. In this research, the implementation of online PjBL is focused on ecological learning, and a review of improving problem-solving skills during learning is carried out. Additionally, a review of the final product developed is carried out..

Based on the description above, research using the online PjBL learning model is applied to ecological learning. This research aims to determine the increase in students' problem-solving abilities and students's responses to implementing online PjBL in ecological learning.

Methods

This type of research is classroom action research using the Kemmis & Mc Taggart (1988) model. This type of research model states that one cycle consists of four steps, namely: planning, action, observation and reflection. This research was carried out at the Tadris IAIN Kudus Science Study Program for four months from February to June with research subjects totaling 38 class B students.

This research took place over three cycles. Each cycle consists of (1) planning stages, including the development of RPS which contains the online PjBL model in ecological learning and the development of observation instruments for problem-solving skills, (2) action implementation stages, including the application of online PjBL in ecological learning, (3) stages observation, namely observing the application of learning, students problem-solving skills, and posters (4) reflection stage, namely analyzing problem-solving skills and giving meaning to the implementation of actions, so that an action plan can be prepared created in the next cycle.

The IT media used are media that are easy to operate and are often used by people, namely laptops and smartphones. The applications used are WhatsApp, Google Meet, YouTube, and other social media. These media and applications are often used and easy to operate in everyday life (Rahayu Putri & Sholikhah, 2021; Sunardi, 2021).

The data in this research was collected using observation guidelines for learning implementation and problem-solving skills. Data analysis was carried out quantitatively and qualitatively. Quantitative data analysis was used to determine differences in problem-solving skills, while qualitative analysis was used to determine the application of online PjBL in ecological learning and the results of student responses to learning. Learning is said to be complete if 75% of students reach the minimum good category in measuring problem-solving abilities. Observation of problem-solving skills is carried out at the end of each cycle.

Results and Discussion

Implementation of The Classroom Action Research

The research was conducted in three cycles. The implementation of learning in each cycle is carried out using gadget media and WhatsApp, Google Meet, and YouTube. Whatsapp is used as a medium for learning consultation between students and lecturers and the media to confirm learning readiness at each meeting. Google meet is used as a medium for interaction between lecturers and students remotely at each meeting. Youtube is used as a medium for reporting project products to address ecological problems in real life.

Cycle I was carried out by implementing the PjBL online in ecological learning for 7 meetings. The implementation of cycle I begins with the planning stage. At this stage the lecturer plans learning by compiling lesson plans, learning observation instruments, and problem-solving skills observation instruments. The implementation (action) phase was started by the lecturer by sharing the Google Meet link via the WhatsApp group. The observation stage was also carried out to observe the implementation of the PjBL online in ecological learning and student activities from the beginning to the end of the cycle.

At the first meeting the lecturer motivated students to conduct class discussions on ecological concepts. The lecturer gave several questions and feedback to students as material for class discussion. Furthermore, the lecturer said that the learning model used in ecological learning was the PjBL model. This model consists of several steps, namely determining basic questions, designing project plans, compiling schedules, monitoring project progress, testing processes and results, and evaluation (Istiqomah et al., 2023). Lecturers ask students to analyze problems in the real world or problems around the environment where students live in groups. Each group consists of 3-4 students. Group determination is based on the proximity of the student's residence.

At the second meeting, each group presented basic questions regarding the problems that had been found, the design of the project plan, and the project development schedule. Lecturers provide opportunities for other groups to provide suggestions and comments about the project planning design that has been presented. Furthermore, at the end of learning the lecturer provides reinforcement and input on the project. At meetings 3-5 the lecturer monitors the progress of the project being developed. Students convey project development procedures at meetings 3 and 4 and show videos of project development results at meeting 5. At the 6th meeting the lecturer as well as the researcher examines student learning processes and outcomes. This activity is carried out through observation of solving skills based on presentations and questions and answers with students. At the end of learning, lecturers and students together conclude the learning activities that have been carried out. Lecturers also invite students to reflect after learning.

The results of observations in the first cycle are as follows. a) Lecturers have started learning by providing motivation and ending learning by making conclusions with students. b) Lecturers always provide assistance by monitoring the progress of the project from the beginning to the end of online learning. c) The presentation of the results of project development in several groups has not been consistent between students, especially in groups 1, 5, 8, 9, 10, and 13. d) Observations of problem-solving skills show that as many as 66.58% of students achieve a minimum good category. The results of reflection on cycle I are as follows. a) Student activity in learning is 48.63%, this shows that student activity in interacting online through Google Meet is still relatively low. b) Students have not been able to correctly conclude the results of project development. c) Students have not been able to draw common threads on indicators of problem-solving skills, namely understanding problems, defining problems, formulating alternative solutions, applying solving solutions, and evaluating problem-solving results.

From the reflection of cycle I actions, an action plan for cycle II was prepared as follows. a) lecturers ask students to work more systematically by presenting the results of project development through making scientific posters. b) lecturers ask students to be more active in online learning by requiring students to always turn on the camera on the Google Meet application. c) the lecturer asks students to prepare presentations before learning begins so that each group is more unified and consistent in presenting the results of project development.

Learning in cycle II was carried out in 3 meetings. Students revise the report on the results of project development from the start. At the first meeting, students in groups compiled scientific posters to report the results of project development. In the second meeting, the lecturer monitored the results of preparing scientific posters by asking students to make presentations and show scientific posters on the Google Meet screen. Lecturers provide feedback on the presentation of the results of the development of student scientific posters. In this activity the lecturer focused more on groups that were not consistent and students who were not active in cycle I learning. At the third meeting, the lecturer evaluated problem-solving skills and the results of developing scientific posters.

The results of observing the actions in cycle II are as follows. a) Students have been active in asking questions and carrying out class discussions. b) Student activity increased to 77.53%. c) Each group has been consistent in conveying the results of project development. d) Observation results of problem-solving skills show that as much as 80.72% of students achieve a minimum good category. e) Students have compiled scientific posters which are uploaded in the video description section on the YouTube application. The results of reflection on the actions in cycle II are as follows. a) Student activity increases. b) Students are more enthusiastic in explaining the results of project development through scientific posters. c) Students' problem-solving skills increase, students are able to draw common threads on indicators of problem-solving skills. d) The preparation of scientific posters is still not systematic in terms of content and proportions of appearance.

Based on the reflection of the actions in cycle II, an action plan in cycle III is then prepared as follows. a) Lecturers ask students to revise the systematics, content, and proportions of scientific poster displays. b) The lecturer focuses attention on students who are not active and have not been able to reach a good category in problem-solving skills.

Cycle III was implemented in 3 meetings. Students revised the preparation of scientific posters on the results of project development at the first meeting. Furthermore, students report the results of scientific poster revisions at the second meeting monitored and accompanied by lecturers via Google Meet. At the third meeting the lecturer observed problem-solving skills in student presentation activities. The results of observing the actions in cycle III are as follows. a) Lecturers and students carry out the online learning process smoothly. b) Student activity increased to 87.6%. c) Each group is more consistent and unified in conveying the results of project development. d) Observation results of problem-solving skills show that as much as 92.44% of students achieve a minimum good category. e) Students have revised the scientific poster and uploaded it in the video description section on the YouTube application.

Reflection of action in cycle III as follows. a) Cooperation and student activity in each group increases. b) The group that is the focus of attention is able to link between indicators of problem-solving skills and project development properly. c) Implementation of the next cycle is no longer needed.

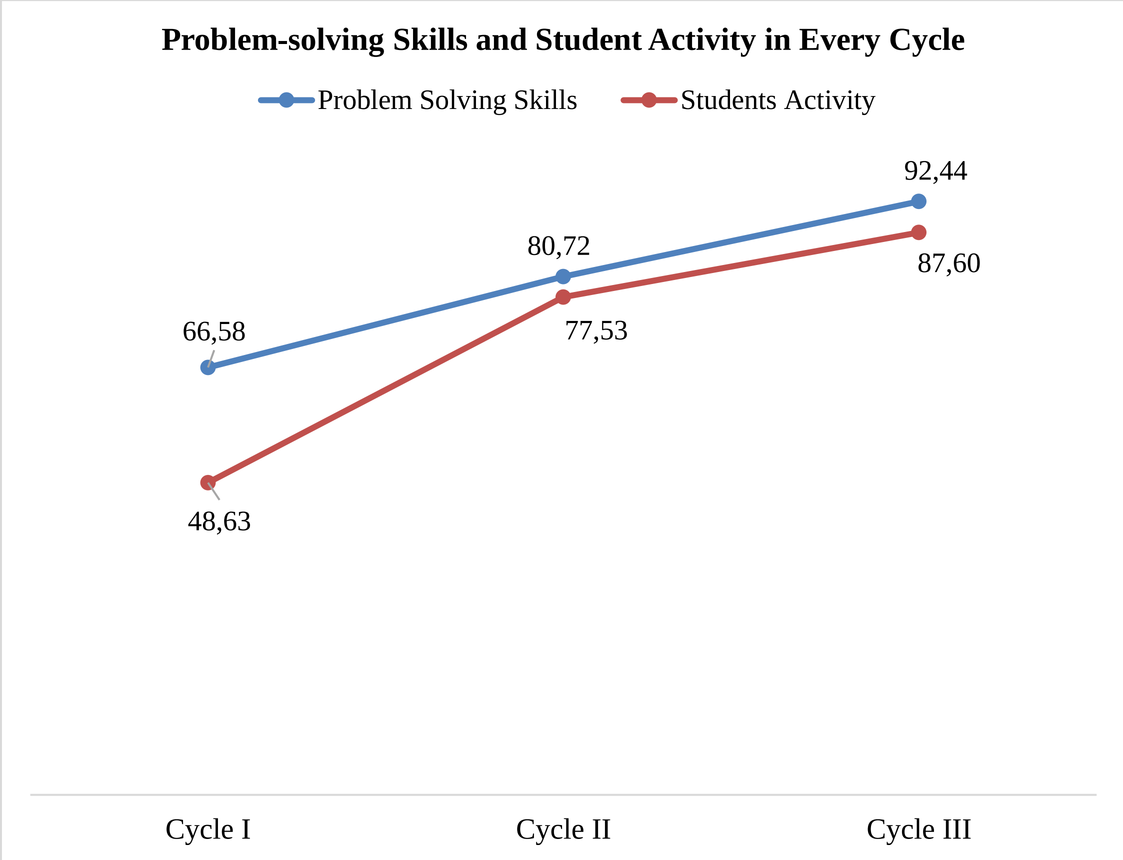

Figure 1. Line Chart of Problem-solving Skills and Student Activities in Each Cycle

Based on the three cycles above (Figure 1), the results of observing problem-solving skills were obtained, namely 66.58% in cycle I, 80.72% in cycle II and 92.44% in cycle III. This indicates an increase in problem-solving skills in students through the application of the PjBL online in ecological learning. In addition, student activity also increases in the application of this learning. The activeness of students in the first cycle was 48.63%, in the second cycle it was 77.53% and in the third cycle it was 87.6%. Observations were also made on aspects of student attendance, readiness in learning, attention to learning, ethics in online communication, as well as systematics and poster content developed by students (Figure 2). This aspect of the assessment is translated into 20 assessment indicators using a checklist directly. The observation results show that these aspects in the application of learning from cycle I to cycle II have increased and decreased which tend to be stable, namely in the range of 70-90%.

In this study also obtained student responses to learning. Student response questionnaires are given as a way to find out student responses to ongoing learning. Based on research data, it can be seen that 82% of students gave a positive response to learning for each question item. Student responses are also known based on the results of open interviews.

Figure 2. Final Poster Results

The online PjBL model in ecological learning has a positive impact on students. Even though it is carried out online, this learning model can motivate students to be more active in the learning process. The learning process in the PjBL is not centered on the lecturer but on each student (Ardianti et al., 2022). Students choose their ecological problems in the environment around where they live, students design projects to overcome these problems and continue to report the progress of their projects to the lecturer. This is to research by Mustika Parwita Dewi (2012); Pantiwati & Permana (2020); Sutomo et al. (2023) dan Widiastuti (2021) that PjBL can provide space for students to explore and develop their ideas, develop student interest and involvement in projects through the use of technology, and motivate students to always develop through constructive feedback.

Lecturers in implementing the PjBL model must be able to communicate clearly and effectively to direct students to complete projects (Rahmawati & Purnomo, 2017). Students need to feel supported by lecturers in facing project challenges so that they remain motivated and confident (Fitriani & Sarkity, 2023). The application of this model begins with providing apperception and motivation by the lecturer. The lecturer conveys the objectives of learning ecology and the importance of its application in daily life now and in the future. The lecturer said that online learning was not only carried out using a direct learning model but also used a project-based learning model. This can provide a different atmosphere in online learning so that students are more enthusiastic about following it from start to finish.

PjBL is implemented through several learning stages. In the first stage, students formulate basic questions related to a problem. Learning begins by asking students to explore problems around their home and formulate important questions about these problems. Essential questions related to problems can instill empathy in students. In this PjBL learning, students feel responsible for environmental problems around them by developing a project (Mahtari et al., 2023).

The second stage is developing a project plan. Students are responsible for the problems around them and feel ownership of the project. At this stage, students make plans regarding the rules for developing projects. Planning contains the game's rules, selecting activities that can support answering important questions, integrating various possible subjects, and knowing the tools and materials that can be accessed to help complete the project. A well-planned project will produce the expected product by the project development objectives.

In the third stage, students create a project development schedule. In this step the lecturer provides several limitations in this stage, namely 1) Creating a timeline (time allocation) to complete the project; 2) Setting a deadline for project completion; and 3) Bringing students to plan new ways. According to Portuna et al. (2024), the PjBL model usually requires a lot of time so it is feared that it will not be able to complete the project being developed. In PjBL online in ecological learning, all students could complete the project well. This is because students have prepared a project development schedule at the start of learning so that students can estimate the type of project by the predetermined deadline.

The fourth stage is to monitor project implementation and progress. Students report project progress to lecturers via Google Meet. This monitoring is carried out as a form of lecturer responsibility in monitoring student activities in project development. In implementing the PjBL model, lecturers monitor student activities during project completion proyek (Mustika, 2020; Riani, 2023; Ruhul Jihadah Gaffar, M. Juaini, 2023). Monitoring is carried out by facilitating students in each process. In other words, the teacher acts as a guide to student activities. Learning activities that are monitored and guided by lecturers can keep students motivated to complete projects until the end of learning (Raida, 2018).

The fifth stage is testing and assessing the project being created. Assessment plays a crucial role in PjBL as it assesses both the process and outcomes of student projects, ensuring meaningful learning experiences. It allows educators to gauge student understanding, collaboration skills, and application of knowledge in real-world contexts (KOVÁCSNÉ PUSZTAI, 2021). This assessment is carried out using observation techniques during student presentation activities. Assessments are carried out to assist lecturers in measuring CPMK achievements, evaluate the progress of each student's problem-solving abilities, provide feedback regarding the level of understanding students have achieved, and assist lecturers in developing further strategies.

The final stage is experience evaluation. At the end of the lesson, lecturers and students reflect on the activities and results of the projects that have been implemented. The reflection process is carried out both individually and in groups. Based on the results of the learning reflection, the lecturer and researcher followed up by encouraging students to make scientific posters about the development flow of the projects that had been implemented. This is intended so that students are truly able to construct meaning in learning and improve problem-solving abilities. Posters serve as effective tools for students to present their research findings and solutions to environmental issues in a visually engaging format. They encapsulate scientific data, methodologies, and conclusions, making complex information accessible (HASTÜRK, 2018). In making scientific posters, students develop creativity by presenting an attractive, conservative appearance to introduce the results of the project so that they get responses from readers, even criticism, suggestions, and input. In this way, students are better able to organize the flow of project development and draw threads from background to conclusion in a coherent and informative manner. Systematic preparation of scientific posters can improve students' problem-solving abilities. Students can fulfill problem-solving indicators when making presentations and briefings with lecturers.

Several indicators of problem-solving (Aisyah et al., 2021; Anugraheni, 2020; Riyani & Hadi, 2023; Siregar, 2024) are as follows. First, the skill of understanding the problem. This skill is achieved when students can clearly describe the problems raised. Students describe environmental problems and where the problems lie. Second, define the problem. Students convey the types of environmental problems they face and the causes of these problems. Third, formulate/plan alternative solutions. Students present the project product they have developed and explain the reasons why the product was developed. Students explain the names of products, tools, and materials as well as the use of products in solving environmental problems. Fourth, implement a solution/solution strategy. Students describe work procedures by practicing using products to solve problems. Fifth, solve problem-solving. Students can describe the obstacles, limitations, and advantages of product development project results.

The problem-solving ability indicators above can be achieved through student activity in going through the PjBL stages. Students explore problems around them and solve problems through real projects in online learning. Subsequently, the project was developed in the form of a scientific poster. Students explain the project through the poster. Students' problem-solving skills can be seen in this activity. Students who have made scientific posters systematically and understand, their problem-solving abilities are increasingly developing (Mayfield et al., 2018; Nordstrom & Korpelainen, 2011; Sahoo et al., 2018). Students can explain in detail and sequentially the stages of the project that have been implemented as a solution to solving problems in the surrounding environment.

The interesting thing in this research is that during online learning, the five indicators of problem-solving skills increased in each cycle. The more student activity increases, the more problem-solving abilities will increase (Komarudin et al., 2020; Tria Amalia & Suryaningtyas, 2023). Students also seemed enthusiastic about participating in learning. This is proven by the positive response at the end of the lesson that students prefer outdoor learning in the surrounding environment rather than just listening to the lecturer's lecture via IT media.

The results of this research provide benefits for students as follows. 1) Students' problem-solving skills can develop, so that these skills can be applied in everyday life. 2) Students become enthusiastic about completing learning to show the results of product work in solving problems. 3) Online ecological learning becomes meaningful because students actively construct ecological knowledge to apply in real life. However, in its implementation, there were also limitations in implementing learning, namely signal problems in online learning, so there were still some students who had difficulty participating in learning.

Conclusion

There was an increase in problem-solving skills in implementing online PjBL in ecological learning, namely 66.58% in cycle I, 80.72% in cycle II, and 92.44% in cycle III. Student activity also increases in implementing this learning. Student activity in cycle I was 48.63%, cycle II was 77.53%, and cycle III was 87.6%. Apart from that, 82% of students gave positive responses to learning in each statement item.

The advice in this research is that lecturers, researchers, and students should prepare for online learning by paying attention to signal quality and moving to a place with the best signal. Apart from that, students should also prepare a backup data package that can be used if connection problems occur.

Credit Authorship Contribution Statement

Sulasfiana Alfi Raida: Conceptualization, Methodology, Visualization, Formal analysis, Resources Writing – original draft, Writing – review & editing, Project administration. **Sekar Dwi Ardianti**: Conceptualization, Formal analysis, Resources, Writing – review & editing, Supervision.

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