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RESEARCH ARTICLE

Student Creative Thinking and Environmental Literacy Through The Implementation of High-Level PJBL Biology Tools: Enrichment of Local Plant Concepts

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ABSTRACT

This research aims to determine the creative thinking abilities and environmental literacy of students in upper and lower academic groups through an enrichment program. Learning utilizes high-level PJBL-based teaching tools, employing the local potential of Seagrass Plants as a learning resource. High-level PJBL is an innovative learning model with modified learning steps, including the phases: Reading while Underlining, Project Planning, Project Action, Project Expo, and Project Evaluate. This research is a quantitative experiment, using a pre-experimental design with a one-group pretest-posttest. The population in this study is class X students of SMAN Maluku Tengah for the 2023/2024 academic year. The sampling technique used is purposive sampling, with a sample of 120 class X students from 4 schools: SMAN 7, SMAN 41, SMAN 42, and SMAN 12 Central Maluku, located on Saparua Island. Data analysis of differences in creative thinking abilities and environmental literacy of students used Ancova and N-Gain, preceded by normality and homogeneity tests. The results of the pretest-posttest scores of creative thinking abilities and environmental literacy of students in the upper and lower academic groups showed a significant difference before and after using high-level PJBL Biology learning tools based on the local potential of seagrass plants in Biology learning enrichment programs.

INTRODUCTION

The 21st century education is marked by the rapid development of science and technology. This development has a very significant impact on various aspects of human life, including social, political, and economic relations. Technological and knowledge advancements also impact education systems worldwide. In line with this development, education is expected to equip students with the skills needed in the 21st century. Several competencies are considered crucial and must be possessed by students, namely creativity, critical thinking, collaboration, and communication to solve the problems faced (Riberio, 2023; Anwar et al., 2024). Thus, learning must be directed to encourage the development of these skills so that students can adapt to the developments of the 21st century (Rahmawati et al., 2023). One essential skill is creative thinking, which must be developed through effective learning (Adhiriyanthi et al., 2021).

Creative thinking is a life skill needed to solve various problems through the ability to generate new ideas, evaluate information, and create solutions (Jawad et al., 2021; Sultanova, 2024;Carqueijó et al., 2022). Creative thinking is also a process of understanding difficulties, problems, information gaps, inconsistencies, formulating problems clearly, formulating and testing hypotheses and revising them for retesting and communicating the results personality (Sitorus, 2019). There are several indicators of creative thinking, including (1) fluency, (2) flexibility, originality, elaboration, and symbolic thinking (Mason et al., 2021; Treffinger et al., 2002). These abilities can guide students to achieve the

main goals of education in order to change individuals to be better in terms of cognitive skills, attitudes, and behavior Environmental (Putra et al., 2021). Thus, learning must be designed to be more than just memorizing facts, but to provide space for students to build their own knowledge and utilize that knowledge to solve problems in the surrounding environment.

A problem currently faced by global society is environmental degradation. Environmental quality is largely influenced by human cognitive skills, attitudes, and behavior in protecting the environment, and these three abilities are already included in environmental literacy Environmental literacy (Gani, A.R.F., & Arwita, 2020). Thus, it can be concluded that environmental problems are greatly influenced by the environmental literacy variable of society. Environmental literacy can be defined as the ability of each individual to understand and interpret environmental conditions and then decide on appropriate actions to overcome problems (Fang et al., 2023). Environmental literacy is a measure of human knowledge about human interaction with the environment, knowledge about environmental issues, and knowledge about various variables in ecological components. Regarding its urgency, (Ariyatun et al., 2024) explain that environmental literacy helps individuals understand how human activities are interconnected with the environment and encourages sustainable development. Based on the definition, structure, and urgency, efforts to encourage improved environmental quality can begin by educating and creating environmentally intelligent people through formal education in schools.

Based on the results of an initial needs analysis conducted at SMAN 7, SMAN 41, SMAN 42, and SMAN 12 Central Maluku, it is known that on average, teachers have not been able to develop learning tools that can encourage students' creative thinking abilities and environmental literacy. On the other hand, the surrounding environment provides learning resources that can be integrated into learning to improve various student thinking skills (Spector & Ma, 2019) explain that thinking is always influenced directly and indirectly by social interaction. Individual thinking ability is influenced by opportunities and challenges in different contexts. Therefore, presenting the surrounding environment containing local potential as learning material will be able to challenge students' thinking abilities, especially creative thinking and environmental literacy, which are very necessary.

Local potential is the wealth of an area that can be utilized by teachers and students as a learning resource so that students are more aware of the conditions of the environment around them (Destiara et al., 2018; Halik et al., 2021). By utilizing the potential of local natural resources available in the surrounding environment by teachers as a learning resource, students not only understand the subject matter theoretically but also more applicatively and are more concerned about the surrounding nature. The local potential referred to in this study is the potential of natural resources in the form of seagrass ecosystems, which are part of the coastal aquatic ecosystem of Saparua Island around schools and student residences that can be used as a learning resource as well as a conservation target to ensure sustainable development. However, appropriate learning tool documents are needed to engineer learning to facilitate improving students' creative thinking abilities and environmental literacy. To facilitate this, this research was conducted to determine the effectiveness of students' creative thinking abilities and environmental literacy through the application of project-based learning tools by integrating the content of seagrass plant objects in biology learning of ecosystem concepts and environmental change. Biology teaching tools based on the local potential of seagrass bioecology, high-level PJBL, termed BIOLA PJBL High level, refers to Lucas and Dopelt 2005 in (Kementerian Pendidikan Dan Kebudayaan, 2017; Jawad et al., 2021; Kepmendikbudristekdikti, 2022) whose steps have been modified with the aim of facilitating a learning process that has the potential to create deep learning space for students to carry out exploration, assessment, interpretation, synthesis and information to produce various forms of research product-based learning outcomes.

Project Based Learning is a learning model that emphasizes constructivist learning which allows teachers to control learning by giving projects that will encourage students to develop in exploring

material, solving problems, making decisions, conducting research and providing opportunities for students to work individually or work together in groups (Hastuti et al., 2023). Several previous studies have found that Project Based Learning can improve students' creative thinking skills at Vocational (Usmeldi, 2019; Ummah et al., 2019; Yamin et al., 2020). Integrated Project Based Learning model teaching tools can also be used to improve students' environmental literacy. This is supported by the results of research including (Ginting et al., 2023;KUSNADI et al., 2008; Farida et al., 2017)which found that learning with a Project Based Learning pattern can improve students' environmental literacy.

MATERIAL AND METHODS

This research is a type of quantitative experimental research in the dissemination stage, which is a continuation of the 4-D model development research that has been modified with the stages: definition, design, development (Tuapattinaya, et al., 2024). The subjects in this study were 120 tenth-grade students from four schools in Central Maluku Regency located on Saparua Island, namely SMAN 12, SMAN 41, SMAN 42, and SMAN 7 Central Maluku, which are located on the coast of Saparua Island where seagrass beds are found in the coastal waters. Students from each school were categorized into only two academic groups, namely students with low academic ability and students with high academic ability to participate in the enrichment program. The division was based on student scores obtained from the formative test results of ecosystem and environmental change material that had been studied previously in the even semester. The research was conducted for one month in June 2023 through an enrichment program. The learning tools used were the result of development that had been tested for validity and practicality on 90 tenth-grade students from SMAN 7, 12, and 42 Central Maluku located on Saparua Island.

The learning tools used for the enrichment program are valid and practical high-level Project Based Learning (PjBL) teaching tools that utilize seagrass (seagrass) as a learning resource available around the school environment. The validity value is 3.93 with a very good/feasible category and the practicality value is 89.20% with a very practical category. The learning tools consist of lesson plans, student worksheets, and high-level PjBL-based teaching materials as well as evaluation instruments for creative thinking abilities and environmental literacy.

The research procedure consisted of three stages: Preparation stage: observation and preparing high-level PjBL learning tools for the concept of ecosystems and environmental change, as well as preparing assessment instruments for creative thinking abilities and environmental literacy. The research instrument used was a pretest-posttest to measure students' creative thinking abilities and environmental literacy, which had been tested beforehand to determine validity, reliability, and difficulty level. Next, the implementation stage: conducting pretests, implementing learning using high-level PjBL tools, and conducting posttests. The next step is the data analysis stage; research data were analyzed descriptively and inferentially. Testing for differences and improvements in students' creative thinking abilities and environmental literacy was carried out using Covariance Analysis and N-Gain. The analysis process used SPSS 27 software.

RESULT AND DISCUSSION

1. Seagrass Beds in Saparua Island as a Learning Source

Seagrass on Saparua Island is spread across the coastal waters of several villages, including Haria, Portho, Tiouw, Saparua, Kulur, Mahu, and Ihamahu (Novaczek et al., 2001). Seagrass plays a very significant role in coastal ecosystems as a foraging ground, spawning and nursery area, wave breaker, and other functions (Unsworth et al., 2019). Seagrass beds support global fisheries productivity and provide food and habitat for various types of vertebrates and invertebrates (Tuya et al., 2014); Jones et al., 2022). Jones et al., (2022)stated that one hectare of healthy seagrass bed can support the life of 40,000 juvenile fish and 50 million juvenile shellfish. In addition, Oseanologi Indonesia (Arkham et al., 2016) states that every one hectare increase in the area of the seagrass ecosystem can increase the availability of fish resources by 9049.3 kg or equivalent to a habitat value of Rp. 166,963,204.72

per hectare per year. However, reports from BPS Central Maluku indicate that 3.40 hectares of seagrass beds have been damaged on Saparua Island out of a total area of 126.40 hectares.

The wide distribution is one opportunity for seagrass beds to be utilized as a contextual learning resource to deepen the biological concepts of ecosystems and environmental change, which ultimately leads to the formation of cognitive skills, attitudes, and behaviors in the learning community to carry out in-situ conservation and utilize seagrass beds as a guarantee of long-term economic welfare for coastal communities.

2. High-Level Project-Based Learning Teaching Tools

The high-level PJBL Seagrass bioecology-based Biology teaching tools consist of: Lesson Plans (RPP) containing modified learning steps which include the phases: Read while Underlining, Project Planning, Project Action, Project Expo, and Project Evaluate. The developed high-level PJBL model refers to Lucas and Dopelt 2005 in Kementerian Pendidikan Dan Kebudayaan, (2017;(Jawad et al., 2021;Mason et al., 2021; (Kepmendikbudristekdikti, 2022), whose steps are modified and focused on creative process design integrated with a high-order thinking skills (HOTS) approach and Technology Pedagogical Content (TPACK) based on research. The lesson plans are equipped with Student Project Activity Sheets (LAP2D) adapted to the principles of the High-level PJBL learning model, whose components include: identity, research info, research project activities (materials, tools, work procedures, data collection instruments, performance/product assessment instruments). LAP2D serves as a reference and guide for students in carrying out project activities. The teaching materials for ecosystems and environmental change are integrated with the local bioecology potential of Seagrass, equipped with learning video links, SBC (Seagrass Bed Challenge) content, and "Now I Understand" content, which includes a space for students to write down their understanding and attitudes that should be realized in preserving seagrass beds.

The BIOLA PJBL High-level teaching tools are used by teachers in carrying out enrichment programs that involve all students, both those with upper and lower abilities. Considering that so far enrichment programs have only been intended for upper-ability students who are classified as fast in completing their learning tasks (Tan et al., 2020), even though all students should have the same opportunity to participate in all educational programs implemented by teachers. The seagrass bioecology-based PJBL high-level teaching tools are expected to facilitate a learning process that has the potential to create deep learning space for students to carry out exploration, assessment, interpretation, synthesis, and information to produce various forms of research product-based learning outcomes.

3. Effectiveness of Learning Tool Implementation on Students' Creative Thinking Ability

The High-Level Project Based Learning (PjBL) teaching tools are applied in learning that involves upper and lower academic groups of students. The assumption is that effective learning tools are those that can be followed and are able to improve the thinking abilities of both low and high academic ability students.

The results of variance analysis show that the Fcount variable for students' academic ability is 37.214 with a significance level of 0.000, which is still smaller than alpha 0.05 and 0.01, so H0 can be rejected and H1 accepted. This means that there is a very significant difference in creative thinking ability between upper and lower academic students. The results of the variance analysis are presented in Table 1.

Table 1. Variance Analysis Results of the Average Difference in Students' Creative Thinking Ability.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1107.455[a]	2	553.727	18.906	.000

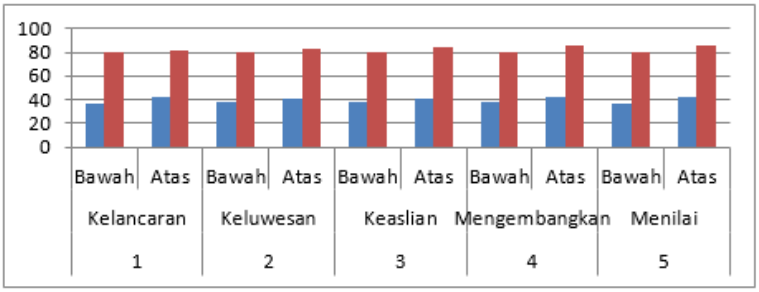
Intercept	45971.120	1	45971.120	1569.639	.000
Pretest	35.480	1	35.480	1.211	.273
Academic Ability	1089.907	1	1089.907	37.214	.000
Error	3426.660	117	29.288		
Total	818425.521	120			
Corrected Total	4534.115	119			

Furthermore, to see the average improvement in creative thinking ability for each aspect within the upper and lower student groups after undergoing the enrichment process with the Biola PJBL high-level tools, a statistical test was conducted using N-Gain, which can be seen in Tables 2 and 3.

Table 2. N-gain Test of Creative Thinking Ability.

Indicator	**Academic Ability**	**Rata-rata Berpikir Kreatif**		**Gain**	**Category**
		Pretest	**Posttest**		
Fluency	Lower Bound	36.88888889	79.66666667	0.677816901	Moderately Increased
	Upper Bound	42.22222222	82	0.688461538	Moderately Increased
Flexibility	Lower Bound	38.44444444	80.44444444	0.682310469	Moderately Increased
	Upper Bound	41.11111111	83.44444444	0.718867925	Highly Increased
Originality	Lower Bound	38.22222222	80.11111111	0.678057554	Moderately Increased
	Upper Bound	41.22222222	84.33333333	0.733459357	Highly Increased
Elaborating / Developing	Lower Bound	37.55555556	80.33333333	0.685053381	Moderately Increased
	Upper Bound	41.66666667	85.22222222	0.746666667	Highly Increased
Evaluating / Assessing	Lower Bound	37	80.44444444	0.689594356	Moderately Increased
	Upper Bound	42.33333333	85.22222222	0.743737958	Highly Increased

Table 3. Data Projection of Results (N-gain Test) Improvement in Students' Creative Thinking Ability in Each Aspect.



Meanwhile, the average increase in students' creative thinking ability overall can be seen in Table 4.

Table 4. Average Creative Thinking Ability of Students Before and After Learning

Academic Ability	Average Creative Thinking Ability		N-Gain	Category
	Pretest	Posttest		
lower bound	37.62183	80.19967	0.682575972	Moderately Increased
upper bound	41.71067	84.04467	0.726273574	Highly Increased

The improvement in students' creative thinking ability was analyzed using the results of scores obtained by students on each aspect of the pretest and posttest questions. The average of the analysis results for each aspect obtained in the table was calculated, and an average of 0.682575972 was obtained for students with lower academic ability, categorized as moderately increased, and 0.726273574 for students with higher academic ability, categorized as highly increased.

The research results indicate that there is a significant difference related to students' abilities, and that students' creative thinking abilities increased at the end of learning using high-level PJBL tools. Students with both low and high academic abilities were able to follow the learning well and showed a significant increase in creative thinking ability at the end of learning. This indicates that the Biola PJBL high-level learning tools can develop the creative thinking abilities of both upper and lower groups. This research finding also confirms that students with lower academic abilities benefit more because their creative thinking abilities increase more rapidly compared to students with higher academic abilities.

The effectiveness analysis using the N-Gain test shows that there is an influence of the learning model application on the improvement of creative thinking results in students with both upper and lower academic ability levels, so there is a significant difference in the comparison of creative thinking results between the initial test (pretest) and the final test (posttest). The assessment results for each indicator of students' creative thinking, which include fluency, flexibility, originality, elaboration, and evaluation, showed that the average score for each indicator of creative thinking ability experienced a high increase with varying N-Gain value presentations. This shows that the level of creative thinking of students before the application of Biola PjBL-High Level learning tools was low, which is inversely proportional to after the application of the learning tools, indicating that the level of student creativity increased highly in each indicator.

The results of this study indicate that the application of bio-based biology learning tools local potential BioLa PjBL high level aligns the creative thinking abilities of students with lower academic abilities with students with higher academic abilities. This is evident in the values of each creative thinking indicator, both fluency, flexibility, originality, elaboration, and evaluation indicators of students who do not have significant value differences between students with upper and lower academic abilities. These results are also influenced by learning activities using seagrass bioecology-based teaching tools based on the high-level PJBL steps that use the seagrass environment as a learning resource. The learning process steps focus on practical activities that are the main activity, starting with the read while underlining activity where all students read seagrass bioecology material while underlining reading materials that have the potential to directly increase interaction with the material where students not only read, but also involve the thinking process to determine which parts of the reading material are classified as important ideas to be underlined in order to respond to questions in the SESAPA (Now I Understand) content in the teaching material as reflection material as well as a theoretical basis and brilliant ideas in developing research-based project problems related to the potential and problems in the seagrass bed environment. Furthermore, students carry out in-depth concrete learning through the project planning, project action, project expo, and project evaluate phases. The enrichment learning process activities in this study are quite full of learning experiences that are experienced by both upper and lower students to immerse them in learning experiences to encourage personal reflection that fosters their creative skills by thinking in new

ways, exploring solutions related to the potential and problems of the seagrass bed environment independently or in groups.

Project based learning is a learning model that emphasizes learning activities through complex activities in a contextual way (Indrawan et al., 2020). Meaning that in this learning, students conclude understanding based on direct experience (Hastuti et al., 2023; Sari et al., 2023). These studies found that learning using the Project Based Learning (PjBL) approach can improve students' creative thinking abilities. (Illahi et al., 2022) explain that Project Based Learning (PjBL) is one of the learning models that is very effective in improving students' creative thinking abilities. Research conducted by Lesman et al., (2023) concludes that Project Based Learning (PjBL) encourages students to be more active in learning and use their skills in overcoming various real problems in the surrounding environment. The high-level Project Based Learning model offers a number of benefits that can help improve students' creativity and critical thinking skills Effectiveness of Using the Project-Based Learning Model in Improving Creative-Thinking (Ningsih et al., 2020).

Thus, to foster students' creative thinking abilities, especially for the lower group, teachers need to create meaningful contextual learning that involves students in solving problems through literacy, research activities using the environment as a learning resource, expressing research-based thoughts in the form of innovative products that are beneficial for environmental sustainability and human welfare, and communicating findings in the form of action and work exhibitions.

The innovative BioLa PjBL high-level learning tools, if understood and applied properly by teachers in the learning process, are predicted to have an impact on improving the quality of students' thinking abilities, so that what (MICHA, 2017) stated that students with low academic abilities are often associated with learning failure will never happen. In addition, the results of this study can change the educational culture so far that enrichment programs can only be attended by upper-ability students, which should be reconsidered, and educators must change the paradigm that all students have the same right to participate in enrichment programs. Enrichment seeks to develop thinking skills, creativity, problem-solving, experimentation, innovation, discovery, art and movement skills, etc. Enrichment is a higher learning challenge to help students reach their optimal capacity in learning.

The results of this study are in line with several previous studies such as (Hastuti et al., 2023). These studies found that learning using the Project Based Learning (PjBL) approach can improve students' creative thinking abilities. Overall, the Project Based Learning model offers a number of benefits that can help improve students' creativity and critical thinking skills and can comprehensively solve environmental problems ((Arkham et al., 2016; Putri et al., 2023).

4. Effectiveness of High-Level PJBL Learning Tool Implementation on Students' Environmental Literacy Ability

The results of the covariance analysis of environmental literacy for students with high and low academic abilities are explained as follows.

a. Cognitive Skill Aspect.

Analysis was conducted to examine the average difference in cognitive skills between students with low and high academic abilities after using the BioLa PJBL high-level tools. The analysis results are presented in Table 5.

Table 5. Covariance Analysis Results of Differences in Cognitive Skills

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	777.379[a]	2	388.690	5.104	.007
Intercept	26406.579	1	26406.579	346.776	.000
X2	20.715	1	20.715	.272	.603

X	776.952	1	776.952	10.203	.002
Error	8909.403	117	76.149		
Total	768964.489	120			
Corrected Total	9686.782	119			

The covariance analysis results in Table 5 show that the F-statistic for the academic ability variable is 10.203 with a significance level of 0.000, which is still smaller than alpha 0.05 and 0.01, thus H0 is rejected and H1 is accepted. This means that there is a very significant difference in the average cognitive skills of students with high academic ability at 76.97 and low academic ability at 82.11. Meanwhile, the average cognitive skills of students before and after learning are shown in Table 6.

Table 6. Average Cognitive Skills of Students Before and After Learning

No.	variable	Pre	Post	%Improvement
1.	Academically low	37.33	76.98	106.21
2.	Academically high	39.33	82.11	108.77

Table 6 shows that the average cognitive skills of students significantly increased after learning with the BioLa PJBL high-level tools. The average cognitive skill of students with low academic ability is 76.98 and for those with high academic ability is 82.11. The average cognitive skill of students with low academic ability increased by 106.21%, while students with high academic ability increased by 108.77%. This means that both groups of students were able to follow the stages in learning well and benefited cognitively from the process.

The covariance analysis results in Table 5 show that there is a very significant difference in the average cognitive skills of students with high and low academic abilities who learn with the Biola PJBL high-level tools. Furthermore, the data analysis results in Table 6 show that students' cognitive skills significantly increased after learning with the Biola PJBL high-level tools. This means that the environmental literacy ability in the cognitive aspect of both student groups is categorized as "highly increased." This indicates that both groups of students were able to follow the stages in learning well and benefited cognitively from the process.

The knowledge aspect of environmental literacy is included in the "Highly Increased" category in both upper and lower classes. This is because the tools and learning engineering created by the teacher provide many opportunities for information on concepts related to environmental issues of the Seagrass ecosystem based on research results and learning experiences using seagrass beds as a learning resource, which leads to students having good environmental knowledge and being trained in applying this knowledge to identify, analyze, and solve problems that occur in the Seagrass ecosystem environment.

Environmental cognitive skills are knowledge in the form of information possessed by students related to the seagrass ecosystem field. In this study, the knowledge aspect assessed is knowledge related to seagrass bioecology that explores the ability of knowledge related to information processing, knowledge application, and mental activities in the form of reasoning, problem-solving, and the formation of knowledge concepts (Putri et al., 2023). The highly increased knowledge aspect of environmental literacy can also be due to the many learning experiences of students using the learning stages based on the high-level PJBL model, starting with the read while underlining stage. In this phase, students carry out reasoning activities by reading seagrass bioecology material outside of enrichment program hours, underlining material deemed relevant, and answering questions related to SESAPA content individually or in groups. This certainly helps students simplify and summarize the information they have learned and connect it to real-world situations.

Reading while underlining is an activity that involves selecting important concepts during reading (ARI, 2017). This activity clearly has the potential to track student understanding and help them find more important information during literacy. In addition, it helps students learn independently and focus on more important things and can create more productive students in collaborating,

understanding when planning, implementing, and expressing and communicating research results in the form of products such as articles, leaflets, videos, etc. Of course, this happens through the project planning, project action, project expo, and project evaluation phases.

The stages in project-based learning provide space for learning independence for students to interact directly with environmental problems that occur around them. The increase in students' cognitive skills is an implication of the consistent application of the Project Based Learning (PjBL) stages. Project Based Learning (PjBL) is learning that emphasizes students' ability to complete projects given by the teacher (Spector & Ma, 2019). Learning experience is an activity to identify problems in the surrounding environment through a scientific approach, so it needs to be designed to train the ability to observe, ask questions, experiment, associate, and communicate (Alberida, 2020). The results of this study are in line with a meta-analysis conducted by Zhang & Ma, (2023), which concluded that Project Based Learning is very effective in improving student learning outcomes such as thinking skills, academic achievement, and student attitudes. This approach allows students to solve problems and complete a specific project, thus requiring prerequisites in the form of students' prior knowledge. Project Based Learning (PjBL) prioritizes providing learning experiences for students through a series of investigation activities to achieve goals. These activities and experiences are advantages that influence various aspects of student learning achievement, including cognitive skills.

b. Attitude Aspect

Analysis has been conducted to determine the difference in attitudes towards the environment between students with high and low academic abilities after learning with the BioLa PJBL high-level tools. The average difference in students' attitudes towards the environment after the enrichment program is presented in Table 7.

Table 7. Covariance Analysis Results of Differences in Attitudes Towards the Environment

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1759.738[a]	2	879.869	12.352	.000
Intercept	15454.533	1	15454.533	216.959	.000
X1	52.154	1	52.154	.732	.394
X	1758.221	1	1758.221	24.683	.000
Error	8334.198	117	71.232		
Total	678111.587	120			
Corrected Total	10093.936	119			

Table 7 shows that the F-count for the Academic Ability variable is 24.683 with a significance level of 0.000, which is still smaller than alpha 0.05. Thus, H0 is rejected and H1 is accepted. This means that there is a very significant difference in attitude towards the environment between students with low and high academic abilities. Meanwhile, the average attitude of students before and after learning is shown in Table 8.

Table 8. Average Attitude of Students Before and After Learning

No.	variable	Pre	Post	% Improvement
1.	Academically low	38.00	70.74	86.17
2.	Academically high	36.25	78.48	116.49

Table 8 shows that the average attitude of students towards the seagrass bed environment increased at the end of learning using the BioLa PJBL high-level tools. The average attitude of students with low academic ability is 70.74 and students with high academic ability is 78.48. The attitude of students with low academic ability increased by 86.17%, while students with high academic ability experienced a very significant increase of 116.49%. This means that both groups of students were able to follow the learning with the developed tools and benefited from an increased attitude towards

the seagrass bed environment at the end of learning. These results also confirm that the BioLa PJBL high-level tools are very effective in improving students' attitudes towards the seagrass bed environment.

The data analysis results indicate an increase in environmental literacy in the attitude aspect. This fact is inseparable from the contextual knowledge understanding that students have possessed related to seagrass bioecology and threats to its existence, as well as how to conserve seagrass beds, accompanied by real actions in the environment carried out by students when carrying out projects related to identifying seagrass species and biota within them, identifying waste in seagrass beds, and plastic waste management projects in the form of ecobricks. In addition, there is a research project on utilizing seagrass plants as an alternative food source, for example, utilizing seagrass fruit and leaves, and as nuggets, chips, tea, and various other products. This is beneficial for the welfare of coastal communities and indirectly provides awareness and motivation for students to show sensitive and reflective attitudes in taking in-situ conservation actions towards seagrass beds. This statement is in line with the explanation from (Supriyadi et al., 2024) that when someone has sensitivity to the environment, they will see the environment from an empathetic perspective. Students' pro-environmental attitudes can be formed through several environmental management activities carried out in educational units.

These results also confirm that the BioLa PJBL high-level tools are very effective in improving students' attitudes towards the seagrass bed environment. (Shalehah & Alimah, 2024) explains that environmental literacy is a person's ability consisting of knowledge about ecological systems and attitudes towards the environment, which is very crucial in determining positive or negative behavior towards the environment. The results of this study are in line with research conducted by Adawiyah & Mahmuddin, (2023) which found that Project Based Learning is very effective in improving students' attitudes towards the environment. As part of the environmental literacy component, this research is also in line with Ginting et al., (2023) who found that Project Based Learning integrated with STEM is very effective in improving students' environmental literacy. Wardah et al., (2022) also conducted research on the benefits of Project Based Learning (PjBL) and found that the PjBL model is very effective in improving students' environmental literacy and problem-solving abilities.

c. Behavior Aspect

Another aspect of the environmental literacy variable is student behavior. Analysis was conducted to determine the average difference in behavior between students with low and high academic abilities who were taught using the BioLa PJBL high-level learning tools. The results of the covariance analysis are presented in Table 9

Table 9. Covariance Analysis Results of Differences in Student Behavior Scores

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1037.931	2	518.966	7.028	.001
Intercept	29499.064	1	29499.064	399.473	.000
X5	282.923	1	282.923	3.831	.053
Academic	766.135	1	766.135	10.375	.002
Error	8639.860	117	73.845		
Total	788113.000	120			
Corrected Total	9677.792	119			

Table 9 shows that the F-statistic variable is 10.375 with a significance level of 0.002, which is still smaller than alpha 0.05 and alpha 0.01, thus H0 is rejected and H1 is accepted. This means that there is a very significant difference in the average behavior of students. Meanwhile, the average cognitive skills of students before and after learning are shown in Table 10.

Table 10. Average Behavior of Students Before and After Learning

No.	variable	Pre	Post	% Improvement
1.	Academically low	38.42	78.03	103.07
2.	Academically high	38.58	83.05	115.,32

Table 9 shows that the average behavior of students increased higher at the end of learning. The average behavior of students with high academic ability is 83.05 and students with low academic ability is 78.03. The average behavior of students with low academic ability increased by 103.07% and the average behavior of students with high academic ability increased by 115.32%. This means that both groups of students were able to follow the stages in learning well and benefited from an increase in behavior from the learning process using the BioLa PJBL high-level tools.

Based on the data analysis results in Table 9, there is a very significant difference in the average behavior of students. In addition, the data analysis results in Table 10 show that the average behavior of students increased higher at the end of learning.

Thus, it can be explained that the use of BioLa PJBL high-level learning tools in enrichment learning can provoke and change the behavior of the learning community, both upper and lower groups, regarding their responsibility in preserving the seagrass bed environment, which is very beneficial both ecologically and economically for coastal communities and ensures sustainable development. Both academic groups have equally increased behavior, which is certainly inseparable from the cognitive skills and attitudes they already possess. This is in line with the opinion of Yusliza et al., (2020) who explained that behavior based on knowledge will last longer than behavior that is not based on knowledge. Students' awareness of the environment will shape responsible environmental attitudes and behavior.

The BioLa PJBL high-level learning tools designed in this study can facilitate student behavior. The learning process using these tools emphasizes students' awareness of real problems in the surrounding environment, discussing and finding solutions to solve them (Zhai et al., 2024). These tools are designed to minimize the role of the teacher as a source of knowledge and students are given the opportunity to be more active in learning. Students can work together in small groups to solve real-world problems, especially in the seagrass bed environment. Student activity in learning is what impacts various skills, both cognitive, psychomotor, and affective (Anand, 2024). Research conducted by Almulla, (2020) found that Project Based Learning is very effective in increasing student involvement in learning through discussion activities and sharing knowledge and information.

Based on the data analysis results of environmental literacy which includes cognitive skills, attitudes, and behavior aspects, it shows that both academic groups of students, both upper and lower, have literacy abilities that are not too far apart, or even similar. This means that the BioLa PJBL high-level learning tools applied in the fieldtrip and outdoor enrichment program provide opportunities for teachers to engineer learning to create learning experience activities for students. Marougkas et al., (2023) explain that experience-based learning emphasizes contextual activities and sensory experiences as the main learning resources. In addition, project-based learning experiences carried out directly in seagrass bed areas substantially cause positive changes in knowledge, attitudes, and behavioral changes. Active student involvement in the seagrass bed environment as a learning resource encourages the development and expansion of knowledge, resulting in positive learning abilities for students. Thus, biology learning by integrating the seagrass bed environment as a learning resource will be more meaningful. Through this research process, it can also be explained that when students' cognitive skills and attitudes increase, students tend to feel connected and empathetic towards the preservation of the seagrass bed environment. This is shown by students through solutions to plastic waste management found in seagrass beds in the form of ecobrick products, and various other economic products for the welfare of coastal communities. Learning

experiences that interact directly with the local seagrass bed environment are able to develop a closer relationship with nature and have a tendency to protect seagrass beds.

This statement is in line with Kusnadi et al., (2024), who explained that outdoor experiences allow students to gain a better understanding in-situ of the landscape related to the environment, in this case the seagrass bed environment and the animals that inhabit it, and the various different processes that influence and connect them. This learning experience in the seagrass bed environment is expected to have a positive effect on knowledge, attitudes, and a sense of connection with the seagrass bed environment in the future. This is because when emotional, physical, and social interactions occur in the learning process by involving seagrass beds as a learning resource, it can promote memory and application of knowledge in new ways that are directly related back to previous experiences which provide a lot of space for students to explore their knowledge, attitudes, and behaviors through learning experiences by being able to collectively engineer their abilities in memory and influence student decisions in pro-environmental behavior planning(Boyle, 2024).

Environmental literacy is a major challenge in protecting environmental ecosystems, especially seagrass bed ecosystems. With the availability of these BioLa PJBL high-level teaching tools, it can facilitate the learning community through enrichment learning programs to build the quality of environmental literacy which includes cognitive skills, attitudes, and behavior aspects of students. Thus, the learning community can have learning experiences in finding, evaluating, and weighing solutions to environmental issues that occur rather than just learning and accepting one particular approach or solution. Environmental literacy carried out by the learning community can provide opportunities for the learning community for realistic problem-solving and in-situ conservation actions.

CONCLUSION

Biology teaching tools based on High-Level Project Based Learning (PjBL) integrated with local Seagrass Bed potential are effective in increasing the creative thinking abilities of both low and high academic ability students. The average creative thinking ability of students with low academic ability increased by 140.91%, while students with high academic ability increased by 129.03%. There is a significant difference in the cognitive skills of high and low academic ability students who learn with Project Based Learning tools. The average cognitive skill of students with low academic ability is 76.98 and students with high academic ability is 82.11. There is a significant difference in students' attitudes towards the environment between high and low academic ability students who learn with High Level PjBL Biology tools integrated with local Seagrass Bed potential. The average attitude of students with low academic ability is 70.74 and students with high academic ability is 78.48. Students with low academic ability increased by 86.17%, while students with high academic ability experienced a very significant increase of 116.49%. There is a significant difference in the behavior of high and low academic ability students who learn with Project Based Learning tools. The average behavior of students with high academic ability is 83.05 and students with low academic ability is 78.03. The average behavior of students with low academic ability increased by 103.07% and the average behavior of students with high academic ability increased by 115.32%.

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