13 (2) (2024) 76-85

**Unnes Science Education Journal**

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# Implementation of the Problem Based Learning Model with Blended Learning on Ecosystem Topics to Enhance Scientific Literacy and Pancasila Student Character

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**DOI: http://dx.doi.org/10.15294/usej.v13i1.11706**

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## Article Info

Submitted 2024-08-12
Revised 2024-08-20
Accepted 2024-08-31

## Keywords

Problem Based Learning; Blended Learning; Scientific Literacy; Pancasila Student Character

## Abstract

The Ministry of Education and Culture has changed the national assessment strategy from the National Examination to the Minimum Competency Assessment, Character Survey, and Environmental Survey to address the decline in Indonesia's PISA ranking. This issue needs to be addressed by implementing a technology-based model that can be applied in education to help students develop scientific literacy skills and character in preparation for AKM and PISA. One of the recommended learning models today is the student-centered learning model, which requires students to actively participate in the learning process, such as Problem-Based Learning with Blended Learning. This study aims to analyze the effectiveness of implementing the blended PBL model in ecosystem material in enhancing students' scientific literacy and Pancasila student character in the experimental class and to assess the implementation of the PBL model with Blended Learning. This research is a quasi-experimental study. The research design used is the Nonequivalent Control Group Design. The study was conducted at SMAN 1 Kramat, with the research subjects being students from classes X1, X5, X6, and X8.The results showed a significant increase in scientific literacy and Pancasila student character in the experimental class where the blended PBL model was applied to the ecosystem material. The implementation of the blended PBL model was successfully carried out, as evidenced by positive student responses, with 68.86% of the questionnaire scores falling into the good category. Based on the research, it can be concluded that the implementation of the blended PBL model in ecosystem material effectively improves students' scientific literacy and character can be successfully implemented.

## How to Cite

Nugraheni, K. N. F, Rusilowati, A., & Marianti, A. (2024). Implementation of the Problem Based Learning Model with Blended Learning on Ecosystem Topics to Enhance Scientific Literacy and Pancasila Student Character. *Unnes Science Education Journal*, 13(2), 76-85.

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p-ISSN 2252-6617
e-ISSN 2502-6232

## INTRODUCTION

The Programme for International Student Assessment (PISA) has garnered significant attention from researchers and educational policymakers in recent years. One of the focal domains of PISA assessment is scientific literacy. According to PISA (Programme for International Student Assessment) test results and evaluations, students' scientific literacy skills in Indonesia remain low, falling below the average. Indonesia's students rank towards the lower end of the PISA scale. In 2018, Indonesia's rank and average score showed no significant improvement, remaining at 62nd out of 70 countries with a score of 395 (OECD, 2019). The decline in PISA achievement in Indonesia prompted the Ministry of Education and Culture to reform the national assessment strategy, replacing the National Examination with the Minimum Competency Assessment (AKM), Character Survey, and Environmental Survey. These assessments measure literacy and numerical reasoning skills, based on PISA tests (Kemendikbud, 2019: 1). Another aspect of the National Assessment is the character survey, which is based on the character profile of Pancasila students. The Ministry of Education and Culture conducts character surveys to measure six components that reflect the implementation of Pancasila values in schools. According to Marini et al. (2018), character development in Indonesia requires serious attention due to the impacts of globalization. Moreover, ecosystem material is a biology topic included in the PISA assessment, related to ecosystem changes caused by widespread industrialization and the increasing demand for natural resources (OECD, 2019). In the Merdeka curriculum, the ecosystem is one of the learning outcomes in biology.

These issues must be addressed by implementing technology-based models that can be applied in learning to help students develop scientific literacy skills and character in preparation for AKM and PISA. Several studies have shown that the application of Problem-Based Learning (PBL) through Blended Learning in the learning process enhances students' scientific literacy skills and character. Research conducted by Lestari (2020) showed that students' scientific literacy skills improved as a result of implementing Blended Learning with the aid of the Moodle platform. Kurniawati & Hidayah (2021) revealed a significant difference in the average scientific literacy skills between the experimental class, which implemented PBL with a Blended Learning approach, and the control class, which applied the Direct Instruction Model. A study by Sari & Haryani (2015) found that students' scientific literacy skills on redox material increased after applying the PBL model. According to Spiteri et al. (2022), PBL aims to create more meaningful learning by placing students in situations where they must apply the knowledge they have learned to solve complex real-world problems. Research by Sinurat et al. (2018) revealed that implementing computer-assisted PBL significantly improved students' character, with an average increase of 74.5% in the high category. A study conducted by Alsalhi et al. (2019) on ninth-grade students in the United Arab Emirates showed that the application of blended learning in natural science education had a positive impact on student achievement and attitudes towards its use. Research by Li et al. (2017) on Blended Learning using Moodle in medical education also achieved good results in terms of knowledge, attitudes, and practices.

The researcher views it as essential to conduct further studies to explore the use of Problem-Based Learning through Blended Learning as an instructional method that enhances scientific literacy and character skills based on the Pancasila student profile.

## METHOD

The research method in this study is a quasi-experiment. The research design is the Nonequivalent Control Group Design. All tenth-grade students at a Senior High School in Kramat, Tegal, were considered the population for this study. The sample was selected using purposive sampling. The research subjects were students from classes X1, X5, X6, and X8. This study involved two different groups of students: an experimental group and a control group. Both the experimental and control classes were given a pre-test to measure the students' prior knowledge. The two classes then received different treatments. The experimental class received treatment through the application of PBL with Blended Learning, while the control group was taught using PBL through offline learning. After the treatment, both classes were given a post-test to determine the difference in the improvement of students' scientific literacy and character. Data analysis was conducted using the Normalized Gain Test (N-Gain) and statistical tests. The statistical tests in this study included prerequisite tests and hypothesis testing. The prerequisite tests included the normality test and the homogeneity test. If the data were normally distributed and homogeneous, an independent sample T-Test was applied. However, if the data

were not normally distributed, a non-parametric statistical test was used, specifically the Mann-Whitney U-Test (Aripin, 2013).

## RESULT AND DISCUSSION

### Results

#### Scientific Literacy

Research on Problem based learning model by Blended Learning to measure scientific literacy skills. Students' scientific literacy skills are obtained from the score after working on the initial test (pretest) and final test (posttest) with a total of 30 multiple choice questions. The pretest and posttest on ecosystem material includes aspects of scientific literacy including 20 knowledge domain questions and 10 competency domain questions. The graph below shows the data on students' pretest and posttest scientific literacy scores obtained in the control class and experimental class.

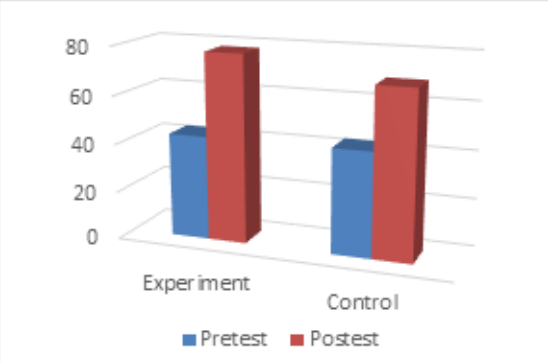


**Figure 1.** The Average Pretest and Posttest Scores of Scientific Literacy

Figure 1 illustrates the average pretest and posttest scores in both the experimental and control classes. The average pretest score for the experimental class is 43.29, while the control class has an average score of 43.48. The pretest score graph shows that the initial abilities of students in the control and experimental classes are almost the same. However, the control class pretest score is slightly higher compared to the experimental class.

The average scientific literacy scores of the experimental and control classes increased after the learning process. The posttest average for the experimental class is 77.95, while the control class has an average score of 69.19. The experimental class has a higher posttest average compared to the control class. This is because the experimental class engaged in the learning process with the application of the PBL model through blended learning. From this data, it can be concluded that the pretest and posttest scores of the experimental class increased more significantly compared to the control class.

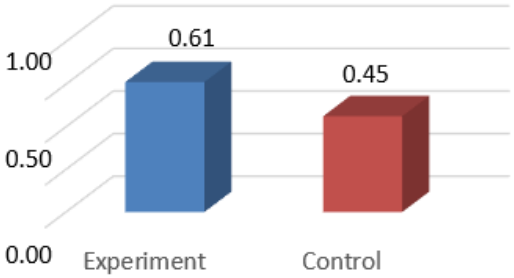


**Figure 2.** Average N-Gain of Science Literacy

Figure 2 shows the average N-Gain in literacy skills for the experimental and control classes. The results indicate that the N-Gain value for the experimental class is 0.61, and for the control class, it is 0.45, both of which fall into the medium category ($0.30 < g < 0.70$). However, the average N-Gain of the experimental class is higher than that of the control class. The difference in N-Gain values between the experimental and control classes is 0.16.

**Tabel 1** Result of Hypothesis testing data

| Data | Uji Beda | Sig. | Notes |
|---|---|---|---|
| N-gain | Independent sample test | 0.00 | Significantly different |

The results of the N-Gain test data are generally presented in Table 4.4. The significance value of N-Gain based on the independent sample test results is 0.000, which is less than 0.05, indicating that Ho is rejected and Ha is accepted. Based on this data, it can be concluded that there is a significant difference in the improvement of students' science literacy between the experimental class, which implemented PBL (Problem-Based Learning) through blended learning, and the class that implemented PBL without blended learning.

#### Character

Data from the national assessment character survey was obtained through the observation of student character and the pretest-posttest character survey assessment. The observation of student character during the learning process was conducted by the researcher and the biology te-

acher. The character survey indicators are based on the six elements of the Pancasila Student Profile: 1) faith in God Almighty and noble character, 2) global diversity, 3) cooperation, 4) independence, 5) critical thinking, and 6) creativity. The observation data collected was then analyzed, and an average was calculated for each session. Below are the results of the character observations for students in the experimental and control classes during three learning sessions.

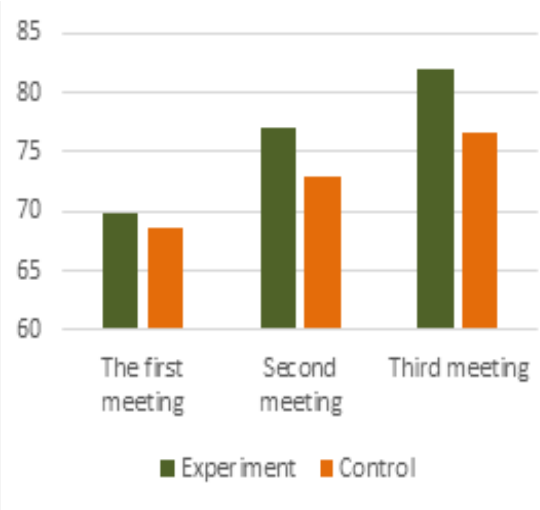


**Figure 3.** Observation of Student Character

Based on the figure, there are differences in character during the three learning sessions between the experimental and control classes. These differences can be seen in the average observation scores for each session, including the first, second, and third sessions. The average character observation scores of students in the experimental class were higher compared to the control class. The first session had the lowest percentage compared to the second and third sessions.

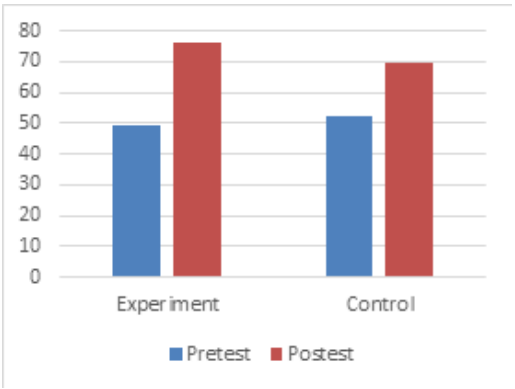


**Figure 4.** The Average Pretest and Posttest Scores of Character

Based on the graph, the average pretest score of the control class was 52.25, while the experimental class scored 49.07. The average pretest score of the control class was higher than that of the experimental class.

After the learning process, the posttest character scores of both the control and experimental classes increased. The average posttest score of the experimental class was higher than that of the control class. It was found that the experimental class achieved a posttest score of 76.07, while the control class only achieved a score of 69.54. The pretest-posttest survey data was analyzed using N-Gain to observe the difference in character improvement between the experimental and control classes.

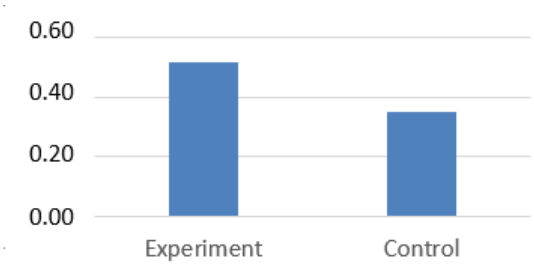


**Figure 5.** Average N-Gain Scores of Character

Average N-Gain scores of student character in the experimental and control classes. Both the average N-Gain scores of the experimental and control classes fall into the medium category. The average N-Gain score of the experimental class was higher compared to the control class. The average N-Gain score of the experimental class is 0.52, while the average N-Gain score of the control class is 0.35

**Tabel 2** Result of Hypothesis testing data

| Data | Uji beda | Sig. | Notes |
|---|---|---|---|
| N-Gain | Independent sample test | 0.000 | Significantly different |

Table 2 shows the results of the difference test for the overall N-Gain data. The significance value of the N-Gain based on the results of the independent sample test is 0.000, which is less than 0.05, indicating that Ho is rejected and Ha is accepted. Based on this data, it can be concluded that there is a significant difference in the improvement of students' character between the experimental class and the control class.

## Discussion

### PBL with Blended Learning to Enhance Scientific Literacy

The following section will discuss the

application of Problem-Based Learning (PBL) through blended learning on students' scientific literacy skills. The learning process in the experimental class employed the PBL model with blended learning, while the control class used the PBL model in a traditional, face-to-face setting. Dos (2014) explains that blended learning is a learning model that combines face-to-face instruction with online learning. Driscoll, as cited in Lakhal (2019), adds that blended learning not only integrates face-to-face and online learning but also includes various teaching methods, such as the use of diverse media and instructional techniques, to meet the different learning needs of students. The blended learning approach in the experimental class involved the use of flipped classroom learning. According to Jihyun (2023), flipped classroom learning is an inverted learning model where direct instructional activities are moved outside the classroom, while in-class time is used for deeper learning activities such as discussions, practice, and group work.

The series of processes for implementing PBL through blended learning in the experimental group began with the researcher sending teaching materials, learning design sheets (LDS), and video content via the Google Classroom platform before the in-class learning sessions, which were asynchronous (online). Students were asked to study the materials independently. During the synchronous (offline) face-to-face sessions in the classroom, activities included the teacher reviewing the material, assigning students to work on LDS using Canva in groups, discussing, and presenting. The core learning activities consisted of several phases. The first phase involved orienting students to the problem; the second phase organized students to investigate; the third phase supported independent and group inquiry; the fourth phase involved developing and presenting; and the fifth phase analyzed and evaluated the problem-solving process.

In the first meeting, students learned about ecosystems and their components. The teacher had previously sent the materials via Google Classroom. During the classroom session, the teacher initiated the lesson by showing a video related to ecosystem components and asking students about the interconnections between living organisms. In the phase of orienting students to the problem, the teacher reviewed the material provided earlier in Google Classroom and allowed students to ask questions. The teacher also provided an LDS containing an observation task to record ecosystem components and their roles in a specific area. Additionally, real-world problems, such as the impact of pesticide use on ecosystem components, were presented. In the second phase of organizing students for inquiry, students worked on LDS tasks through Canva, actively discussed, and collaborated within their groups. In the third phase, the teacher provided limited assistance to students or groups experiencing difficulties. In the fourth phase, the teacher asked groups to present the results of their discussions, with each group presenting their data and discussing their conclusions. In the fifth phase, other groups responded to the presented material, offering correct answers when there were disagreements with other groups. According to Vo, Zhu, and Diep (2022), integrating technology into PBL allows students to collaborate without time and place constraints, enriching their learning experience and strengthening their teamwork skills.

In the second meeting, students studied interactions between ecosystem components. The teacher had previously provided the materials in Google Classroom for students to study. According to research by Garrison and Vaughan (2019), blended learning allows students to access learning materials and participate in discussions anytime and anywhere, which greatly supports the PBL process, which requires time for exploration and deep thinking. The classroom session began with the teacher initiating the lesson by providing pictures to the students and asking questions about the interaction between a butterfly and a flower. In the phase of orienting students to the problem, the teacher reviewed the material provided earlier in Google Classroom and allowed students to ask questions. The teacher also provided an LDS containing an analysis of interactions between living organisms, a growth graph of ecosystem components in a rice field, and a problem about what would happen to ecosystem balance if a predator went extinct. In the second phase, students worked on LDS tasks through Canva and actively discussed. In the third phase, the teacher provided limited assistance to students or groups experiencing difficulties. In the fourth phase, the teacher asked groups to present their discussion results, with each group presenting their data and discussing their LDS solutions. In the fifth phase, each group presented their solutions to the class, explaining how their solutions could affect the ecosystem and why they chose them. PBL, implemented through blended learning, enhances student engagement by providing opportunities to solve real-world problems both independently and in groups. Research by Baran and AlZoubi (2020) shows that this model encourages students to be more active and engaged

in the learning process, both in face-to-face and online sessions. Students feel more motivated because they can see the direct relevance of the material to the real world.

In the third meeting, students learned about energy flow and biogeochemical cycles. The teacher initiated the lesson by asking a triggering question about how food chains influence the organization of living organisms within an ecosystem. In the first phase, the teacher reviewed the material on energy flow and biogeochemical cycles and presented real-world problems in the LDS, such as how to address crop failures due to rodent infestations, how to deal with locust infestations in Sumba Timur in relation to understanding food chains and energy flow, and environmental imbalances affecting biogeochemical cycles and water scarcity. In the second phase, students engaged in group discussions and were asked to identify questions from the LDS, which were then answered in Canva. In the third phase, the teacher monitored the learning process by providing guidance, resources, and encouragement for further exploration. In the fourth phase, students presented their discussion results in front of the class. In the fifth phase, the teacher and students reflected on the process, evaluating what had been learned and how the problems had been solved.

The research results on the implementation of the PBL model through blended learning on ecosystem material effectively enhanced students' scientific literacy skills. Moreover, there was a significant difference between the experimental and control classes, as the experimental class implemented PBL through blended learning. This finding aligns with research conducted by Jayden Houghton (2023), which shows that integrating PBL with blended learning can significantly improve students' literacy. The learning program designed for the Land Law course at the University of Auckland, combining PBL and blended learning principles, revealed that students participating in this program had higher literacy scores than those in classes using traditional teaching methods. A study conducted by Indriani (2023) also revealed that PBL based on blended learning has proven to have a positive impact on improving problem-solving skills and scientific literacy among students. The use of a blended learning model combined with problem-solving strategies has been recognized as an effective approach in science education to enhance scientific literacy (Hadiprayitno et al., 2021). For example, students in the experimental class demonstrated better understanding of interactions between ecosystem components, such as food chains and food webs. This is because the PBL approach encourages students to solve real-world problems related to ecosystems, allowing them to see firsthand the application of the concepts they have learned (Jonassen & Hung, 2012).

Learning through blended learning facilitates students' understanding of the material and allows them to access learning content anytime and anywhere (Shoukat et al., 2024). Blended learning combines face-to-face teaching methods with online components, enabling students to learn more flexibly and deeply. Students can use various learning resources such as videos, books, and interactive assignments outside the classroom, helping them to learn more personally and adjust the pace of their understanding. The combination of the PBL model with blended learning encourages students to apply knowledge in daily life, based on advancements in current communication, technology, and information (Kurniawati, 2021). Additionally, problem-based learning through blended learning helps students develop 21st-century skills, such as problem-solving, collaboration, and the use of information technology, which are essential for future success (Zulfa, 2022).

**PBL with Blended Learning to Enhance Student Character**

The implementation of Problem-Based Learning (PBL) through blended learning in biology education on ecosystem topics involves observing student characteristics using six indicators based on the Profile of Pancasila Students, which include: 1) faith in God Almighty and noble character, 2) global diversity, 3) cooperation, 4) independence, 5) critical reasoning, and 6) creativity. The discussion of each characteristic in the Profile of Pancasila Students that showed significant improvement among the experimental class students is as follows. First, faith in God Almighty and noble character, which encompasses spiritual and moral aspects, including religious ethics, personal ethics, ethics towards others, nature, and the nation.

The application of Problem-Based Learning (PBL) through Blended Learning provides a rich context for students to internalize spiritual and moral values. During the learning process, students are encouraged to solve real-world problems that often touch on moral and ethical aspects, such as how the extinction of a particular species can impact an entire ecosystem. Throughout the problem-solving process, students are urged to consider the ethical implications of their

actions on the environment. This includes discussions on the importance of honest, fair, and responsible behavior in maintaining ecological balance, reflecting the noble character expected of a faithful individual. Research indicates that the interactions within PBL can enhance students' moral and spiritual sensitivity. According to Sinurat et al. (2018), computer-based PBL has been proven to significantly enhance students' character, including in the spiritual and moral dimensions. Similarly, Anderson & Johnson (2023) have shown that integrating religious values into PBL can deepen students' understanding of the relationship between faith and responsibility toward nature. Another study by Rahman et al. (2023) revealed that implementing PBL in ecosystem education through Blended Learning not only strengthens students' conceptual understanding of ecosystems but also fosters a greater sense of responsibility for environmental conservation as part of their faith.

Secondly, regarding global diversity, the ability to recognize and appreciate cultural differences, engage in intercultural communication, and reflect on and take responsibility for diverse experiences are central to this characteristic. PBL combined with blended learning allows students to interact and collaborate in diverse environments, both directly and through online platforms. This encourages students to understand and appreciate cultural differences while developing intercultural communication skills. During the ecosystem learning process, the Discussion Sheets involve environmental cases from various regions and countries with different cultural contexts. For example, farmers in Tapanuli Selatan, North Sumatra, face the threat of crop failure due to rodent infestations in their rice fields. Outside Indonesia, the scarcity of wolf species in Yellowstone National Park, USA, presents another case. Students were provided with questions to address these issues. Research by Chen & Wang (2023) indicates that using PBL in an international context can strengthen students' critical thinking and teamwork skills in culturally diverse teams, which are crucial skills in an increasingly connected world. A study by Alsalhi et al. (2019) supports these findings, showing that blended learning positively impacts students' attitudes toward cultural diversity. Additionally, Smith & Taylor (2023) have shown that Blended Learning can facilitate interactions between students from diverse cultural backgrounds through online discussions and collaborative projects, helping them develop global awareness and appreciation for cultural diversity.

Third, concerning cooperation, which includes collaboration, care, and sharing, these are key elements of the gotong royong (mutual cooperation) character. In the learning process, students were required to work in groups to solve real-world problems presented in the Student Discussion Sheets (LDS) using the Canva application, highlighting teamwork and shared responsibility. Canva's collaboration features allow multiple users to work on the same project in real-time. This is particularly beneficial in an online learning environment where collaboration and teamwork are often required. A study published in the Journal of Interactive Learning Research found that Canva's collaborative capabilities promote further interaction between learners and instructors, as well as among the learners themselves, enriching their learning experience. Through these group activities, students learn to help one another and share roles to achieve common goals. Research by Retnawati (2016) revealed that PBL enhances students' collaborative skills, aligning with the gotong royong values in the Profile of Pancasila Students. Combined with blended learning, which allows students to collaborate on assignments, the value of gotong royong becomes even more pronounced. In the character education reinforcement movement, gotong royong emphasizes the attitude and behavior of valuing cooperation to solve problems through communication and friendship, and a willingness to assist in projects (Piesesa & Camellia, 2023).

Fourth, the independence character encompasses self-awareness and self-regulation. Before face-to-face learning, students were provided with materials, instructional videos, and discussion sheets on Google Classroom, and the teacher instructed them to study these independently at home. Students could access the materials anytime and anywhere. During classroom learning, the teacher reviewed the material again. Blended Learning offers students opportunities to develop independence by providing various digital resources that can be accessed independently (Gracia, 2023). Students take responsibility for their own learning progress, choosing when and how they will access learning materials and complete assigned tasks. Other research indicates that the combination of PBL and Blended Learning is effective in enhancing students' independence. Johnson et al. (2023) found that students engaged in PBL through Blended Learning showed higher levels of learning independence compared to those using traditional learning methods. Hosnan (2016) stated that PBL helps students develop learning independence, which

is reflected in the increased independence character among students in the experimental class. This independent learning experience is crucial for shaping individuals who can independently overcome challenges in the future. PBL combined with blended learning can influence students' self-regulation and independence, demonstrating that this approach enhances students' ability to learn independently and engage in active learning (Suhirman et al., 2020).

Fifth, regarding critical reasoning, the ability to acquire and process information, analyze and evaluate reasoning, and make sound decisions are important aspects of the critical reasoning character. The PBL implemented in this study emphasized problem-solving and critical thinking. Students were encouraged to identify problems, seek solutions based on evidence, and evaluate the results of proposed solutions. Research shows that students who learn through PBL have better critical thinking skills (Jonassen & Hung, 2012). This is because students are continuously faced with challenges that require in-depth analysis and appropriate decision-making. A similar study conducted by Marnita (2020) indicated that the problem-based learning model, combined with blended learning, had a positive impact on students' critical thinking skills in thermodynamics courses. The results showed a significant increase in critical thinking skills among students using this model compared to those using conventional teaching methods.

Sixth, concerning the creative character, which involves generating original and innovative ideas, PBL provides students with space to explore various possible solutions and encourages them to think outside the box. The investigative and exploratory nature of PBL activities develops students' ability to generate creative ideas. Lestari (2020) showed that media-assisted PBL enhances students' creative abilities. Moreover, when PBL is combined with blended learning, a study by Wahyudi (2020) revealed that the implementation of PBL blended learning significantly improves students' creative thinking abilities through activities that promote systematic thinking and meaningful reflection.

The PBL model through blended learning has positive implications for shaping student character in accordance with the Profile of Pancasila Students. Characters such as cooperation, independence, critical reasoning, and creativity can be developed through learning that encourages students to collaborate, actively participate in discussions, and solve problems independently (Yuliandari & Hadi, 2020). Blended learning allows flexibility in learning and provides space for students to learn according to their abilities and needs (Berga et al., 2020). This supports the development of independent and responsible character. Additionally, the use of technology in blended learning strengthens students' digital skills, which are essential in today's globalized era. In practice, the implementation of PBL through blended learning in ecosystem material facilitates students in developing various competencies expected in the Profile of Pancasila Students. For example, in group activities, students learn to collaborate and respect others' opinions, which are essential elements of cooperation (Marini et al., 2018). Students are also encouraged to take the initiative in seeking information and solving problems independently, which supports the development of independence and critical reasoning (Sani, 2021).

## CONCLUSION

Based on the research, it can be concluded that the implementation of the blended PBL model in ecosystem material effectively improves students' scientific literacy and character and can be successfully implemented.

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