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Integrated PjBL-STEM in Scientific Literacy and Environment Attitude for Elementary School

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Abstract

Integrating Project-Based Learning (PjBL) and Science, Technology, Engineering, and Mathematics (STEM) in elementary schools can increase the quality of human resources in industrialization and globalization to maintain the environmental system and fulfill 21st century competencies. The research method used Quasi-Experiment from elementary schools in Bengkulu, Indonesia, with 50 respondents for the experiment and control class. For all attitude, context, and knowledge indicators, the data was analyzed using a non-parametric test and an ANOVA. The instrument's validity was tested statistically and by experts. The results show that PjBL and STEM significantly affect scientific literacy and environmental attitudes in three indicators. Furthermore, the diorama project with PjBL and STEM allows students to investigate environmental conservation efforts, accommodate science and technology. Students' success in making slogans to solve science problems. Environmental literacy instruments and STEM are suggested to be integrated with cognitive, motivation, behavior, and values.

Keywords: Scientific literacy, PjBL, STEM, Environmental attitude, Diorama, Student, Elementary school.

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Contents

Contribution of this paper to the literature
This research contributes to the exploration of STEM components through the PjBL learning process, which can help students actively learn. Students' competency and attitudes must create concepts in slogans for the animal life cycle stages, from literacy to factual and conceptual knowledge components and higher-level thinking context. The research involved 50 Indonesian fourth-grade pupils. For the three indicators related to animal life cycles, environmental attitudes demonstrate a strong association with scientific literacy with the Diorama project.

1. Introduction

Science education in the 21st century is expected to form high-quality human resources in the industrialization and globalization era. One of the life skills that everyone must possess is described by scientific literacy and environmental attitudes. Efforts to develop scientific and environmental literacy skills are made by integrating the interdisciplinary PjBL with STEM in teaching and learning. The PjBL model facilitates students to solve problems through project work. Then STEM integration as a multidisciplinary discipline of science into one comprehensive subject to build knowledge, competence, and implement concepts in students' daily lives.

Program for International Student Assessment (PISA) evaluates students in the three areas of mathematics, science, and literacy for Indonesia in 2018 (OECD, 2018). Based on the PISA score, Indonesia's reading score is 72nd, mathematics is 72nd, and science is 70th out of 78 countries (OECD, 2019).

Environmental literacy has components related to: attitude, context, and knowledge (OECD, 2017). Assessment of the aspects of scientific literacy and environmental attitudes can describe a person's scientific literacy ability and environmental care attitude as a whole. Scientific literacy and attitudes affect a person's ability to understand and interpret environmental problems faced by community (Winarni, Hambali, & Purwandari, 2020). Giving insight into scientific literacy and environmental attitudes to students aims to make students care about maintaining environmental balance and understanding and acting on natural changes. Scientific literacy and environmental care attitude help students take proper actions to maintain, restore, and improve ecological stability (Cofré et al., 2019). Veisi et al. stated that humans with environmentally literate have environmental sensitivity, knowledge, skills, attitudes and values, personal responsibility, and active contribution (Veisi, Lacy, Mafakheri, & Razaghi, 2019).

STEM used as an approach to teaching and learning between one or more STEM components and other disciplines (Nugroho, Permanasari, & Firman, 2019). The STEM integration in teaching and learning can be carried out at all educational levels, from elementary to university. STEM aspects like intelligence, creativity, and design abilities are implemented not depend on age. STEM integration also trains problem-solving skills with scientific behavior support. Literacy includes using scientific learning and processes to comprehend the natural world and its decision-making ability (Winarni et al., 2020). Technological literacy involves using new technologies, understanding new technologies, and analyzing new technologies that affect individuals and society. Design literacy focuses on understanding design techniques using PjBL by integrating interdisciplinary subjects. Mathematical literacy means being able to analyze, reason, communicate ideas clearly, and formulate, solve, and interpret mathematical problems.

STEM integrates the four components by focusing on real problem-solving in daily life (Erduran, 2020). The learning process with the STEM approach will apply and practice the STEM content in real-life situations (Suprapto, 2016). Not only discussing knowledge but also to technology, engineering, and mathematics. The STEM education purpose is to produce students who will develop their community competencies and apply their knowledge to solve daily life problems. STEM involves 4Cs, including creativity, critical thinking, collaboration, and communication.

Several related studies have developed environmental literacy, PjBL, and STEM. Australia's teachers have explored and developed inquiry in environmental literacy integrated with the curriculum so that students can develop their potential in classroom activities (Kidman & Casinader, 2019). The PjBL application for science learning on electrical energy in life has shown an understanding increase for grade 6 elementary school students in Bursa, Turkey (Ergül & Kargın, 2014). The STEM integration in chemistry is suitable and improves elabo-ration among students in Malaysian secondary schools (Huri & Karpudewan, 2019). The implementation of social scientific issues in Malaysia's science curriculum encouraged students in informal reasoning, especially in society, ecology, economy, and science arguments (Karpudewan & Roth, 2018). The application of STEM as a virtual lab has increased scientific literacy on air pollution for secondary high school (Ismail, Permanasari, & Setiawan, 2016). STEM PBL in American high schools is more beneficial for low achieving students and decrease performance variation (Han, Capraro, & Capraro, 2015). Schools that implement STEM PjBL in America have a higher level of student learning success than students from schools that do not implement STEM PPA (Erdogan, Navruz, Younes, & Capraro, 2016). Furthermore, STEM-PjBL has a significant impact on developing students' problem-solving skills in impulse and momentum (Purwaningsih, Sari, Sari, & Suryadi, 2020).

Based on previous research, this study focused on integrating PjBL and STEM in learning to improve scientific literacy, especially on the animal life cycle topic. STEM is expected to involve collaboration between students, increase teacher efficiency, and support the curriculum to enhance student learning outcomes (Margot & Kettler, 2019). Students can develop their competencies in STEM and solve environmental problems in daily life through technology. This research was conducted with integration between PjBL and STEM. The research objectives are: (1) analyzing the effectiveness of PjBL and STEM on environmental literacy; and (2) analyzing the relationship between attitude component literacy. The characteristics of PjBL contribute to build understanding based on challenges or problems that guide students to explore, make decisions, design, and deduce with project. Furthermore, PjBL method is very suitable for combined with inter-disciplinary frameworks such as STEM. The contribution of PjBL can increase higher-order thinking skills from students to achieve 21st century abilities.

2. Method

The research used is the quasi-experimental method with experimental and control groups. The experimental group is influenced by PjBL and STEM models, while the control group with conventional learning. The research uses matching only pretest-posttest control group design. The research steps used four stages of educational research and development, starting from (1) need analysis, (2) design, (3) develop initial product, and (4) initial field testing (Borg & Gall, 1979).

In the analysis stage, the researcher identifies the context and content of learning plan in the animal life cycle topics integrated with the PjBL and STEM models. We pay attention to the 2013 curriculum and conduct literature studies of reading materials from fourth-grade books in Indonesia. The first stage, we analyze the learning tools to integrate the PjBL and STEM models for making dioramas. An animal life cycle diorama is a three-dimensional miniature object that depicts the animal's life cycle steps. Secondly, we designed an assessment instrument for environmental care attitudes, measured using an attitude questionnaire with five Likert scales.

The third step is the initial product development process, namely learning tools. Before testing, the instruments were validated by three experts from senior teachers as practitioners, lecturers in science, and language expertise in primary education. Validation was carried out to determine the suitability of competency, indicators, teaching materials, cognitive levels, knowledge dimensions, question formulation, answer keys, attitude questionnaire, and competency assessment rubrics. The validation results are used to complete the instrument. Furthermore, the instrument was tried out in different schools in fourth grade, elementary school number 8 Bengkulu City with very good accreditation.

The fourth step is small-scale testing in other elementary schools with the control and experimental classes. Science learning with the PjBL and STEM integration implements the complete PjBL steps. The teaching takes 3 meetings, or 210 minutes, with details of the preliminary first meeting and pretest for 15 minutes, reflection for 20 minutes, and research for 35 minutes. The second meeting is the discovery activity for 20 minutes and monitors the project's progress for 50 minutes. Last meeting, application activities for 20 minutes, communication for 35 minutes, and posttest evaluation for 15 minutes.

The PjBL core activities include fundamental questions, designing projects, compiling schedules, monitoring project progress, testing, and evaluating project results. STEM activities consist of reflection, investigation, discovery, application, and communication. In the reflection stage, the student determines the fundamental questions. Students observe videos and pictures about the animal's life cycle as a stimulus to the problem context that accommodates science and technology elements. Questions about the life cycle related to the preservation efforts as a preliminary investigation that accommodated by science aspects. In the implementation phase, students design plans and compile a project schedule. Students observe a video the process of making a diorama project about the animal's life cycle with technological elements. Then, students make designs and project schedules in groups. They designed the discovering process for the animal life cycle that which adapted the engineering element. In the discovery stage, students discussed science, technology, and engineering projects. Students individually modeled problem-solving for the animal life cycle project as a slogan to animals caring in their environment, accommodated by science, technology, and engineering elements in the application stage. The experience evaluation stage is carried out through students presentations and communicates the results of diorama project.

Students in the experimental class also facilitated using PjBL and STEM with diorama project worksheet. The steps for making a diorama are: (1) read the animal life cycle in material and student books; (2) search for information and pictures from the Internet about the animal life cycle; (3) choose an animal suitable for the diorama project; (4) find information about the animal life cycle and diorama; (5) choose materials that quickly obtained; (6) make a design or diorama sketch with clear elements and measurements; (7) choose a frame and background, by giving paint or paper to make it more attractive; (8) make a basic diorama of the animal's life cycle to make it more alive; (9) add a frame to the Diorama project work; (10) finish and complete the diorama; and (11) individually create animal conservation slogans based on the stages of animal life cycle.

The instruments were arranged based on the suitability between environmental literacy indicators that related to (1) animal life cycle, (2) complete metamorphosis, and (3) incomplete metamorphosis. Environmental literacy attitudes indicate knowledge, context, competence, and caring attitudes for animals' lives. Environmental literacy in component science consists of four aspects: knowledge, context, attitude, and competence. Knowledge was measured using 10 multiple-choice questions. Aspects of factual knowledge literacy include metamorphosis, the life cycle of dragonflies, cockroaches, butterflies, mosquitoes, and frogs. Meanwhile, conceptual knowledge literacy focuses on students' ability to analyze metamorphosis in the animal life cycle. Literacy instruments in the context component were measured using 8 multiple choice questions, namely, the frog's life phase that requires water, the best stage for mosquito eradication in his life cycle, the life cycle including cockroaches and butterflies, the similar phase for dragonflies and mosquito's life cycle, the frog egg cycle, the life cycle of cocoons, the bird life cycle, and the chicken life cycle.

The instrument and competency for environmental literacy is a rubric to assess slogans' work after making a diorama in groups. The competency aspect in explaining scientific phenomena with a descriptor. Students write down the animals from the surrounding environment, create a slogan about one of the animals, and explain which animals have complete or incomplete metamorphosis. Next, designing and evaluating scientific investigations, having descriptors select words relevant to environmental preservation, creating a slogan calling for conservation, and constructing words for animals' life cycles. Then, interpret data and facts, descriptor assessment with the slogans' suitability, explain the description of animal conservation, and encourage animal preservation.

The environmental instrument used an attitude questionnaire with a five-category Likert scale. This questionnaire consists of 13 items, with 8 items to measure the attitude for protecting animals in their environment and 5 items to measure the pets' responsibility. All research data was analyzed using IBM SPSS Statistics 26. The expert was tested with the research instrument to determine the questionnaire's validity.

Table 1. Reliability test results.

Attitude		Context		Knowledge	
CA	**N**	**CA**	**N**	**CA**	**N**
0.74	13	0.69	8	0.75	10

Based on Table 1, the reliability test for environmental care aspects, scientific context, and scientific knowledge shows that all elements have a Cronbach Alpha value> 0.5. So, the literacy instrument for all science components is valid and feasible to use. The reliability test was used to check if the instrument was trusted and made sure the collected data was reliable. This indicates the research instrument is reliable and can be used.

The research sample was the elementary schools 11 and 04 in Bengkulu City, with very good accreditation, which implemented 2013 curriculum. This accreditation shows the same quality as primary schools throughout the country, such as teachers' quality, availability of facilities, infrastructure, learning environment, and learning facilities. The sample was randomly selected, with the total of respondents is 50 students. Before the research was carried out, the two-sample levels were tested for homogeneity. This test showed the Levene sigma value was 0.99> 0.05, which indicates that the experimental and control classes are homogeneous (see Table 2).

Table 2. Homogeneity of samples.

Levene	df1	df2	Sig.
2.829	1	48	0.099

3. Results and Discussion

This section describes the result of experiment with STEM and PjBL. Pretest and posttest data for the components of scientific literacy, namely attitude, context, and knowledge, shown in Table 3. The literacy component of student competence seen from the average score and the percentage of students who achieved good criteria in the experimental class, was higher than in the control class.

Based on Table 4, the Kolmogorov Smirnov value with the 50 data has a normal distribution for scientific literacy with Sig. > 0.05. Context data with knowledge does not have a normal distribution with Sig. < 0.05, so it is tested using non-parametric methods. The pretest and posttest data's homogeneity test shows that all data has a Sig. > 0.05, indicating that the information is homogeneous.

Table 3. Descriptive statistics.

Indicator	N	Min	Max	Mean	SD
Attitude					
PreControl	25	20	76	47.36	14.64
PostControl	25	46	80	57.76	8.96
PreExperiment	25	30	80	52.48	13.01
PostExperiment	25	60	100	77.20	9.09
Context					
PreControl	25	0	60	28.00	16.33
PostControl	25	20	80	52.00	17.32
PreExperiment	25	0	60	32.80	17.20
PostExperiment	25	40	100	76.80	17.01
Knowledge					
PreControl	25	20	70	40.40	13.69
PostControl	25	40	90	58.00	12.25
PreExperiment	25	20	70	42.80	14.87
PostExperiment	25	70	100	86.40	9.95

Table 4. Normality test and homogeneity.

	Normality			Homogeneity	
Indicator	**Statistic**	**Df**	**Sig.**	**Levene**	**Sig.**
Attitude					
Pre	0.10	50	0.200*	0.25	0.43
Post	0.11	50	0.200*	0.00	0.11
Context					
Pre	0.27	50	0.000	0.16	0.68
Post	0.32	50	0.000	0.15	0.69
Knowledge					
Pre	0.16	50	0.002	0.02	0.89
Post	0.17	50	0.001	1.78	0.18

Note: *. This is a lower bound of the true significance.

Table 5. Non-parametric and ANOVA.

Variable	Sig.
PostAttitude – PreAttitude	0.003
PostContext – PreContext	0.001
PostKnowledge – PreKnowledge	0.000
R-value for all variable	0.263

The Sig results with a non-parametric test for context and knowledge variables are below 0.05, so Ha is accepted. It shows that PjBL improved STEM in context, knowledge, and environmental care attitudes. In Table 5, the Sig value with the ANOVA test for the attitude variable is 0.003 <0.05. The data has a difference, so using PjBL on increasing scientific literacy and student attitudes towards the environment. R-value for attitude, knowledge, and context is 0.263> 0.05, so there is a high relationship between the components of attitude, context, and knowledge of environmental attitude.

3.1. The Effectiveness of PjBL and STEM on Environmental Literacy

Based on the analysis, the integration of PjBL and STEM significantly affects environmental literacy skills in the three aspects, namely context, knowledge, and attitudes. Control class with conventional learning does not affects critical thinking and problem-solving ability (Han et al., 2015). PjBL and STEM involve students in problem-solving, interdisciplinary curriculum, open-ended questions, student-centered, collaborative workgroup, and interactive activities (Siew, Amir, & Chong, 2015). The students project is make a diorama about animal's life cycle. Diorama, a mini three-dimensional scene, depict the actual scene with objects placed on a stage.

This integration increases the literacy of attitude components about the animal life cycle. Student responses to flower and butterfly survival; home and environment cleanliness; presence of nuisance animals such as cockroaches; presence of fruit plants and animals; game and survival of animals such as cocoons, dragonflies, caterpillars, and frogs; cleanliness of cages and pets; environmental cleanliness; and the life cycle of mosquitoes are described in the literacy attitude component.

Students learn to understand the learning material by making a diorama project. Students get more meaningful experiences during learning by their enthusiasm during the learning process. The PjBL model can encourage students to creatively and independently produce a product and provide student experiences to build their knowledge (Lestari, Sarwi, & Sumarti, 2018). Knowledge for fourth-grade elementary school students includes facts and concepts. Factual knowledge about the life cycle of animals studied and the learning outcomes measured.

Meanwhile, the conceptual component of knowledge literacy is focused on students' ability to analyze metamorphosis in the animal life cycle. Students can ask questions about the life cycle and relate it to its preservation efforts as an initial investigation and accommodated by science elements. According to STEM education, a multidisciplinary approach aims at mastery of science and mathematics and technology and engineering (Ryoo & Winkelmann, 2021). Engineering was thought through the engineering design project to solve problems.

The effectiveness of this model starts at the beginning of the learning activity. Students observe videos and pictures about the animal life cycle stages as a stimulus for the problem context, according to the initial stages of PjBL-STEM. The motivation becomes more meaningful because the science elements accommodate it. A presentation of facts and concepts from student books and a video presentation adapted from technical aspects. Students are also facilitated with instructions for making dioramas, where students are required to understand knowledge through reading the stages of animal life cycles on the material and student books. They strengthen science elements by looking for information and pictures about animal life cycle stages on the Internet to reinforce technology elements. Animals were selected for the manufacture of diorama project to strengthen engineering elements. Students were asked to make animal conservation slogans based on the animal life cycle stages at the end of the lesson. Competency problems developed when made a Diorama project. This competency starts with determining the main concepts in a sketch, adding information based on Internet information, writing down the elements as the sketch balance display, and adjusting the sketch size.

The diorama project can apply, investigate, and inform the animal life cycle stages. The advantages of diorama media could foster student interest in learning, increase creative thinking, independence in education, and promote an active classroom atmosphere (Zhbanova, 2018). The project assessment applied in learning causes all students to be active, both visual and educational. Students must develop or enrich other people's ideas (Maba & Mantra, 2017). They can determine and argue about animals that cause disease to humans.

(a) (b)

Figure 1. Diorama project group (a) highest score, and (b) lowest score.

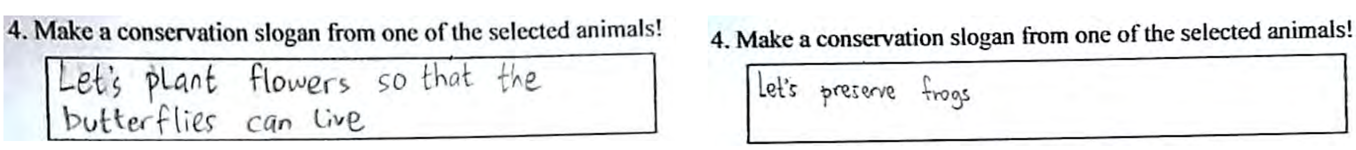
The diorama project in Figure 1.a gets the highest score of 83, while Figure 1.b receives the lowest score of 50. The diorama project assessment is based on the group's creativity that contains the concept of animal life cycle. From books and internet sources, we have assessed the descriptor for the determination of animal's life cycle. It is accommodated by science and technology elements. The sketches show the form's clarity in the concept of engineering element. However, the pictures in the illustrations are still imitated from books. The descriptions of diorama procedures are exciting color variations and following facts and events (technology), the completeness of elemental components following the animal's life cycle (science), and the incomplete direction or cycle flow according to animal life cycle stages (engineering). Animal life cycle diorama with the descriptor of pictures and information that is conceptually correct. Elements of science and technology accommodate it. The proportion of diorama image shows the balance and flow of correct cycle, adjusted by engineering elements. The image proportion of diorama shows the balance, accommodated by the engineering element. Answers to the questions with worksheet indicators include solutions to the science factors in diorama, containing new opinions and ideas about science with the life cycle flow in a diorama for engineering. The PjBL model could increase students' creative thinking abilities (Musa, Mufti, Latiff, & Amin, 2012).

Table 6. Recapitulation of the diorama project assessment.

Group	Aspects				Score	Conversion
	S	T	E	M		
Group I	2	2	3	3	10	83
Group II	1	2	1	2	6	50
Group III	2	3	2	2	9	75
Group IV	1	2	2	3	8	66
Score	6	9	8	10	33	68.5
Conversion	50	75	66	83		

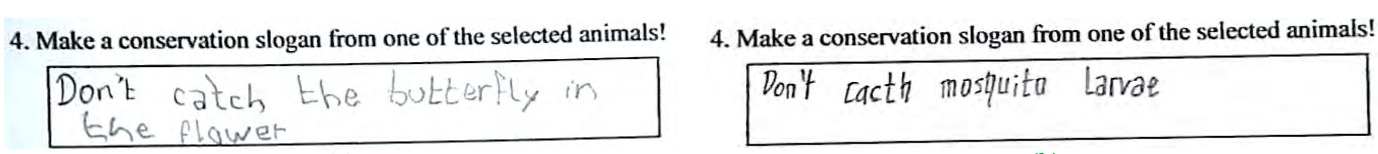
Table 6 shows the assessment results for the four STEM aspects. The PjBL-STEM model facilitates students in reading the animal stages in their life cycle in student materials and books that support science elements and searching for information and pictures from the Internet to support the technology aspect. Then, animals were selected to make the Diorama project, which is accommodated by elements of science and engineering. Choose the readily available materials around the environment and adapt the engineering elements. The dio-rama sketch supported technology and engineering aspects with clear features and measurements. Choose a frame and background for the diorama by providing paint or paper for the residents to make it more attractive, supported by technology and engineering elements. Make a basic diorama of the animal's life cycle to make life more memorable, supported by engineering elements. PjBL and STEM are helped by the parts of science, technology, engineering, and math that require more standard steps to learn (Yusuf, Student, Engineering, & Malang, 2021).

Whereas in the control class, learning is carried out through exploration. Students are given several questions about the animal life cycle material. Next, elaboration, students work on the assignments in groups. They report the results of their work in front of the class. Students and teachers discuss with added reinforcement. Last confirmation, students conclude learning outcomes, and students work on posttest questions that include literacy components of attitude, context, and knowledge. The assessed scientific competence is a slogan that is made by students individually. The slogan assessment rubric consists of three indicators. First, the ability to determine the animals around them to make a slogan about animal conservation. The descriptor includes selecting three animals from your surrounding environment, choosing one of the animals to make a slogan, and describing the chosen animal as a complete or incomplete metamorphosis. Second, the ability to make slogans about animal preservation regarding the life cycle of animals. Its descriptors are the selected words relevant to conservation efforts; the word chosen is related to the animal's life cycle; the slogan is made to contain an invitation sentence. Third, use slogans about animal conservation that have been made regarding the animal life cycle. Its descriptor is the suitability of the information between the slogan, and its explanation, which describes animal conservation efforts.



(a) (b)

Figure 2. Experimental class slogan (a) good criteria; (b) enough criteria.



(a) (b)

Figure 3. Control class slogan (a) good criteria; (b) enough criteria.

The slogan compiled in control and experimental classes is shown in Figure 2 and Figure 3. The slogan with good criteria in the experimental class (Figure 2.a) displays a positive sentence "Let plant flowers so that the butterflies can live". Furthermore, there are enough criteria in the experimental class to express positive and simple sentences (Figure 2.b), namely "Let's preserve the frogs". While in the control class with good criteria, students used negative sentences, namely "Don't catch butterfly in the flowers" (Figure 3.a) and "Don't catch mosquito larvae" for adequate scores because they do not fulfill animal conservation (Figure 3.b). The sentence used attempts to invite the conservation animals. The factor determining the success of implementing an integrated curriculum related to STEM disciplines is a key to hands-on activities, creativity, and problem-solving (Gunawan & Shieh, 2020).

3.2. The Relationship between Attitude Component Literacy

The literacy component of attitude is measured based on students' responses to animals in their environment. The dioramas are made with synchronization knowledge and material relevancy in the context of understanding (Teske, Gray, Klein, & Rule, 2014). Each group is given the task of making a different diorama project. Group one created a frog life cycle, group two created a cockroach life cycle, group three created a grasshopper life cycle, and group four created a butterfly life cycle. The diorama project is made in groups to allow interaction and discussion between students. Learning intends to involve students as system components, stimulating and motivating students to be creative in overcoming a problem (Musa et al., 2012). Students were able to study animals that experienced a complete and incomplete metamorphosis.

The teacher monitors students, and the diorama project's progress is completed. At this stage, the teacher observes the students' work from each group. Students are allowed to ask the teacher about steps that are not understood. The diorama's descriptions don't look like pictures in books. They don't show how many animals are in each stage of the animal life cycle, how many different colors they have, or what happens at each stage.

After completing the animal life cycle diorama project, the teacher must assess and evaluate what indicators have been achieved in each group. The reflection process is carried out both individually and in groups at this stage. Students are asked to express their feelings and experiences during the project's completion. Project appraisal in this study was used to decide understanding, application skills, investigative abilities, and inform students of the subject. A project appraisal is an assessment activity for a task that must be completed within a specific time (Mingazova, 2014). There are three things in project assessment, namely: (1) students' ability to select topics, find information, organize data, and write reports; (2) suitability with knowledge, understanding, and skills in learning; and (3) student projects must be the result of their work by considering the teacher's contribution in the form of guidance and support for student projects.

Literacy is an essential part of developing literacy skills and is part of 21st-century education. Learning with the PjBL method and multidisciplinary STEM can encourage students to better understand environmental knowledge from theory and to solve problems in the environment (Gao, Li, Shen, & Sun, 2020). PjBL and literacy in the learning environment become more meaningful with student-centered learning. Students can study, research, and analyze knowledge differently (Kaya & Elster, 2018).

Students' success in making slogans through STEM learning activities when faced with problems in a scientific concept (Bozkurt, Üçüncüoğlu, & Özek, 2019). The issues resolved through the diorama project were the sequence and the length of animal's life cycle. It includes the stages of complete and incomplete metamorphosis life cycle. Based on the problem, students conduct research activities to find concepts and answers the questions. Students create project designs and schedules in groups. The impact of this activity, students can design a process of discovering an idea in the animal life cycle accommodated by engineering elements. In the discovery stage, students discuss what things need to be done for project development. The teacher monitors the implementation and development of the project. Dioramas are accommodated by science, technology, and engineering (Zhbanova., Rule, & Tallakson, 2019). The next step of application is testing the project process and results. Students individually model animal life cycle problem-solving in the form of a slogan that care for the animals in their environment, accommodated by the elements of science, technology, and engineering. The last stage of communication is the stage of evaluating the experience. Students present art in the diorama project accommodated by science, technology, and engineering (Grace et al., 2021).

Further development can involve extracurricular activities outside the school curriculum, affecting students' motivation, morale, attitudes, and cognitive abilities to collaborate and communicate, positively impacting environmental literacy (Kaya & Elster, 2019). In the future, research can determine and analyze individual factors that affect student achievements, such as ethnicity, economic status, and gender for STEM students in elementary schools. Further research can also investigate the differences in group study group collaboration in PjBL STEM activities to determine heterogeneous group members' impacts.

4. Conclusion

Integrating learning with the PjBL and STEM models can be carried out through five stages: reflection, research, discovery, application, and communication. In reflection, students determine fundamental questions as problem context stimuli accommodated by elements of science and technology. Then students researched to design plans and compile a Diorama project schedule as the first step in finding concepts accommodated by engineering elements. Students discuss and discover in groups to make projects that accommodated aspects of science, technology, and engineering. Students find application models in problem-solving animal life cycles in caring slogans for animals in their environment. Last, students communicate to present the results of making the Diorama project and receive feedback from other groups and teachers about the project's effects.

STEM elements in PjBL learning process can facilitate students learning actively. The project assessment applied in learning causes all students to be more active in visual and educational activities. From literacy to factual and conceptual knowledge components, higher-level thinking context, students' competence and attitudes must develop ideas in slogans for the animal life cycle stages of environment.

In the animal life cycle, the students' scientific literacy skills in the context component, knowledge, competence, and environmental care attitude for elementary school students showed a significant increase using PjBL and STEM models. Environmental attitudes show a strong relationship to scientific literacy, the components of fourth -grade elementary school students' context, knowledge, and competence regarding animals' life cycles.

Future researchers could involve extracurricular activities outside the school curriculum, positively impacting environmental literacy, affecting students' motivation, morale, attitudes, and cognitive abilities. Furthermore, research was developed to analyze individual factors in student achievements, such as ethnicity, economic status, and gender, for STEM students in elementary schools.

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