

Uncovering The Effectiveness of the Project-Based Learning Model and Ecological Intelligence: Impact on Environmental Problem-Solving Ability in Senior High School

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ARTICLE INFO

Article History:

Received: 2024-02-12

Accepted: 2024-03-19

Published: 2024-03-30

Keywords:

Ecological intelligence; Environmental problem-solving; PjBL

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DOI: 10.37905/jgej.v5i1.24461

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ABSTRACT

Equipping students with proficient environmental problem-solving skills is critical in the 21st century to address pressing global problems. This research explores the effectiveness of Project-Based Learning (PjBL) combined with ecological intelligence as a strategy to increase students' cognitive understanding and environmental awareness. A quasi-experimental design with a pre-test and post-test control group design was used. The participants were class XI IPS (Class XI IPS) students from SMA Negeri 1 Karangrejo (n = 5 classes). Purposive sampling resulted in an experimental class that was exposed to PjBL and a control class that followed traditional learning. Data collection was carried out through descriptive tests and observations that were validated and reliable. A two-way ANOVA analysis showed a significant positive effect (p less than 0.05) between PjBL and ecological intelligence on students' environmental problem-solving abilities. Interestingly, no significant interaction effects (p greater than 0.05) were detected, indicating the potential dominance of the PjBL structured learning environment. These findings highlight the potential of PjBL as a pedagogical tool to foster environmental literacy and problem-solving in geography education.

How to cite: Rianti, N. S., Utaya, S., Purwanto, & Shreshta, R. P. (2024). Uncovering The Effectiveness of the Project-Based Learning Model and Ecological Intelligence: Impact on Environmental Problem-Solving Ability in Senior High School. *Jambura Geo Education Journal*, 5(1), 33–43. <https://doi.org/10.37905/jgej.v5i1.24461>

1. Introduction

21st-century education, education was recognized as the main factor that guarantees sustainable development (Rasulov, 2022). That is a global program initiated from the results of the 70th UN conference to implement the SDGs of quality education as graduates gain awareness and quality human abilities (Hidayah & Yuliawati, 2021). Sustainable development and the environmental crisis are recognized globally as relevant to education and teaching (Ferreira & Molala, 2017). The abilities needed in this century are also stated in the Minister of Education and Culture Regulation No. 21 of 2016 concerning content standards and educational standards, namely communication skills, problem-solving, critical thinking, creativity and innovation, and collaboration (Sarwi et al, 2021). These abilities can be integrated through environmentally friendly school policies or involving class teachers to involve material concepts and environmental aspects in learning (Miranto, 2017). So problem-solving abilities are a part that must always be developed in dealing with current environmental problems.

The relationship between geography in problem-solving is explained by (Urbańska et al, 2022) that learning geography creates opportunities for the transfer of knowledge about the environment and how to solve it. that learning geography creates opportunities for the transfer of knowledge about the environment and how to dominate it through spatial ability (Silviariza et al, 2020) as the ability to understand and study the relationships between objects in space. It was stated by (As'ari et al, 2021) that spatial abilities can help people understand environmental characteristics, study problems, and solve problems in space. Environmental solving is an individual process that attempts to provide solutions by involving cognitive abilities with analysis and inference processes (Retno et al, 2019; Woa et al, 2018). Problem-solving skills were important for students to have, considering that natural resource issues are currently not receiving attention. This was expressed by (George et al. 2018) that attitudes and behaviors toward sustainable practices will be crucial in the future.

The results of observations at SMA Negeri 1 Karangrejo showed that students had not been able to solve problems that exist in the school environment, such as piling up rubbish at the edge of the classroom, excessive use of plastic and environmental problems in the area where students live, such as damage to rivers due to illegal sand mining, polluted seas. and deforestation. This was related to students' lack of awareness and ability

to understand natural resource management material. Problems like this require resolution and solutions through ideas to support the environmental ecosystem in the future. So the role of geography teachers was to instill understanding by connecting geography material with students' environmental conditions. It was stated ([Lestari, 2016](#)) that problems found in the field require students' in-depth abilities to have the ability to think and reason in understanding each problem found.

Students' lack of achievement of this ability could be addressed through education as a solution to help instill awareness in the younger generation to fight alienation from nature, which is naturally unaware of it. This educational role is pursued with approaches and innovations that link learning material with the problems faced by utilizing contextual learning resources ([Hariawan et al., 2014](#)). An effective learning model to shape students to become more independent by increasing cognitive, affective, and psychomotor aspects is the PjBL model. The PJBL model is used because it involves students being active and creative, especially if the PJBL model is integrated into geography learning, students' abilities will further develop through interactions between students and peers, students and teachers, and students' relationships with the natural environment. It was stated ([Genc, 2015](#)) that the PjBL model has a positive influence on improving environmental attitudes,

PjBL trains students academically and builds content understanding effectively through a project ([Ilhan, 2014](#)). The focus of learning using this model lies in the concepts and principles of study discipline, namely involving students fully in problem-solving investigations and providing opportunities for students to work independently and collaboratively. So the essence of this learning model was to connect students' experiences with school life and stimulate students' thinking to acquire new knowledge ([Efstratia, 2014](#)). Advantages of the PjBL model; First, PjBL increases students' ability to learn cooperatively. Two, PjBL can increase student creativity. Third, PjBL improves students' communication skills. Students are required to work with other people. Fourth, PjBL can improve problem-solving ability and management abilities, and Five creates a pleasant learning environment ([Sumarni, 2013](#)). Apart from its advantages, the PjBL model also has disadvantages, namely that it requires quite a long time to efficiently and teachers need to prepare various equipment before starting learning ([Almulla, 2020](#)).

A factor that can also support students in solving environmental problems is intelligence. The theory developed by Howard Garder, a developmental psychologist and Professor of Education, explains that intelligence is the ability to solve problems and produce products in a variety of settings in factual situations. The intelligence that supports students' abilities is ecological intelligence. It was explained ([Purwono & Jannah, 2020](#)) that ecological intelligence is the natural intelligence possessed by an individual to apply what is understood to be the result of human attitudes towards the environment.

Ecological intelligence is important for students to have, as expressed by ([Wulan et al., 2023](#)) that humans who have ecological intelligence could naturally recognize and respond to environmental changes. This intelligence was seen as a form of ability to understand the relationship between humans and nature to realize the impact of humans on the environment, as well as find solutions to preserve the harmonious relationship between humans and nature ([Vreja et al., 2018](#)). Educating a good attitude towards nature was based on the acquisition of healthy knowledge. There is an urgent need to educate and improve teachers' knowledge, awareness, skills, and attitudes in the teaching and learning process for sustainable development ([Mróz et al., 2020](#))

Several research results conducted by previous researchers related to the PjBL model with ecological intelligence on the ability to solve environmental problems. Research conducted by ([Hindriyanto et al. 2019](#)) shows a significant difference in the influence of the PjBL model on geographic problem-solving abilities. PJBL has meaningful benefits in solving problems through the syntax of the PJBL model that supports students in developing their abilities, and research conducted by ([Khasanah & Dwiastuti, 2016](#)) suggests that there was an influence of using the guided discovery learning model on scientific literacy in terms of naturalist intelligence. The influence of naturalist or ecological intelligence is seen in students who can link knowledge and skills and relate learning material to the surrounding conditions

This research was a modification of previous research, and the novelty obtained from this research was knowing the ability to solve environmental problems from the level of students' ecological intelligence and the application of the PjBL model. Based on the explanation above, this research aims to determine the influence of the PjBL model on solving environmental problems, the influence of ecological intelligence on solving environmental problems, and the interaction between the PjBL model and ecological intelligence on solving environmental problems.

2. Method

This research was located at SMAN 1 Karangrejo, which is located on Jl. Raya Karangrejo – Sendang, Karangrejo District, Tulungagung Regency, East Java. A map of the research location can be seen in [Figure 1](#).

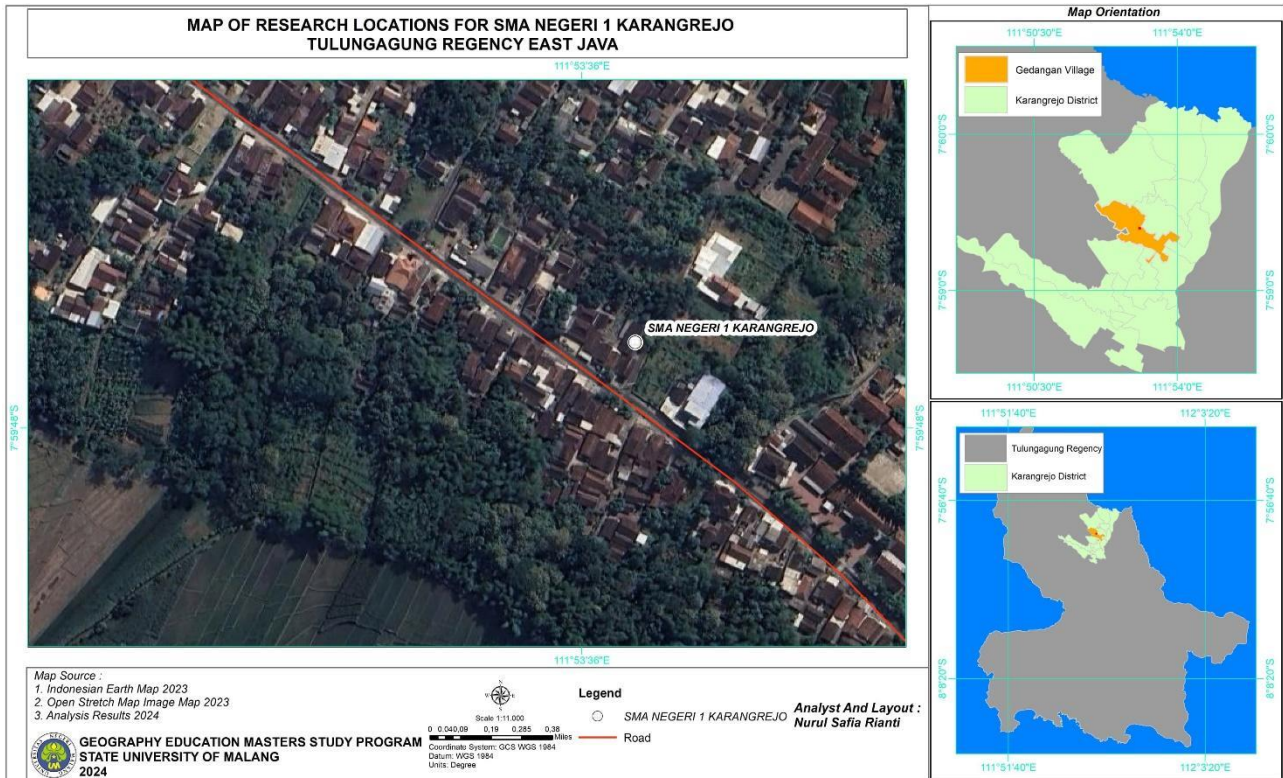


Figure 1. Research location map

This research is a quasi-experiment and uses a pretest-posttest control group design consisting of an experimental group and a control group. The research design can be seen in [Table 1](#).

Table 1. Research design

Group	Pretest	Treatment	Posttest
Experiment	O ₁	X ₁	O ₂
Control	O ₁	X ₂	O ₂

Source: (Creswell, 2012)

Information;

O₁: pretest

O₂: posts

X₁: Learning uses the PjBL model

X₂: learning uses a conventional approach

The research phase began by giving a pretest to both groups to measure initial knowledge before being given treatment. The experimental class was treated using the project-based learning model (PjBL), and the control class was treated using the conventional approach or discussion lecture method, with the teacher as a source of information for students. The implementation of PjBL on environmental problem-solving capabilities can be observed in [Table 2](#).

Table 2. Implementation of PjBL syntax with environmental problem-solving capabilities

Syntax	Environmental Problem Solving
Basic question	Analyze the potential of natural resources in the surrounding area using maps Identify and explain natural resource problems found
Design project planning	Develop problem-solving strategies Design a problem-solving plan based on the project theme obtained from the analysis of the problems found
Arrange a schedule	Students have skills in time management, self-management, and working together.
Monitor students and project progress	Ensure that the projects carried out are related to the problems and planned solutions Guiding and assisting if there are difficulties in making the project Ask about the progress that had achieved
Assess project results	Present project results and provide assessments
Evaluate project results	Provide conclusions on solutions to problems Reflecting on project results and experiences felt when finding solutions to the problems faced.

The research subjects were class XI IPS at SMA Negeri 1 Karangrejo which consisted of 5 classes XI D, XI E, XI F, XI J, and XI K. Sampling was carried out using a purposive sampling technique with the criteria of having the same initial abilities obtained from student tests results and 2 classes were obtained consisting of class XI K as the experimental class with a total of 34 students, and class XI E as the control class with a total of 38 students.

The instrument used to determine environmental problem-solving abilities was an essay test with 10 questions and to determine students' ecological intelligence through the Center for Ecoliteracy reference indicator (Ilela et al, 2021) which consists of aspects; first, the knowledge aspect; understanding environmental issues and problems, understanding ecological principles, considering sustainability, critical thinking skills, solving application problems, the impact and influence of human actions, secondly, the attitude aspect; provide a caring attitude, empathy, and respect for living creatures, respect differences in background, interaction and cooperation, commit to justice, equality and inclusiveness, third, psychomotor aspects; manufacture the required objects and tools, apply practical and effective steps. Below you can observe the criteria for ecological intelligence in [Table 3](#).

Table 3. Criteria ecological intelligence

Value	Criteria
>75	High
65-75	Medium
<55	Low

Source. Primary data 2023

Instruments could be applied in learning if the testing and verification stages have been carried out, including the validity and reliability testing stages. Following are the results of the instrument trial analysis which can be observed in the following [Table 4](#).

Table 4. Instrument trial results

Items	Validity	Criteria	Reliability	Criteria
questions 1	0.420	Quite valid	0.863	Reliability
questions2	0.542	Quite valid	0.871	Reliability
questions 3	0.688	Valid	0.840	Reliability
questions 4	0.859	Very Valid	0.820	Reliability
questions 5	0.663	Valid	0.842	Reliability
questions 6	0.524	Quite Valid	0.855	Reliability
questions 7	0.807	Very Valid	0.827	Reliability
questions 8	0.656	Valid	0.843	Reliability
questions 9	0.859	Very Valid	0.820	Reliability
questions 10	0.656	Valid	0.843	Reliability

Based on the [Table 4](#), the results of the test questions met the requirements. The data collection method was carried out through tests and observations. The test was carried out to determine students' environmental problem-solving abilities through pretest and posttest scores. The observation sheets include observation sheets of attitudes and skills carried out during learning. The data analysis technique uses a two-way ANOVA test at

a significance level of 0.05 using SPSS 26. This test was carried out to determine the influence of the independent variables on the results obtained along with their interactions.

3. Results and Discussion

The results of the data on the environmental problem-solving abilities of the experimental and control classes before being given treatment were carried out through a pretest, then the two groups were given treatment, in the experimental class using the PjBL model and the control class using a conventional approach, then a posttest was carried out. The results of the pretest and posttest scores in the experimental and control classes can be seen in [Table 5](#).

Table 5. Results of analysis of environmental problem-solving ability scores

Group	Pretest		Posttest		Pretest	Posttest	Gain score
	Xmin	Xmax	Xmin	Xmax	Mean	Mean	
Experiment	45	75	70	92	57.53	80.29	55.62
Control	40	72	60	87	59.44	77.34	45.09

Based on [Table 5](#), it is evident that there were differences in the value of solving environmental problems between the experimental class and the control class. This difference was obtained from the results of different treatments between the experimental and control classes. The experimental class uses PjBL, where the PjBL syntax begins with basic questions to identify surrounding problems, gives students the freedom to develop creativity, integrates students' abilities independently, and directs students' analytical ability in various actions. The control class uses conventional learning, namely the transfer of knowledge from teachers to students through discussion

The average pretest score for the experimental class was 57.53 and the control class was 59.44. After being given treatment and testing students' abilities through a posttest, the experimental class experienced an increase in their ability to solve environmental problems, with an average posttest score of 80.29 for the experimental class and 77.34 for the control class. To determine the effectiveness of increasing environmental problem-solving abilities, it could be seen from the results of the experimental class gain score of 55.62 which was higher than the control class gain score of 45.09. These results showed that the average of the experimental class was higher than the control class. It can be concluded that students' environmental problem-solving abilities using the PJBL model were better than learning using the conventional approach. Based on these findings, the implication of using the PjBL model was that students could express their thoughts and ideas in discussions and become more competent in relating the material to current environmental issues.

Table 6 shows the results of students' ecological intelligence categorized into high, medium, and low categories based on the student's scores. The level of ecological intelligence of the experimental and control classes is in the following [Table 6](#).

Table 6. Category of ecological intelligence experimental class and control class

Value	Qualification	Frequency	
		Experiment	Control
>75	High	11	11
65-75	Medium	18	20
<55	Low	5	7
Total		34	38

Based on the data results in [Table 6](#), the ecological intelligence of students in the experimental class was classified as high 11 (29%), medium 18 (53%), and low 5 (18%), and the control class had the ecological intelligence categories high 11 (34%), medium 20 (50%), and low 7 (16%). Based on the results of the scores received, it could be concluded that most of the experimental and control class students had ecological intelligence in the medium category. The level of ecological intelligence influences attitudes and actions towards nature. As found by (Retnowati et al. 2018) high ecological intelligence is correlated with a caring attitude and sensitivity towards the surrounding environment. Students will realize that every action they take will affect nature. The results of students' environmental problem-solving ability scores based on the level of ecological intelligence can be observed in [Table 7](#).

Table 7. Environmental problem-solving ability based on ecological intelligence

Group	Ecological intelligence category	Mean	N
Experiment	High ecological intelligence	60.04	11
	Medium ecological intelligence	54.77	18
	Low ecological intelligence	51.90	5
	Total	56.05	34
Control	High ecological intelligence	55.93	11
	Medium ecological intelligence	43.47	20
	Low ecological intelligence	33.71	7
	Total	45.28	38

Based on the data results in [Table 7](#), it could be concluded that students who have a high level of ecological intelligence had a good average score for environmental problem-solving abilities, and students with a low level of ecological intelligence had low environmental problem-solving abilities. This was demonstrated by the normal scores of the two high natural knowledge groups in the exploratory and control classes, which had scores of 60.04 and 55.93, which were higher than those with low biological insight, which had a typical score of 51.90 and 33.71 with low ecological critical abilities to think.

The prerequisite tests were carried out, consisting of a normality test and a homogeneity test. The normality test results used the Kolmogorof-Smirnov and Shapiro-Wilk methods with a sig level. 0.05 and obtained the experimental class (sig. 0.13 and sig. 0.12) and the control class (sig. 0.07 and sig. 0.36). It can be concluded that the overall experimental and control values had sig. >0.05 , which means the data was normally distributed. Then a homogeneity test was carried out using the Levene test on both groups with sig $0.22 > 0.05$ so that it can be used as a basis for determining that the two groups had homogeneous variances.

Hypothesis testing using the two-way ANOVA test with SPSS 26. Decision-making was based on the sig value. <0.05 , then the hypothesis was accepted, and if the value is sig. >0.05 then the hypothesis is rejected. The results of the two-way ANOVA test are shown in [Table 8](#).

Table 8. Two-way ANOVA test results

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	7634.835^a	8	954.354	12.815	0.00
Intercept	239398.788	1	239398.788	3214.567	0.00
Model PjBL	3651.325	2	1825.663	24.514	0.00
Kecerdasan_Ekologis	2584.826	2	1292.413	17.354	0.00
PjBL * Kecerdasan	488.911	4	122.228	1.641	0.17
Error	7521.784	101	74.473		
Total	332526.863	110			
Corrected Total	15156.619	109			

The results of the two-way ANOVA test table show the answer to research objective 1) based on the data results in [Table 8](#), it shows that the PjBL model influences the ability to solve environmental problems, seen by the F-count value of 24.514 with sig. $0.00 < 0.05$, which means that the hypothesis was accepted, namely that there was a difference in the environmental problem-solving abilities of students who studied using the PjBL model and students who studied using conventional learning. 2) It can be seen in Table 7 that the score results show the influence of ecological intelligence on the ability to solve environmental problems with an F-count value of 17.354 with sig. $0.00 < 0.05$, which means the hypothesis was accepted, namely that there were differences in environmental problem-solving abilities based on ecological intelligence

Based on the value obtained from the PjBL interaction model and ecological intelligence on the ability to solve environmental problems with sig. $0.170 > 0.05$, the hypothesis results were rejected, namely that there was no interaction between the PjBL model and ecological intelligence on environmental problem-solving abilities. Based on these findings, it can be concluded that the PjBL model and ecological intelligence influence students to solve environmental problems. These findings can be a reference for improving learning by increasing students' abilities to be more critical and creative.

3.1. The Influence of the PjBL Model on Environmental Problem-Solving Ability

Based on the results of the two-way ANOVA hypothesis test carried out in the experimental class, the ability to solve environmental problems was shown through the results of the student posttest and observations of attitudes and skills during learning. then analyzed through statistical tests with sig <0.05 . The analysis results

show sig. $0.00 < 0.05$, which means the hypothesis was accepted. Based on these results, it can be concluded that the PjBL model presents contextual learning that involves aspects of the student's environment. Apart from that, one of the syntaxes of PjBL is creating projects. This project was an important point for developing student creativity and innovation. This was in line with research conducted by (Benzer & Şahin, 2013), that the project-based learning approach had a positive influence on students' environmental problem-solving abilities.

The opinion expressed by (Hindriyanto et al. 2019) was that PjBL had benefits for students' abilities in problem-solving. This benefit was obtained through project learning, which directs students' abilities to think critically, creatively, and skillfully to solve problems around them. Students are given the freedom to provide ideas and suggestions for real or contextual problems with solutions carried out collaboratively between colleagues. Next, students will share what they have learned with teachers and peers (Zheng et al. 2021). The application of PjBL can be used as a summative assessment but is also supported formatively during project creation through discussions (Bramwell-Lalor et al., 2020). Formative assessment in PjBL provides interaction or feedback during the product-making process and is used to calculate the time needed for subsequent project learning. The summative assessment uses student observation sheets to discuss problem-solving.

PjBL directs students to solve environmental problems in stages starting from the problem identification stage to the resolution stage and ending with a useful product. In line with the theory put forward by (Zheng et al., 2021) that students' abilities can be improved step by step through the project work process, students can pose problems based on what is observed in outdoor ecology, explore independently, and learn knowledge from other teams to share information. To encourage students' paradigm of environmental concern towards achieving sustainable development, one of the independent curriculum programs was initiated, namely the project to strengthen the profile of Pancasila students.

This learning convinces students that practice can help them define environmental problems more clearly and can take part in solving them (Genc, 2015). PjBL was implemented with the aim that students could increase awareness and empathy for nature. Meaningful learning is one that actively involves students in contributing ideas or challenging any ideas (Zulhaimi et al. 2020). So students need to be involved in contextual learning that can help them understand the surrounding conditions and gain real experience in solving them (Anon UA-Umakul et al. 2018).

The application of the PjBL model directs students to carry out investigations through open questions and gathering information to produce creativity in the form of products that are useful in solving environmental problems so that students' abilities to solve problems can be formed and become the first step to improve the structure of a sustainable environment. In line with the opinion of (Fauzi et al. 2022) that to support better survival on the surface of the earth, small steps are needed in the realm of environmental education which are packaged with innovative learning models and methods. Starting in the school environment, students can be provided with simple actions to live an environmentally friendly life at school, at home, and in the community.

3.2. The Influence of Ecological Intelligence on Environmental Problem-Solving Ability

Based on the results of the two-way ANOVA hypothesis, which was carried out to obtain environmental problem-solving abilities in the experimental class and control class, which were taught using the PjBL model and the conventional approach, the hypothesis results were obtained with sig. $0.00 < 0.05$. This means that the hypothesis was influential and significant, namely that there is an influence on the level of ecological intelligence of students in the high, medium, and low categories on their ability to solve environmental problems. Based on the results of statistical calculations for each intelligence category, it was found that the average ecological intelligence of students was predominantly moderate. Students' ecological intelligence determines their conscious behavior toward their relationship with the environment so that when faced with environmental problems, students are naturally encouraged to provide creative ideas and ideas to contribute to improving the environment.

Ecological intelligence influences students' ability to solve environmental problems. Ecological intelligence provides students with an understanding of the impact of human behavior on the surrounding environmental ecosystem. So environmental damage cannot be done (Purwono & Jannah, 2020). The opinion was also expressed by (Ilela et al. 2021) that environmental sustainability in the future will depend on ecological intelligence. The important role of ecological intelligence in sustainability is to make each individual aware that the actions or attitudes taken towards nature will influence and change the ecosystem (Vreja et al., 2018). Interaction between humans and nature occurs naturally where humans can control nature. If, in this interaction, a person does not have ecological intelligence, then environmental damage occurs, such as the exploitation of natural resources. so it is necessary to continue to develop ecological intelligence (Husin, 2012)

A person can naturally recognize and respond to environmental conditions around him through his ecological intelligence. Ecological intelligence is categorized into three dimensions; cognitive, behavioral, and technological. The cognitive dimension of ecological intelligence emphasizes a person's ability to think and learn. The behavioral dimension emphasizes how a person will behave, carry out activities, and respond to ecological changes and dimensions. In the technological dimension, the emphasis is on choosing the appropriate use of technology in life. This third dimension directs ecological awareness based on basic human mental abilities regarding the internalization of learning, actions and reactions, moral emotions, and how to make decisions in determining appropriate and environmentally friendly technology (Wulan et al., 2023). It can be concluded that this third dimension illustrates that ecological intelligence is needed and has an influence on solving environmental problems in the future.

Students have different levels of ecological intelligence, high, medium, and low. Differences in levels of ecological intelligence influence students' attitudes towards nature. The opinion expressed by (Retnowati et al., 2018) is that someone who has high ecological intelligence can demonstrate attitudes and knowledge toward nature and is of the view that sensitivity to the environment is a necessity. According to the theory put forward by (Wirdianti et al., 2019) awareness of the environment can influence students' perspectives on changes in environmental issues that occur around them. Ecological intelligence can continue to be developed through the involvement of educators and educational elements influencing policy regarding the importance of school culture in forming attitudes and skills to preserve the environment. (Ningrum et al., 2018) Ultimately ecological intelligence will help produce students who care about the environment.

3.3. Interaction of the PjBL Model with Ecological Intelligence on Environmental Problem-Solving Ability

Given the consequences of the two-way ANOVA test done in the trial class and control class, it very well may be seen that there was no connection between PjBL and natural knowledge on the capacity to tackle ecological issues, This should be visible from the F-count worth of 1.641, with sig. 0.17 meaning the sig value is >0.05 . This shows that these two factors have separate influences, there is a more dominant factor that influences the ability to solve environmental problems. This is because ecological intelligence in students is an internal factor that students already had before being given action and external factors in the form of teaching and learning strategies, such as the application of learning models.

This research was also supported by the theory put forward by (Suhirman & Ghazali, 2022) that ecological intelligence and the PBL-CD model do not have a significant influence on students' abilities. The abilities possessed by students do not depend on the level of ecological intelligence, both students with high and low intelligence benefit from applying the learning model. The PjBL learning approach emphasizes student participation to identify and develop abilities through a project.

According to the theory put forward by (Retnowati et al., 2018), to achieve the expected results in the learning process, it is necessary to choose teaching methods that are adapted to the student's level of intelligence. This is supported by several previous studies, such as research conducted by (Safithri et al., 2021), showing that there is no interaction between the implementation of PBL, PJBL, and self-efficacy on students' problem-solving abilities, further research conducted by (Khasanah & Dwiastuti, 2016), that there was no interaction between the guided discovery learning model and naturalist intelligence on scientific literacy.

Based on the aforementioned findings, the PjBL model and ecological intelligence have no bearing on students' capacity to solve environmental problems and are more influenced by the learning activities used than by the growth of students' ecological intelligence. The learning activities that are being used only concentrate on the pupils' capacity to solve environmental challenges.

4. Conclusion

First, there is the influence of the PjBL model on the capacity to solve environmental problems, sig. $0.00 < 0.05$, according to research study results. This suggests how ecological intelligence is affected by the PjBL model when it comes to environmental problem-solving abilities. The ability to solve environmental problems is influenced by ecological intelligence, with a statistical significance of $p < 0.05$. Third, sig. $0.17 > 0.05$ indicates that there is no connection between ecological intelligence and the PjBL model on the capacity to solve environmental problems. Based on these findings, the application of the PjBL model can be a reference in any subject, especially learning material related to environmental problems, as an effort to improve students' abilities in solving environmental problems. can be realized through collaboration between various elements of education to evaluate school policies and changes to the vision and mission of integrating learning models that support students' problem-solving abilities. Suggestions for further improvement in the

future are that the ecological intelligence possessed by students is not only observed at the school level, where they follow the rules or patterns applied in the educational unit, but requires deep ecological intelligence with natural awareness, namely being directly involved with the lives of students.

5. Acknowledgments

The writing team would like to thank SMA Negeri 1 Karangrejo for their support in completing the research and the Geography Education Master's Study Program, Faculty of Social Sciences, State University of Malang as the place where the first author completed his master's program. Thank you to Andri Estining Sejati, who helped review and support this article.

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