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Project-Based Learning in Environmental Learning: Can It Improve Learners' Problem-Solving Skills and Mutual Cooperation?

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Annotation. This study aims to evaluate the application of the Project Based Learning model on environmental pollution material to improve students' problem-solving skills and mutual cooperation. This type of research is a class action research conducted at Senior High School 3 Surakarta, Indonesia. The results showed that applying the Project Based Learning can improve the problem-solving skills and mutual cooperation of students in class X-2 Senior High School 3 Surakarta.

Keywords: *class action research, environmental pollution, mutual cooperation, Project Based Learning, problem solving skills.*

Introduction

Problem-solving skills and mutual cooperation are crucial for students lives in the 21st century and the Industrial Revolution 4.0 and have qualified abilities to contribute positively to the nation. Education should build quality students who need to adapt and transform to answer the demands of the times (Kollár & Matúšová, 2023). One of the main focuses of education transformation in Indonesia is to develop Pancasila learner

profiles and 21st-century skills (Jayadiputra, 2023). The Pancasila Learner Profile is a collection of characters and competencies that learners in Indonesia are expected to achieve based on the noble values of Pancasila.

The dimensions of the Pancasila Learner Profile and 21st-century skills contain two essential and interrelated skills. That is problem-solving and mutual cooperation (Imania et al., 2022). Problem-solving skills help individuals to identify, analyze, and solve problems effectively (Afandi et al., 2019), adapt to complex situations and conditions, think critically and creatively, and make the right decisions (Choudhar et al., 2022). Then mutual cooperation allows individuals to work together with others to achieve common goals, appreciate differences and diversity, develop empathy and tolerance attitudes, and build effective communication and collaboration (Freitas et al., 2019) These skills are essential foundations for learners to contribute to society and address global challenges, including climate change, natural disasters, and social inequality.

Problem-solving skills and mutual cooperation of students in class X Senior High School 3 Surakarta Indonesia are still low categories. The interviews with biology teachers showed that the quality of class X students decreased compared to the previous generation based on the summative assessment biology scores available with 60% students not reaching the minimum completeness criteria limit (KKM). The summative assessment results show that students who score below the KKM have difficulty working on questions that measure biological problem-solving skills.

The affective domain in students also decreased. Observation of learning activities in the classroom shows students were more individualistic in the learning process in class. In the learning process, teachers distribute PowerPoint containing material to students, then explain the material and continue with students working on problems individually. The results of interviews with students showed that learning in the classroom rarely does activities in groups. Based on the results of observations and interviews that have been conducted, students' problem-solving skills and mutual cooperation are still underutilized.

After observations and interviews followed by pre-cycle activities, all class X students took questionnaires and tests. Class X-2 had lower problem-solving skills and mutual cooperation than other classes. The results of the problem-solving skills test are that six students were in the poor category with scores between 20–40%, 17 students were in the moderate category with scores between 41–60%, and 11 students were in the able category with scores between 61-80%. The problem-solving skills questionnaire obtained the results of aspects of defining the problem at 69% (capable), exploring the problem at 68% (capable), aspects of planning a solution at 69% (capable), implementing the plan at 70% (capable), checking the solution at 69% (capable), and evaluating at 67% (capable). The results of the mutual cooperation questionnaire obtained aspects of empathy at 67% (good enough), cooperation at 69% (good enough), establishing communication and friendship at 68% (good enough), commitment to joint decisions

at 69% (good enough), consensus deliberation at 66% (good enough), respectful actions at 71% (good), voluntary help at 66% (good enough). The test and questionnaire data became the baseline of this research. The categorization is based on problem-solving skills instrument score criteria by Hidayatulloh et al. (2020) and mutual cooperation instrument score criteria by Monika et al. (2023).

Students' lack of problem-solving skills is not only found in Senior High School 3 Surakarta. Program for International Student Assessment (PISA) study in 2015 shows that Indonesian students' problem-solving skills are ranked 64th out of 72 countries. This ranking and average score are not much different from the results of PISA tests and surveys in 2022, which showed that Indonesia was in the low material mastery group, which ranked 64th out of 81 countries. This data shows that the problem-solving skills of students in Indonesia in learning are low (Arif et al., 2018).

It is necessary to transform learning that focuses on developing problem-solving skills and mutual cooperation. This transformation can be done through the application of active and participatory learning models such as Project Based Learning (Bozyiğit et al., 2014), which provides opportunities for students to learn and work together in completing projects and tasks; the use of learning materials that are contextual and relevant to real life, strengthening the values of mutual cooperation in the learning process (Rohmah et al., 2020).

Previous research on the application of Project Based Learning to improve problem-solving skills was conducted by Darwis et al. (2020), who found that the application of the Project Based Learning learning model in connected type integrated science learning can improve problem-solving skills on indicators of analyzing problems, collecting data or information, and proposing problem-solving solutions. Sasmita et al. (2021) researched the application of Project Based Learning to improve students' mathematical problem-solving skills and obtained the results that after applying Project Based Learning, the problem-solving ability test score was 91.24, so there was an increase of 15.086%.

Anengsih et al. (2023) researched the application of Project Based Learning to improve students' mutual cooperation. They obtained favorable results in character learning so that it can be implemented as an implementation of the Pancasila Student Profile in mutual cooperation. Research conducted by Fitri et al. (2023) showed that Project Based Learning increased the character of mutual cooperation. There was a marked increase in three assessment indicators: collaborating, caring, and being able to share solutions in problem-solving, with a percentage increase ranging from 80–89%. Jagantara et al. (2014) explained the advantages of using the Project Based Learning model in learning, which can increase motivation, and improve problem-solving, research, collaboration, and resource management skills.

The theoretical basis for using Project Based Learning to improve problem-solving skills and mutual cooperation is Neo-Piagetian research, Vygotskyan views regarding

learning as a social activity, and epigenetic theory (Krajcik et al., 2014). Piaget's (1963) notion of socio-cognitive conflict (Doise et al., 1984) refers to the mechanism by which an individual realizes that students' thoughts or ideas are inconsistent with the views or new information of others (Esther Care, 2018). This internal conflict makes individuals reflect on their thinking and can be the beginning of conceptual change. The Vygotskyan argument for collaborative learning is based on Vygotsky's (1978) view of the social nature of learning, namely that through social interaction, learners can achieve a higher level of development than learners achieve by working and learning alone (Helle et al., 2006).

Epigenetic theory argues that genes inherited by parents can be modified by each individual as influenced by the environment (Chomitz et al., 2009). Epigenetics plays an important role in the learning process, as it has been shown to occur in parts of the brain responsible for learning and memory formation (Abel et al., 2013 & Cortés-Mendoza et al., 2013). The PJBL model involves learners in projects that require direct application of learning concepts in real-world situations. The projects provide practical experience that can enhance understanding of concepts. Epigenetic theory underscores the role of experience and environment in shaping individual development, especially in regulating gene expression and its impact on cognitive and behavioral development (Fagiolini et al., 2009).

As explained above, the selection of material that is contextual and relevant to real life can also train students' problem-solving skills and mutual cooperation. Therefore, this research was carried out on environmental pollution material in class X of the independent curriculum. This material is very suitable for research because of the increasing environmental problems at local and national levels due to the presence of polluting materials produced by human activities.

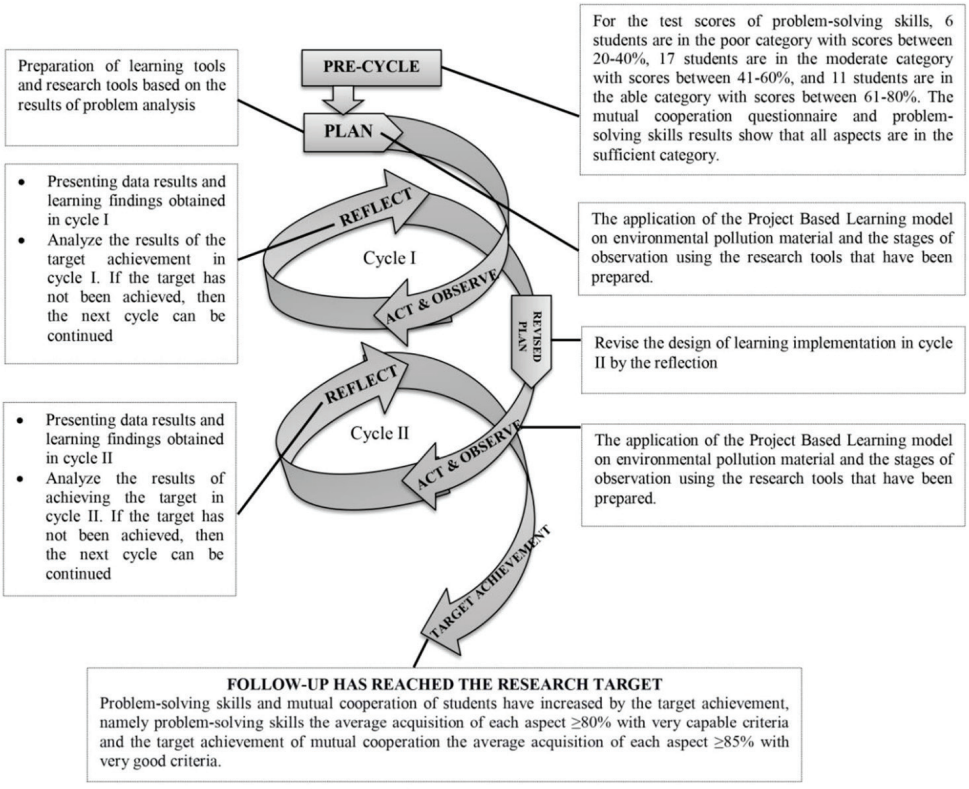
The background explained that the general research objectives are that applying project-based learning models in environmental learning can empower and improve students' abilities, especially problem-solving skills, and mutual cooperation. Several research questions were formulated to facilitate the solution of the research problem: First, how does using the PJBL model affect students' problem-solving skills and mutual cooperation? Second, how are the results for each problem-solving and student's mutual cooperation indicator when applying the PJBL model? The research objectives are as follows: first, to determine the effect of using the PJBL model on students' problem-solving skills and mutual cooperation; Second, to determine the results on each problem-solving skills indicator and each student mutual cooperation indicator after applying the PJBL model.

Methods

Research Design

This study is a classroom action research conducted on environmental pollution material to improve students' problem-solving skills and mutual cooperation using the Project Based Learning model. This research was carried out with several stages adapted from Kemmis et al. (2002): planning, acting, observing, and reflecting (Figure 1).

Figure 1
Schematic of Classroom Action Research Procedure



Population and Sample

The research population was class X Senior High School 3 Surakarta students, and the sample chosen in this research was even semester students who were studying Environmental material. The sample size was determined using purposive sampling, which was to the researcher's needs by considering the characteristics of the learning model. The sample chosen was class X-2, with 17 females and 17 males in one class,

so the total sample was 34 students. Students' ages range from 16 to 17 years. The duration of the research is around 4 weeks. The number of samples is limited because it is adjusted to the actual number of students in the class; this may be a limitation of the study.

Data Collection

The data collection technique of this research is a test and non-test to determine the problem-solving skills and mutual cooperation of students. The test technique is a discourse description question, while the non-test technique is questionnaires, interviews, observation, and documentation. Details of data and research data sources are listed in Table 1.

Table 1
Data and Data Source

No.	Data	Data source
1.	Syntax implementation	Observation of syntax implementation
2.	Intra-group and inter-group learner interaction	Observation of learners' social interaction
3.	Overview of how the teacher treats and responds to learners' questions	Observation of teacher reaction
4.	Learner response after learning	Interview of learners' response after learning
5.	Problem-solving skills	Questionnaires and tests
6.	Mutual cooperation	Questionnaires

Data Analysis

The data analysis technique used in this research is qualitative descriptive analysis. There are three elements in the descriptive analysis technique by Creswell (2009): reduction, data presentation, and conclusion drawing. The data validity test in this study used method triangulation techniques. The data obtained from the problem-solving skills and mutual cooperation questionnaires used scoring modified from Facione (1994). Then, the raw scores that have been obtained can be converted into percentage scores using the following formula:

$$NP = \frac{R}{sm} \times 100 \quad (1)$$

Description:
NP = Value sought
R = Score obtained by the learner
Sm = Maximum test score

The percentage score obtained can be used to determine students' problem-solving skills and mutual cooperation based on 5 categories. The categories for determining the level of problem-solving skills through the administration of test sheets can be seen in Table 2, and the categories for mutual cooperation skills can be seen in Table 3. The target achievement of this research is that students' problem-solving skills increase to ≥80% with highly capable criteria, and students' mutual cooperation becomes ≥85% with highly capable criteria.

Table 2
Problem Solving Skills Instrument Score Criteria

No.	Criteria	Interval
1	Highly Capable	81–100
2	Able	61–80
3	Medium	41–60
4	Less	21–40
5	Very Less	0–20

Source: Hidayatulloh et al. (2020)

Table 3
Mutual Cooperation Instrument Score Criteria

No.	Criteria	Interval
1	Highly Capable	85–100
2	Able	70–84
3	Medium	55–69
4	Less	46–54
5	Very Less	<45

Source: Monika et al. (2023)

Results and Discussion

The pre-cycle activities began with interviews with biology teachers and students and then classroom observations to identify problems. The observations showed that learning activities are individualistic, where students individually work on tasks given by the teacher, and learning activities are rarely implemented in groups. Students' problem-solving skills are still lacking, and it can be seen that students have difficulty working on problem-solving during the end-of-semester summative assessment. Karmina et al. (2021) argue that collaborative learning models and contextualized materials influence problem-solving skills and mutual cooperation. According to Bozyiğit Bozyiğit

et al. (2014), one of the ways that can be done to improve problem-solving skills and mutual cooperation is through the application of active and participatory learning models, such as the Project Based Learning learning model, which provides opportunities for students to learn and work together in completing projects and tasks, the use of learning materials that are contextual and relevant to real life, strengthening the values of mutual cooperation in the learning process (Rohmah et al., 2020).

The results of applying the Project Based Learning model on environmental pollution material to improve problem-solving skills can be seen in Figure 2, Table 4, and Table 5. The histogram in Figure 2 shows that the average test scores of problem-solving skills at each stage increased. The percentage of the acquisition of each aspect of problem-solving skills measured using tests and questionnaires can be seen in Table 4 and Table 5.

Figure 2

Comparison of Problem Solving Skills Test Results for Each Cycle

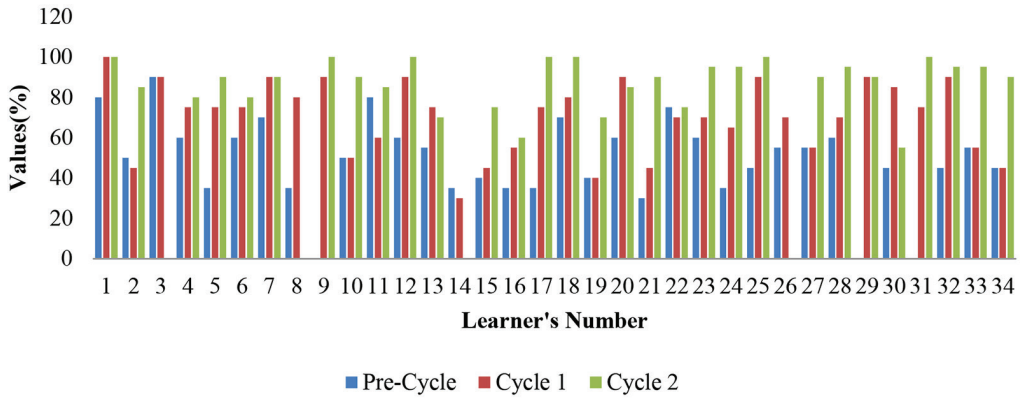


Table 4

Comparison of the Percentage of Problem Solving Skills Test for Each Aspect in Pre- Cycle, Cycle and Cycle 2 Activities

Aspects of Problem Solving Skills	Pre-cycle Result (%)	Value Criteria	Cycle 1 Result (%)	Value Criteria	Cycle 2 Result (%)	Value Criteria
Defining the problem	69	Able	86	Highly Capable	85	Highly Capable
Exploring the problem	70	Able	76	Able	90	Highly Capable
Planning a solution	56	Medium	72	Able	95	Highly Capable

Aspects of Problem Solving Skills	Pre-cycle Result (%)	Value Criteria	Cycle 1 Result (%)	Value Criteria	Cycle 2 Result (%)	Value Criteria
Implementing the plan	35	Less	50	Medium	81	Highly Capable
Checking the solution	34	Less	60	Medium	81	Highly Capable
Evaluate	34	Less	60	Medium	81	Highly Capable

Table 5

Comparison of the Percentage of Problem Solving Skills Questionnaire Results for Each Aspect in Pre-Cycle, Cycle 1 and Cycle 2 Activities

Aspects of Problem Solving Skills	Pre-cycle Result (%)	Value Criteria	Cycle 1 Result (%)	Value Criteria	Cycle 2 Result (%)	Value Criteria
Defining the problem	69	Able	81	Highly Capable	83	Highly Capable
Exploring the problem	68	Able	74	Able	81	Highly Capable
Planning a solution	69	Able	75	Able	80	Highly Capable
Implementing the plan	70	Able	79	Able	83	Highly Capable
Checking the solution	69	Able	79	Able	83	Highly Capable
Evaluate.	67	Able	78	Able	80	Highly Capable

Applying Project Based Learning in cycle I can improve problem-solving indicators: defining problems, exploring problems, planning solutions, implementing plans, checking solutions, and evaluating have not yet reached the research target. The percentage of test scores in aspect of exploring problems in cycle I was 76%, and the questionnaire value in aspect exploring problems was 74% and included in the capable category. The aspect of exploring problems has not reached the target achievement and can be caused by learning activities in cycle I students modeling various conditions of polluted river water using simple tools and materials. Modeling river water conditions limits students' ability to explore existing problems. In the next cycle of learning activities, students can make direct observations of the surrounding environment. Mook (2019) claims that direct observation of the environment can help students explore the problem further.

Sadiman (2014) and Darmawan et al. (2019) also state that proper media selection can foster students' interest and attention during learning and can improve students' problem-solving skills.

The aspect of planning solutions in tests and questionnaires of problem-solving skills has not yet reached the target achievement (≥80%). The aspect of planning solutions on the test received a percentage value of 72% (capable category), while the questionnaire value obtained 75% (capable category). The acquisition of test scores on the aspect of planning solutions aligns students' answers on the problem-solving skills tests. Students are asked to plan project solutions to be carried out but have not come up with products that can be made or used in the real world. Then, based on classroom observations, students in planning solutions have been unable to find new products that differ from other groups. Each group has the same product, a water filter. The difference lies in the constituent components in each group. All products produced are uniform, indicating that the aspect of planning solutions is still lacking. According to Insani et al. (2016), the factor that causes the low aspect of planning solutions is students' cognitive skills. Solving problems requires complex thinking skills, namely cognitive skills and awareness of using the right strategy. Thus, if the cognitive skills possessed by students are low, then students' skills in planning solutions to solve problems will also be hampered. Utomo (2020) argues that teachers can improve the aspect of planning solutions by directing learners to create problem-solving projects that are different from other groups.

The aspect of implementing the learners' plan obtained a score of 50% (medium category) on the problem-solving skills test, while the percentage of questionnaire data was 79% (capable category). These results align with the answer to test question number 4, where students have been unable to make a complete project implementation plan schedule, and students' answers do not elaborate on activities and implementation dates. Besides that, the results of interviews after cycle I learning actions of some learners revealed that some group members did not contribute enough to making products. Teachers must manage group work to ensure equal participation and maximum benefits (Khasaia, 2016). So, the teacher must constantly monitor the project, remind students to contribute actively, and conduct assessments among students in one group (Utomo, 2020).

The aspect of checking solutions that are still classified as capable with the acquisition of a test score of 60% and the acquisition of a questionnaire of 79% is in line with the test answers of students who do not show the suitability of the planned solution with the supporting theory, and the observation data shows that during the water filter product trial, there were several groups whose products did not function properly. The teacher can improve this aspect by constantly monitoring the project, reminding students to contribute actively, and conducting assessments between students in one group (Utomo, 2020).

The results of applying the Project Based Learning model on environmental pollution material to improve mutual cooperation can be seen in Table 6. The percentage of acquiring each aspect of mutual cooperation measured using a questionnaire has increased at each stage. In the results of the assessment of aspects of mutual cooperation in cycle I, 3 aspects had not reached the achievement target (≥85%), namely, aspects of establishing communication and friendship, deliberation to reach consensus, and helping voluntarily. Observation data provides a note that there are submassive students in class discussions. One of the dominant students is more prominent because he actively argues and proposes opinions. In contrast, sub-massive students lack confidence in expressing their opinions in class, so in the next cycle, the sharing aspect needs to be increased again for submissive students by requiring all students to take turns expressing their opinions in learning activities (Utomo, 2020). The aspect of evaluating received a test score of 60% and a questionnaire score of 78%, including in the capable category, in line with the student's answers on the test sheet, did not describe the advantages and disadvantages of the planned solution. In addition, based on the observation results, several groups did not provide responses and evaluations for other groups. Teachers can improve the evaluation aspect by requiring each group to respond to the products made by other groups (Utomo, 2020).

In discussion activities, river water modeling practicum, and presentations, some students do not contribute to their groups, so collaboration and caring must also be re-empowered in the next cycle. The observation data is supported by observations of syntax implementation, where the motivation stage at the first meeting is less visible. According to Posamentier (2015), motivation from the teacher can foster students' interest in learning so that the learning process can take place well.

Table 6

Comparison of Percentage of Mutual Cooperation Questionnaire Results for Each Aspect in Pre-action, Cycle 1 and Cycle 2 Activities

Aspects of Mutual Cooperation Skills	Pre-cycle Result (%)	Criteria	Cycle I Result (%)	Criteria	Cycle 2 Result (%)	Criteria
Empathy	67	Good enough	90	Very good	93	Very good
Cooperation	69	Good enough	87	Very good	87	Very good
Establish communication and friendship	68	Good enough	84	Good	87	Very good
Commitment to shared decisions	69	Good enough	85	Very good	89	Very good
Consensus deliberation	66	Good enough	81	Good	85	Very good

Aspects of Mutual Cooperation Skills	Pre-cycle Result (%)	Criteria	Cycle I Result (%)	Criteria	Cycle 2 Result (%)	Criteria
Acts of respect	71	Good enough	86	Very good	89	Very good
Voluntary help	66	Good enough	83	Good	88	Very good

The reflection results of the application of Project Based Learning during cycle II showed increased problem-solving skills and mutual cooperation among students. The results of the application of Project Based Learning in cycle II show that the research achievements of students have been achieved in all aspects of problem-solving skills and mutual cooperation so that action research has met the conditions for not doing the next cycle.

During the research activities, there was incomplete student data, and the incompleteness of the student data was due to students not following the stages of the research. A list of incomplete learner data can be seen in Table 7.

Table 7
Incomplete Learner Data

Number	Achievement of Problem Solving Test Score			Achievement of Problem Solving Questionnaire Score (%)			Achievement Score of Mutual Cooperation Questionnaire (%)		
	Pre-cycle	Cycle I	Cycle II	Pre-cycle	Cycle I	Cycle II	Pre-cycle	Cycle I	Cycle II
3	90	90	0	70	100	0	74	100	0
8	35	80	0	71	87	0	68	89	0
14	35	30	0	74	74	0	78	98	0
26	55	70	0	71	74	0	72	80	0

Numbers 3, 8, 14, and 26 took part in the pre-cycle and cycle I actions but did not take part in cycle II actions. At the time of the pre-cycle number 3 obtained a percentage of problem-solving test scores of 90% (very capable category), and in the cycle-1 got 90% (very capable category). The achievement percentage of the problem-solving questionnaire in the pre-cycle was 70% (capable), and in cycle I, it was 100% (very capable). The percentage achievement of mutual cooperation questionnaire number 3 in the pre-cycle was 74% (good), and cycle I was 100% (very good). Based on this data, there was an increase in the percentage score from pre- cycle to cycle I action.

Number 8 obtained the achievement percentage of the problem-solving skills test score as follows: in the pre-cycle, 35% (poor category); cycle I of 80% (capable category).

The achievement percentage of the problem-solving skills questionnaire score in the pre-study was 71% (capable category), and cycle I was 87% (very capable category). The achievement percentage of the mutual cooperation questionnaire score in the pre-cycle was 68% (quite good), and cycle I was 89% (very good category). Based on this data, there was an increase in the percentage of scores from pre-cycle to cycle I action.

Number 14 obtained the achievement percentage of the problem-solving skills test score as follows: in the pre-cycle of 35% (less category), cycle I of 30% (less category). The achievement percentage of the problem-solving skills questionnaire score in the pre-cycle was 74% (capable category), and in cycle I it was 74% (very capable category). The percentage of achievement of the mutual cooperation questionnaire score at pre-cycle was 78% (good), and cycle I was 98% (very good category). Based on the data on the percentage score of the mutual cooperation questionnaire, there was an increase in the percentage score from pre-cycle to cycle I action. However, based on the data in the percentage score, achievement of the problem-solving skills test decreased by 5%, and based on the percentage score achievement of the problem-solving skills questionnaire, students' achievement was stagnant (not increasing or decreasing).

Number 26 obtained the achievement percentage of the problem-solving skills test score: in the pre-cycle it was 55% (moderate category); cycle I amounted to 70% (capable category). The achievement percentage of the problem-solving skills questionnaire score in the pre-cycle was 71% (capable category), and cycle I was 74% (capable category). The percentage of achievement of the mutual cooperation questionnaire score in the pre-cycle was 72% (good), and cycle I was 80% (good category). Based on this data, there was an increase in the percentage score from pre-cycle to cycle-I action.

The data from Cycle I and Cycle II align with the theories supporting Project Based Learning: Piaget's constructivism theory, Vygotsky's constructivism, Dewey's experiential learning theory, and epigenetics. Social interaction in groups can improve problem-solving skills and mutual cooperation compared to learning alone (Piaget, 1963; Vygotsky, 1978; Yang et al., 2012; Afandi & Sajidan, 2017). The experience learners gain through direct practice in the field can also help learners understand the material (Dewey, 1933; Afandi & Sajidan, 2017). A classroom environment that is organized to empower problem-solving skills and mutual cooperation can improve students' problem-solving skills and mutual cooperation (Sajidan & Afandi, 2018).

Conclusion

Based on the study's results, applying the project-based learning model in environmental learning can improve problem-solving skills and mutual cooperation of students in class X-2 Senior High School 3 Surakarta in the 2023/2024 academic year. There is a significant difference in students' problem-solving skills and mutual cooperation before

and after learning the integrated PJBL model. Learners become more skillful in solving problems in the environment and work together with their groups.

There was an increase in the six students' problem-solving skills indicators between before and after learning, with the highest score on both the pre-cycle, cycle 1, and cycle 2 on the cognitive indicator of remembering when the pre-cycle all indicators were in the able criteria (69%) and in the cycle 2 all indicators increased to the criteria highly capable (82%). There was an increase in the seven indicators of mutual cooperation between before and after learning when the pre-cycle, all indicators in the good enough criteria (68%), and in the cycle 2, all indicators increased to the criteria of very good (88%).

These results show that applying the PJBL in environmental learning can form problem-solving skills and mutual cooperation. This study has implications for educators' understanding and mastery in implementing PJBL because PJBL can be used as one of the most effective alternative models of teaching and learning activities for improving students' problem-solving skills and mutual cooperation. It is hoped that future researchers will use a more diverse sample to enrich future research findings related to PJBL and other 21st-century skills.

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Projektinis mokymasis aplinkosaugos srityje: ar tai gali pagerinti besimokančiųjų problemų sprendimo įgūdžius ir tarpusavio bendradarbiavimą

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Santrauka

Indonezijos Surakartos 3-osios vidurinės mokyklos X klasės vyresniųjų mokinių problemų sprendimo įgūdžiai ir abipusis bendradarbiavimas vis dar yra nepakankamo lygio. Šiuo tyrimu siekiama įvertinti projektinio mokymosi modelio taikymą tyrinėjant aplinkai taršias medžiagas, kad būtų patobulinti mokinių problemų sprendimo įgūdžiai ir tarpusavio bendradarbiavimas. Šio tipo tyrimas yra grupės veiksmų tyrimas, atliktas Surakartos 3-iojoje vidurinėje mokykloje, Indonezijoje. Tyrime dalyvavo Surakartos 3-iosios vidurinės mokyklos X klasės vyresnieji mokiniai. Pasirinkta X-2 imtis. Tyrimo procedūra apėmė planavimą, veiksmus, stebėjimą ir refleksiją. Duomenims rinkti ir tyrimui atlikti buvo naudojami problemų sprendimo įgūdžių klausimynai ir testai, tarpusavio bendradarbiavimui tirti klausimynai, testai, stebėjimo lapai, mokinių socialinės sąveikos stebėjimo lapai, mokytojų reakcijų stebėjimo lapai, interviu lapai, dokumentacija. Duomenys patvirtinti naudojant trianguliacijos metodą. Rezultatai atskleidė, kad problemų sprendimo įgūdžių testų balai pasikeitė, t. y. padidėjo (nuo 53 proc. prieš ciklą iki 86 proc. II cikle). Visi problemų sprendimo įgūdžių ir tarpusavio bendradarbiavimo aspektai II cikle buvo įgyvendinti. Darytina išvada, kad projektinio mokymosi modelio taikymas gali pagerinti Surakartos 3-osios vidurinės mokyklos X-2 klasės mokinių problemų sprendimo įgūdžius ir tarpusavio bendradarbiavimą.

Esminiai žodžiai: *klasės veiklos tyrimas, projektinis mokymasis, problemų sprendimo įgūdžiai, tarpusavio bendradarbiavimas, aplinkos tarša.*

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