Development of Project Based Learning With STEAM Approach Model in Improving the Science Literacy Ability of High School Students

By Nuraini Nuraini

WORD COUNT 7027 TIME SUBMITTED 25-JUN-2024 12:11PM

PAPER ID 109834076

Jurnal Pendidikan Sains Indonesia
(Indonesian Journal of Science Education)
URL: http://jurnal.usk.ac.id/JPSI/index

11(3), p.639-653, (2023)
e-ISSN: 2615-840X p-ISSN: 2338-4379
DOI: doi.org/**10.24815/jpsi.v11i3.30934**

Development of Project Based Learning With STEAM Approach Model in Improving the Science Literacy Ability of High School Students

Nuraini*, Nurul Fajri, Indra Himayatul Asri, Edy Waluyo

Department of Biology Education, FMIPA, Universitas Hamzanwadi
Jln. Tgk. H.M. Zainuddin Abdul Majid No. 132 Pancor, Selong Lombok Timur,
Nusa Tenggara Barat, Indonesia

*Email: nurainiedy76@gmail.com

Article History:
Received date: February 21, 2023
Received in revised from: July 2, 2023
Accepted date: July 23, 2023
Available online: July 29, 2023

Citation:
Nuraini, Fajri, N., Asri, I.H., & Waluyo, E. 2023. Development of project based learning with STEAM approach model in improving the science literacy ability of high school students . *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 11(3):639-653.

Abstract. Facing today's 21st century learning, teachers need to foster science literacy and consider learning strategies that are appropriate to the conditions and potential of learners. This study aims to develop a PjBL with STEAM approach model in improving science literacy ability of high school students. This study is a development research with the Borg & Gall development model. The sample of this study was class X students of SMAN 2 Selong, totaling 35 students. The instruments used to collect data include guidelines for validating learning design, practicality questionnaires and science literacy ability tests on ecosystem materials. The data analysis used in this study used descriptive analysis. Based on the validation analysis, the products developed are included in the valid category indicated by the average score of product validation by 3 experts, namely linguists, material experts and learning technology experts successively 83.91; 84.64 and 83.73. Similarly, in terms of practicality, the products developed are also classified as practical with an average practicality score of 82.63. The product is also classified as effective with a percentage of effectiveness of 88.57%. The product developed has a potential effect in the high category to improve science literacy ability on ecosystem materials with an N-Gain of 0.76.
Keywords: STEAM, Project Based Learning, Science Literacy

Introduction

The learning of the 21st century is characterized by the rapid development of science and technology in the sphere of life in society, especially information and communication technology. Currently, the world community is entering a new era, an era of accelerating changes in various aspects or fields including education. The demands of the 21st century make the education system must be in accordance with the changing times. Science literacy is very important for students to have as a provision to face the challenges of the development of the 21st century. Science literacy directly correlates with building a new generation that has strong scientific thoughts and attitudes that can effectively communicate science and research results to the general public. Based on PISA 2019, the science literacy ability of Indonesian students is still below average when compared to the average international yaitu peringkat 70 dari 78 negara (Mullis, 2019). The results of the 2019 PISA study are proof that Indonesian formal education

emphasizes more on the aspects of low-level thinking and rarely accustoms students to use higher-order thinking in facing and solving real problems in everyday life (Durden, 2018).

Facing today's 21st century learning, teachers need to cultivate science literacy and consider learning strategies that are in accordance with the conditions and potentials of students where the learning process focuses on providing hands-on experience and applying the nature of science. Literacy skills are fundamental things that must be possessed by students in facing the global era to be able to meet the needs of life in various situations. Science literacy is the ability to understand science, communicate science, and apply science skills to solve problems. Science literacy can be defined as scientific knowledge and skills to be able to identify questions, acquire new knowledge, explain scientific phenomena, and take conclusions based on facts, understand the characteristics of science, awareness of how science and technology shape the natural, intellectual, and cultural environment, as well as the willingness to engage and care about issues related to science (OECD, 2019). A person has science and technology literacy characterized by having the ability to solve problems by using science concepts obtained in education according to their level, getting to know the technological products around them and their impacts, being able to use technological products and maintaining them, being creative in making simplified technological results so that students are able to make decisions based on community values and culture (Nunaki et al., 2019). The main elements contained in science literacy according to (Harlen, 2004), 1) concepts or ideas, which help understanding of scientific aspects of the world around and which enable us to make sense of new experiences by linking them to what we already know, 2). processes, which are mental and physical skills used in obtaining, interpreting and using evidence about the world around to gain knowledge and build understanding, 3). attitudes or dispositions, which indicate willingness and confidence to engage in enquiry, debate and further learning, 4). understanding the nature (and limitations) of scientific knowledge. With science literacy, students can have sensitivity in solving global problems, able to meet the various demands of the times, namely becoming competitive, innovative, collaborative, and characterful students.

The learning carried out by the teacher will affect the learning atmosphere carried out (Kilinc, 2018). Teachers need to design and manage learning by actively engaging students in learning that encourages students to learn (Mbiza, 2021; Öztürk, 2020; Tsakeni, 2021). Project based learning (PjBL) gives teachers the opportunity to manage classroom learning by involving project work (Acar et al., 2018). PjBL is student-centered and gives students the opportunity to conduct in-depth investigations on essential topics (Yamin et al., 2020). PjBL is an activity where students can access knowledge and the teacher facilitates students in conducting investigations (Ramesh, 2020). PjBL requires students to design and develop systems that can be used to conduct investigations and solutions to real-world problems (Sababha, 2016). PjBL is a method in which students engage in intellectually challenging task tasks to gain knowledge and skills used in solving problems (Movahedzadeh, 2012). PjBL provides a structure for students to engage in every practice by taking steps to develop and implement projects (Baker, 2004). PjBL is a complex activity based on challenging problems that engages students in project design and problem solving and provides opportunities for students to work independently (Fitriyani, 2018). PjBL is an effective learning to develop students' science literacy skills (Tasiwan, 2015). Students who perform PjBL activities will have more significant learning outcomes than those who use regular learning as usual (Çakici, 2013). PjBL provides opportunities for teachers to motivate students to develop the right strategies, design projects and make research in solving real problems faced.

Student-centered learning can make students more critical, investigative, communicative and interactive in conducting experiments (Farida, 2017). PjBL emphasizes the interrelationship between concepts and the child's daily experiences so that students can relate concepts they already have with the new knowledge they have gained. Characteristics of PjBL according to Kosasih (2014), 1) the existence of activities that produce products or works, 2) the concept of learning materials is connected to daily life, 3) learning can be carried out in the classroom or outside the classroom, 4) students design the activities or products produced, 5) assessments are carried out from planning activities, processes to results. Tiantong (2013), in his research, he mentioned that PjBL is effective for improving student learning outcomes. Through project-based learning students can gain more active knowledge, and students are more responsible in the learning process.

The challenge of an educator is to provide an educational system that creates opportunities for learners to connect knowledge and skills. Opportunities will not be created if knowledge and skills are separated in a learning process. Pfeiffer (2013) states that in STEAM learning skills and knowledge are used simultaneously by learners. Students are expected to be able to have the ability to live as individuals and citizens who are faithful, productive, and able to contribute to their lives. STEAM based learning approach that offers meta-disciplinary education in developing thinking skills and creativity in solving problems. STEAM as an integration of the discipline of art into the curriculum and learning in the areas of science, technology, engineering and mathematics (Buonincontro, 2018). STEAM is a meta-discipline in which teachers of science, technology, engineering and mathematics teach an integrated approach and each disciplinary material is not divided but handled and treated as a dynamic whole (Mariale, 2019). Based on the description above, this study aims to develop PjBL with STEAM approach model in improving the science literacy skills of high school students in East Lombok.

Methods

The type of research used Borg & Gall model with steps 1) needs analysis, 2) product design, 3) product development, 4) product implementation and evaluation (Borg & Gall, 2007). The needs analysis was carried out by open interviews with biology teachers and providing questionnaires to students about students' feelings in participating in learning by biology teachers. The interview with the biology teacher related to the learning strategy used consists of 5 questions. The questionnaire about students' feelings after attending the lesson consisted of 15 questions. The test subjects of this study were class X of SMAN 2 Selong, East Lombok with a total of 35 students consisting of 10 male and 25 female who were taken by random sampling.

The research instruments used in this study include 1) guidelines for validation of learning products, 2) guidelines for the practicality of learning implementation, and 3) learning outcomes tests on ecosystem materials. The learning product validation guidelines developed contain measurement indicators, including: 1) indicators of goal formulation, 2) content indicators, 3) indicators of the language used, and 4) indicators of time. Meanwhile, the guidelines for the practicality of implementing the developed

product contain indicators of 1) students' feelings of pleasure in the learning process, 2) assessment of the novelty of the product developed in learning, 3) student interest in participating in learning using the developed product. The learning outcomes test instrument on ecosystem materials is an essay test with indicators: 1) explain the facts and concepts, 2) presenting hypotheses, 3) answering questions related to science information. Meanwhile, the product in the form of a learning design that has been developed is validated by 3 experts, namely material experts, learning technology experts, and linguists. To obtain a valid, practical, and effective product, field trials are carried out. The quality of the development product in the form of a learning design PjBL with STEAM approach model is measured based on product validity, product practicality and product effectiveness. Product validation indicators are presented in Table 1.

Table 1. Expert Developed Product Validation Guidelines

Aspects	Indicators
Conformity	The level of conformity of the learning design with the model developed with the basic competencies and indicators of competency achievement in the curriculum
Ease	The language used in developing products with a level of understanding is difficult, moderate or easy by the teacher.
Completeness	Completeness of materials and variations in learning
Clarity	Clarity of description and systematic arrangement of the material in the learning model

The product developed in the form of PjBL with STEAM approach in improving science literacy ability is said to be valid if the product developed is in accordance with each aspect with indicators set for each aspect. The validity criteria of the learning model developed using criteria such as Table 2.

Table 2. Learning Model Validity Criteria

Interval Score	Validity Criteria
$x \geq 85$	Very valid
$70 \leq x < 85$	Valid
$45 \leq x < 70$	Quite Valid
$x < 45$	Less Valid

The practicality of the product developed in the form of a learning design with a PjBL with STEAM approach is tested based on 1) an assessment of the practicality of the product by experts, 2) the magnitude of the teacher's response after carrying out learning with a PjBL with STEAM approach in improving science literacy ability with criteria such as Table 3.

Table 3. Practicality Criteria of Learning Models

Interval Score	Practicality Criteria
$x \geq 85$	Very Practical
$70 \leq x < 85$	Practical
$45 \leq x < 70$	Quite Practical
$x < 45$	Less Practical

Meanwhile, to test the effectiveness of the products developed in improving science literacy ability is carried out by analyzing the scores of science literacy ability test results after getting learning. The indicator of product effectiveness set is that at least 85% of all students who take the ecosystem material learning outcomes test get a minimum score of 75. Meanwhile, to test the potential effects of products that have been developed in improving student learning outcomes, it is carried out by calculating the N-Gain value by calculating the difference between postes scores and pretests of student learning outcomes on ecosystem materials.

Results and Discussion

Needs Analysis

Before conducting research as a basis for developing products, researchers conducted a needs analysis by conducting interviews with biology teachers high school related to the application of the learning strategies used and providing questionnaires to students about students' feelings after participating in biology learning. The results of interviews with 3 biology teachers can be concluded that 1) most of the learning process carried out is still conventional and not student-centered, the teacher's dominance in learning is very high, students' thinking ability has not been developed adequately and the teacher provides more examples and practice questions, 2) In learning, teachers have not carried out variations in learning and have not taken advantage of real problems, 3) In learning, schools need to prepare supporting facilities related to the use of technology and an adequate internet network in integrating technology in learning, 4) Teachers expect support from schools to improve their knowledge of innovative learning as part of the competencies needed in implementing current learning.

Meanwhile, based on the questionnaire given to 35 students of class X Senior High School on the learning carried out by biology teachers, it showed that 1) the learning obtained was generally not fun, boring, and monotonous with a percentage of 75%, 2) in learning, the teacher's efforts to develop students' thinking skills are not optimal so that students are confused when facing non-routine questions, which require the ability to think in solving the problems faced, 3) In learning, teachers and students have not utilized adequate technology as the demands of 21st century learning today because the availability of technology needed in learning in schools is still lacking with a percentage of 80%, 4) In learning, teachers have not used innovative and varied learning strategies so that learning is momoton with a percentage of 75%. Referring to the needs analysis above,

is necessary to develop a learning model that is able to develop students' thinking abilities by actively involving students in learning so that two-way interaction in learning can be carried out.

Product Design Stage

The development product is in the form of an integrated PjBL instructional design of science literacy. Products are developed according to the stages of learning activities that refer to the integrated PjBL model of science literacy, namely: 1) starting with important questions, taking topics that correspond to real-world reality and starting with investigations using students' science skills, 2) project work planning, and selection of activities related to science skills in answering important questions, 3) drawing up a schedule of activities, 4) monitor the progress of student projects, 5) assessment of student project outcomes, 6) evaluation of student learning experiences. This step is in line with the research Muskania & Wilujeng (2017) that the learning of the project begins by providing problems that lead to the final product to be produced by the student. After brainstorming, the next step students are given the task of creating and designing projects. During the design of the project, students are directed to search for valid and scientific-like literature and sources. Collaborating with the team during project learning is of utmost importance. Collaboration is one of the characteristics of project learning activities with the aim of helping students to exchange ideas and have good communication skills. Meanwhile, Astawa, (2017) explained that the PjBL stage trains students to become active and creative thinkers and engage in cooperative learning to work together.

Product Development and Evaluation Stage

The product draft developed was validated by 3 experts, namely learning material experts, learning technology experts and learning practitioners. Expert validation is performed to get feedback, suggestions, comments, and corrections to the initial product for further improvement to improve the product. Based on the results of the validity analysis, a product validity score is obtained as presented in Table 4.

Table 4. Validation Results of Developed Products

Component	Validation Results		
	Material Expert	Technologist	Linguist
Identity	92	90	85
Formulation of Indicators	81	79	85
Goal Formulation	85	80	82
Material suitability	80	82	80
Preliminary Activities	80	85	85
Core Activities	82	85	84
Learning Activities	85	87	86
Learning Resources	87	86	85
Evaluation	85	85	82
Closing	84	87	85
Language Use	82	85	82
Average Score	83,91	84,64	83,73
Conclusion	Valid	Valid	Valid

Based on the validation results by experts in Table 4 above, the average product validation scores of the three experts are successively 83.91; 84,64; and 83.73 so that the product developed is classified as valid and suitable for use.

Product Revisions

Although according to experts, the product is PjBL wiith STEAM approach meets the validity criteria and is feasible to continue with field trials, but there are several components that need to be revised according to experts, including: 1) Aspects of indicator formulation, namely the need to use operational verbs C4, C5, and C6 that measure high-level thinking ability, 2) Aspects of learning activities, it is recommended to use various variations in learning so that learning is more interesting, 3) Aspects of language use, it is recommended to use language that is easy for students to understand.

Product Practicality

The practicality of the product developed is tested based on practicality scores by experts and the implementation of learning carried out by teachers in teaching ecosystem materials using previously established practicality criteria. Based on the data obtained from the observation sheets that have been collected both observation sheets by experts and teacher responses, presented as Table 5.

Table 5. Results of the Practicality Assessment of the Developed Model

Validators	Score	Category
Material Expert	82,25	Practical
Technologist	84,14	Practical
Linguist	80,54	Practical
Average	82,31	Practical

Based on the validation results of experts by both the first, second and third experts and the average results from validation show that PjBL with STEAM approach model developed is relatively practical. The practicality of the product based on the implementation of learning carried out by biology teachers using the developed product is presented in Table 6.

Table 6. Results of the Practicality Assessment of the Products Developed

Aspects	Meeting		
	First	Second	Third
Learning Objectives	84	84	85
Motivating Students	85	85	85
Giving real problems	82	84	82
Material Mastery	83	80	82
Guiding students	80	82	82
Application of learning syntax	79	80	80
Classroom Management	82	80	85
Evaluation	80	84	85
Conclusion	82	84	85
Average	81,89	82,56	83,44
Category	Practical	Practical	Practical

Referring to the scores shown in Table 6 above, it shows that, the application of PjBL with STEAM approach model in improving science literacy ability for 3 meetings shows that the learning model used in learning is included in the practical category both at meetings 1, 2, and 3. However, based on the results of observations at each meeting, there are several things that must be improved in the implementation of learning. At the first meeting, the results of the observations showed that the teacher needed to make improvements 1) the teacher needed to provide real problems according to the material being taught, 2) re-examine the sequence of learning syntax so that the implementation of learning was more systematic and follow the syntax that had been formulated in the learning design, 3) in drawing conclusions, it was suggested that the teacher first ask the students to draw conclusions and the teacher directed not the teacher who immediately conclusion. In the second meeting, the results of the observations showed that mastery of learning syntax is still not fully mastered by teachers, this is because the application of PjBL with STEAM approach model in improving science literacy ability tends to be new to teachers and it is recommended that the learning syntax be better understood. At the third meeting, the real problems chosen by the teacher in the initial activity need to be adapted to the material being taught and more challenging which requires various strategies in solving. In addition, teachers need mastery of maateri both essential and advanced materials because this will affect the management of the class carried out by the teacher. In drawing conclusions, the teacher also needs to ask the students to draw conclusions and the teacher provides reinforcement. Based on the data presented above, it can be said that students' science literacy and understanding of students' concepts can be improved by innovating in learning using PjBL with a STEM approach during the learning process (Anggereini, 2023). Hal ini juga sejalan dengan penelitian yang dilakukan oleh Fadlina (2021) yang menyatkan bahwa the innovation of the STEM PjBL model in improving students' scientific literacy students.

Product Effectiveness

The effectiveness of the product developed is PjBL with STEAM approach model as can be seen from the pretest and posttest scores on the ecosystem material. The scores of the pretest results and postest of the students science literacy are shown as in Figure 1.

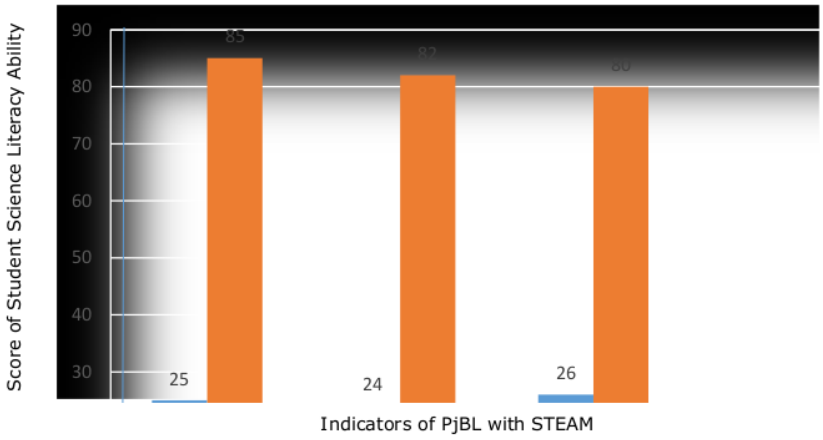

Figure 1. The scores of the pretest and postest of the students science literacy

The test was given to 35 students in class X of Senior High School with average score of the pretest and postest was 26,67 and 81,83 of ecosystem material. Of the 35 class X high school students who were given the test on the ecosystem material, there were 32 students or 91.43% who got a test score of ≥ 75 and only 3 students who did not complete the test score < 75. It can be concluded that the percentage of student completion in learning, which is 91.43%, meets the criteria for the implementation of the product developed, namely the classical score of students after getting learning PjBL with STEAM approach model of least 85%. Thus the product developed is effective to use. The results of this study are in line with those conducted by Putri & Usmeldi (2022) that learning with a STEM approach can increase scientific literacy, because it contains steps that accommodate literacy skills at the time of learning. Similarly, research conducted by Astuti (2023) shows that the STEAM approach can increase students' science literacy and creativity. This is in line with Anekawati (2021) states that science skill process influenced cognitive learning outcome in the learning process using the PjBL model integrated with STEAM, and there was a different influence between the group of students with right and left brain dominance. Meanwhile, Shamdas (2023) states that applying STEAM had a significant effect on high school students' communication skills compared to direct STEM-based learning.

Testing whether the learning model developed has the potential to improve student biology learning outcomes is determined based on the N-Gain value, namely the difference in postes and pretest scores on ecosystem materials after going through trials of applications PjBL with STEAM approach model. Based on the calculation results obtained N-Gain of 0.76 is included in the high category. Based on the foregoing, it can be said that the application of PjBL with STEAM approach model has high potential in improving science literacy ability of the biology of the ecosystem material of high school students. This is in line with the research Fatimah (2018) which explains that PjBL gives students greater opportunities to think and explore their ability to complete tasks and find the right concepts and is significantly able to improve students' science literacy skills. STEM-based project learning was able to increase the average critical and creative thinking skills of students on all indicators that varied from low to moderate categories (Sumarni, 2020).

Learning with PjBL begins with the presentation of important issues and students are asked to play an active role in conveying their ideas and ideas about the material related to it. At the project design stage, students actively discuss conducting experiments, then students present the results of their projects. The series of activities carried out in biology learning with integrated PjBL science literacy is believed to be able to create student curiosity and improve students' science literacy skills. Learning with integrated PjBL science literacy is necessary to be able to provide answers to essential questions, and provide deductive and inductive conclusions on specific problems (Insyasiska, 2015). Research conducted by (Çelik, 2018) states that teachers need to support students to find and discuss solutions by allowing sufficient time. Meanwhile, Ulger (2018) states that in learning teachers can develop students' ide31 and The learning of PjBL with STEAM approach model also has a high potential effect in improving science literacy ability as indicated by an N-Gain score of 0.76 in solving the problems encountered in various ways that are found. In this study, the analysis of ecosystem problems was chosen as the main problem to be solved by students. Projects designed by students are solutions to the problems faced, namely ecosystem problems. Students are divided into four groups with each group given the freedom to determine the materials

and methods used to conduct an analysis of the ecosystem according to their creativity. PjBL is believed to be able to create curiosity and improve students' science literacy (Nuraini & Waluyo, 2021). The results of this study are in line with the research conducted by Nita (2021) which states that the application of PjBL can improve student learning outcomes and science literacy. Through PjBL with the integration of science literacy, students not only identify problems and find solutions to the problems faced, but students can also use various knowledge and abilities to solve problems (Yamin, 2020). PjBL with the integration of science has also facilitated students to develop themselves both academically and practically to find solutions in everyday life (Husamah, 2015). Meanwhile, Sasson, & Malkinson (2018) in his research stated that PjBL is included in innovative learning that can develop students' science literacy skills. By applying integrated PjBL science literacy in learning, students will be facilitated in developing their science literacy skills in dealing with contextual problems (Chen & Yang, 2019). By implementing integrated PjBL science literacy, students are given the freedom to be more active and express their ideas through the project projects they create (Ririn, 2021). By applying this integrated PjBL literacyscience, learning is not only delivered theoretically but also through direct practice in making works or products in learning (Rohana, 2017) states that learning with PjBL can improve students' literacy skills. Meanwhile, (Gunawan, 2017) states that learning to use projects can increase students' creativity and literacy. Similarly, Afriana (2018) showed that learning with PjBL can improve students' scientific literacy skills.

Integrated PjBL with STEAM approach encourages students to be active and skilled in learning activities and they understand the knowledge that must be possessed through project design and its implementation. Through integrated PjBL with STEAM approach, students can build knowledge through real experiences and experiment with group members and between groups, so that students' science literacy can improve. Through PjBL with STEAM approach, student learning outcomes are better than conventional learning models (Siwa, 2013). PjBL with STEAM approach is useful in designing effective learning so that it has the potential to meet its demands. Integrated science literacy PjBL assists students in 1) strengthening meaningful knowledge and skills built through essential tasks, 2) expanding knowledge through investigation, with results or answers not determined by a particular perspective, and 3) building knowledge through real experiences that take place in a collaborative work atmosphere. This is in line with the research (Wijanarko, 2017) that the PjBL model empowers students' science literacy through scientific work to solve a problem and produce products so that the learning outcomes are maximized. Through hands-on experience allows students to practice using their senses, collect evidence and then follow up by asking questions or formulating hypotheses based on existing ideas so that it has the potential to improve students' science literacy ability.

In the PjBL with STEAM approach, teachers need to provide guidance to each group so that each student uses critical thinking skills, using scientific principles in solving problems. Research conducted by Wolthuis (2020) states that in learning teachers must be able to manage classes well, facilitate students in learning and re-conclude the material taught. PjBL with STEAM approach, allowing students to be given the opportunity to discuss in groups to develop science and science literacy skills. Learning with PjBL has a close relationship with student science literacy, because by using the PjBL learning model students can improve their thinking skills so that students' science literacy can develop (Fitriyani, 2018). PjBL with STEAM approach, encouraging students to reflect on what they have done so that they are aware of its weaknesses and advantages (Murniyati, 2018). This results in improving students' science literacy skills. In line with

the research conducted (Hardjo, 2018) that science literacy can equip students with the correct concepts of science and hopefully they can apply them to real life.

Conclusion

The results of the research that has been carried out can be concluded that The PjBL with the STEAM approach model can increase students' science lieration ability as shown by the N-Gain value of 0.76 with a high category. The effectiveness test of PjBL with STEAM approach ecosystem material showed that the score postest of science literacy ability with indicators of the ability to explain the facts, presenting hyphotheses and answering questions with a presentation of 91.43% from 35 students who scored above 75.

Acknowledgement

My gratitude goes to the Dean of the Faculty of Mathematics and Natural Sciences and the Head of the Biology Education Study Program of Hamzanwadi University who has facilitated researchers in completing this research. I would also like to thank my fellow lecturers who have helped complete this research.

References

Acar, D., Tertemiz, N., & Taşdemir, A. 2018. The effects of STEM training on the academic achievement of 4th graders in science and mathematics and their views on STEM training teachers. *International Electronic Journal of Elementary Education*, 10(4):505–513. https://doi.org/10.26822/iejee.2018438141.

Afriana, J., Permanasari, A., & Fitriani, A. 2018. Penerapan project based learning terintegrasi STEM untuk meningkatkan literasi sains siswa ditinjau dari gender. *Jurnal Inovasi Pendidikan IPA*, 2(2):202–212. https://dx.doi.org/10.15446/revfacmed.v66n3.60060.

Anekawati, A., Hidayat, J., Abdullah, N., & Matlubah, H. 2021. Structural equation modeling multi-group of science process skills and cognitive in pjbl integrated steam learning, *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 9(3):512-527. https://doi.org/10.24815/jpsi.v9i3.20447.

Anggereini, A. Siburian, J., & Hamidah, A. 2023. Identification of project based learning and STEM PjBL innovation based on socio scientific issues as an effort to improve students' scientific literacy. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 11(1):165-177. https://doi.org/10.24815/jpsi.v11i1.26927

Astawa, N., Artini, L., & Nitiasih, P. 2017. Project based learning activities and EFL students' productive skills in english. *Journal of Language Teaching and Research*, 8(6):1147–1155. https://dx.doi.org/10.17507/jltr.0806.16.

Astuti, W., Sulastri, Syukri, M., & Halim, A. 2023. Implementasi pendekatan science, technology, engieering, and mathematics untuk meningkatkan kemampuan literasi sains dan kreativitas siswa. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 11(1):25-39. https://doi.org/10.24815/jpsi.v11i1. 26646.

Baker, E., Trygg, B., Otto, P., Tudor, M., & Ferguson, L. 2004. Project based learning model: relevant learning for the 21st century. Pacific Education Institute, Washington.

Borg, W.R. & Gall, M. 2007. Education research: An introduction. Longman, New York.

Çakici, Y. & Türkmen, N. 2013. An investigation of the effect of project based learning approach on children's achievement and attitude in science. *The Online Journal of Science and Technology*, 3(2):9–17. https://dergipark.org.tr/en/pub/tojsat/issue/22659/242010.

Çelik, A. & Bukova Güzel, E. 2018. Describing lesson study designed for improvement of mathematics teachers' knowledge of student thinking. *International Journal for Mathematics Teaching and Learning*, 19(2):176–204. https://doi.org/10.29333/iejme/8461.

Chen, C.H. & Yang, Y. 2019. Revisiting the effects of project based learning on students' academicachievement: A meta-analysis investigating moderators. *Educational Research Review*, 26(1):71–81. https://10.1016/j.edurev.2018.11.001.

Durden, G. 2018. Improving teacher learning: Variation in conceptions of learning study. *International Journal for Lesson and Learning Studies*, 7(1):50–61. https://10.1108/ijlls-09-2017-0041.

Fadlina, F., Artika, W., Khairil, K., Nurmaliah, C., & Abdullah, A. 2021. Penerapan model discovery learning berbasis STEM pada materi sistem gerak untuk meningkatkan keterampilan berpikir kritis. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 9(1):99-107. https://doi.org/10.24815/jpsi.v9i1.18591.

Farida, I., Hadiansah, Mahmud, & Munandar, A. 2017. Project based learning design for internalization of environmental literacy with islamic value. *Journal Pendidikan IPA Indonesia*, 6(2):277–284. https://doi.org/10.15294/jpii.v6i2.9452.

Fatimah, S. & Kartika, C.S. 2018. Project-Based Science Learning And Pre-Service Teachers' Science Literacy Skill And Creative Thinking. *Jurnal Cakrawala*, 7(2):100–115. https://10.21831/cp.v38i3.17229.

Fitriyani, L.O., Koderi, & Anggraini, W. 2018. Project based learning : pengaruhnya terhadap keterampilan proses sains peserta didik di tanggamus. *Indonesian Journal of Science and Mathematics Education*, 1(3):243-253. https://doi.org/10.24042/ijsme.v1i3.3599.

Gunawan, Sahidu, H., Harjono, A., & Suranti, N. 2017. The effect of project based learning with virtual media assistance on student's creativity in physics. *Jurnal Cakrawala Pendidikan*, 36(2):167–179. https://10.21831/cp.v36i2.13514.

Hardjo, F.A. & Permanasari, A. 2018. Pengembangan bahan ajar berbasis proyek pada materi energi untuk meningkatkan literasi sains siswa. *Journal of Science Education and Practice*, 2(1):27–43. https://10.33751/jsep.v2i1.1701.

Harlen, W. 2004. The teaching of science. David Fulton Publisher, London.

Husamah, H. 2015. Thinking skills for environmental sustainability perspective of new students of biology education partment through blended project based learning model. *Jurnal Pendidikan IPA Indonesia*, 4(2):110–119. https://doi.org/10.15294/jpii.v4i2.3878.

Insyasiska, D., Siti, Z., & Herawati, S. 2015. Pen uh project based learning terhadap motivasi belajar. *Jurnal Pendidikan Biologi*, 7(11):9–21. http://dx.doi.org/10.17977/um052v7i1p9-21.

Katz-Buonincontro, J. 2018. Policy, curricular, and programmatic developments in arts-sed science, technology, engineering, and mathematics education Introduction. STEAM Focus. *Arts Education Policy Review*, 119(2):73–86. https://doi.org/10.1080/10632913.2017.1407979.

Kilinc, E., Tarman, B. & Aydin, H. 2018. Examining turkish cial studies teachers' beliefs about barriers to technology integrat . *TechTrends: Linking Research and Practice to Improve Learning*, 6(2):221–233. https://doi.org/10.1007/s11528-018-0280-y.

Kosasih. 2014. Strategi Belajar dan Pembelajaran. Yrama Widya, Jakarta.

Mariale, M., Hardiman, & Ranjini, M. 2019. From ST M to STEAM : How Can Educator Meet The Challenger ?. *Science Education*, 5(2):1-10 https://doi.org/10.1007/978-3-030-25101-7_1.

Mbhiza, H. 2021. Shifting paradigms: rethinking education during and post-covid-19 pandemic. *Research in Social Sciences and Technology*, 6(2):279-289. https://10.46303/ressat.2021.31.

Movahedzadeh F., Patwell, R., Rieker, J.E., & Gonzalez, T. 2012. Project based learning to promote effective learning in biotechnology courses. *Education Research International*, 5(2):1–8. https://doi.org/10.1155/2012/536024.

Mullis, M., Martin, O., Pierre, F., & Dana, L. 2019. TIMSS 2019 International Results in Mathematics and Science, Publishers: TIMSS & PIRLS International Study Center, Boston

Murniyati, W. 2018. Perbedaan penerapan model project bsed learning (PJBL) dan problem based learning (PBL) ditinjau dari pencapaian keterampilan proses siswa. *Pancasakti Science Education Journal*, 3(1):25–33. https://10.24905/psej.v3i1.914.

Muskania, R.T. & Wilujeng, I. 2017. Pengembangan perangkat pembelajaran project based learning untuk membekali foundational knowledge dan meningkatkan scientific literacy. *Jurnal Cakrawala Pendidikan*, 36(1):34–43. https://10.21831/cp.v36i1.8830.

Nita, R. & Irwandi, I. 2021. Improving Students' Creative Thinking Ability through Project Based Learning (PjBL) Models. *Bioedusains: Jurnal Pendidikan Biologi dan Sains*, 4(2):231–238. https://doi.org/10.31539/bioedusains.v4i2.2503.

Nunaki, J.H., Damopolii, I., & Kandowangko, N. 2019. The effectiveness of inquiry-based learning to train the students' metacognitive skills based on gender differences. *International Journal of Instruction*, 12(2):505–516. https://doi.org/10.29333/iji.2019.12232a.

Nuraini & Waluyo, E. 2021. Development of instructional design project-based learning model integrated science process skills to improve science literacy. *Jurnal Pendidikan Sains*, 9(1):104–112. https://doi.org/10.26714/jps.9.1.2021.104-112.

OECD. 2016. PISA 2015 Assessment and *analytical framework : science, reading, mathematic and financial literacy*. OEDC Publishing, Paris. http://www.oecd-ilibrary.org/education/pisa-2015

Öztürk, I. 2020. Educational leadership and management: Developing insights and skills. *Educational Policy and Management*, 2(2):133–137. https://10.46303/repam.2020.8.

Pfeiffer, H.D, Ignatov, D.I., & Poelmans, J. 2013. Conceptual Structures for STEM Research and Education. *20th International Conference on Conceptual Structures, Proceedings*. https://link.springer.com/book/10.1007/978-3-642-35786-2.

Putri, M., Afrizal, & Usmeldi. 2022. Metaanalisis efek pendekatan STEM pada literasi sains dan pemahaman konsep peserta didik di setiap satuan pendidikan. *JIPI (Jurnal IPA dan Pembelajaran IPA)*, 6(1):86-98. https://doi.org/10.24815/jipi.v6i1.23897.

Ramesh, K. & Duncan, M. 2020. Project based learning in an engineering design course developing mechanical engineering graduates for the world of work. *Science Direct* 9(1):565–570. https://10.1016/j.procir.2020.02.215.

Ririn, P., Wiyanarti, E., & Kurniawati, Y. 2021. The analysis of students' creative thinking skills through the implementation of the project based learning model in social studies learning. *International Journal Pedagogy of Social Studie*, 6(2):9–18. https://doi.org/10.17509/ijposs.v6i2.28622.

Rohana, R.S. & Wati. D. 2017. Project based learning untuk meningkatkan berpikir kreatif siswa SD pada materi makanan dan kesehatan. *Jurnal Penelitian Pendidikan*, 16(3):235–243. https://doi.org/10.17509/jpp.v16i3.4817.

Sasson, I. & Malkinson, N. 2018. Fostering the skills of critical thinking and question-posing in a project-based learning environment. *Thinking Skills and Creativity*, 29(1):203–212. https://10.1016/j.tsc.2018.08.001.

Shamdas, G., Bialangi, M., Buntu, A., & Ihwan. 2023. Application of problem based learning model stem-based on biology lessons for high school students communication skills. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 11(2):345-359. https://doi.org/10.24815/jpsi.v11i2.28541.

Siwa, I.B., Muderawan, I.W., & Tika, I. 2013. Pengaruh pembelajaran berbasis proyek dalam pembelajaran kimia terhadap keterampilan proses sains ditinjau dari gaya kognitif siswa. *Journal Program Pascasarjana*, 3(1):1–13. https://ejournal-pasca.undiksha.ac.id/index.php/jurnal_ipa/article/view/794/579.

Sumarni, W. & Kadarwati, S. 2020. Ethno-stem project-based learning: Its impact to critical and creative thinking skills. *Jurnal Pendidikan IPA Indonesia*, 9(1):11–21. https//:10.15294/jpii.v9i1.21754.

Tiantong. 2013. The project based learning model on student's multiple intelligency. *Journal of Humanities and Social Science*, 3(7):352–365. https://www.ijhssnet.com/journal/index/1740.

Tsakeni, M. 2021. Transition to online learning by a teacher education program with limited 4IR affordances. *Research in Social Sciences and Technology*, 6(2):129–147. https://doi.org/10.46303/ressat.2021.15.

Ulger, K. 2018. The effect of problem-based learning on the creative thinking and critical thinking disposition of students in visual arts education. *Interdisciplinary Journal of Problem-Based Learning*, 12(1):1–21. https://doi.org/10.7771/1541-5015.1649.

Wijanarko, A.G. & Supardi, K. 2017. Keefektifan model project based learning terbimbing untuk meningkatkan keterampilan proses sains dan hasil belajar IPA. *Journal of Primary Education*, 6(2):120–125. https://10.15294/JPE.V6I2.17561.

Wolthuis, F., Veen, K.V., Vries, S.D., & Hubers, M.D. 2020. Between lethal and local adaptation: Lesson study as an organizational routine. *International Journal of Educational Research*, 100(1):1–12. https://doi.org/10.1016/j.ijer.2020.101534.

Yamin, Y., Permanasari, A., Redjeki, S., & Sopandi. 2020. Implementing project-based learning to enhance creative thinking skills on water pollution topic. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 6(2):225–232. https://doi.org/10.22219/jpbi.v6i2.12202.

Yanti, M.N., Sudia, M., & Arapu, L. 2019. Pengaruh model pembelajaran mind mapping terhadap kemampuan berpikir kreatif matematis peserta didik kelas VIII SMP Negeri 8 Konawe Selatan. *Jurnal Penelitian Pendidikan Matematika*, 7(3):71–84. http://dx.doi.org/10.36709/jppm.v7i3.11375.

Development of Project Based Learning With STEAM Approach Model in Improving the Science Literacy Ability of High School Students

ORIGINALITY REPORT

13%
SIMILARITY INDEX

PRIMARY SOURCES

1	repository.pedagogica.edu.co Internet	34 words — < 1%
2	ejournal.uin-malang.ac.id Internet	32 words — < 1%
3	ojs.uho.ac.id Internet	32 words — < 1%
4	seminar.ustjogja.ac.id Internet	32 words — < 1%
5	www.ejournal.unmuha.ac.id Internet	32 words — < 1%
6	es.scribd.com Internet	31 words — < 1%
7	ejournal.unhasy.ac.id Internet	30 words — < 1%
8	sciendo.com Internet	29 words — < 1%
9	www.atbuftejoste.net Internet	29 words — < 1%

10	prosiding.iahntp.ac.id Internet	28 words — < 1%
11	uvm.dk Internet	28 words — < 1%
12	www.jssidoi.org Internet	28 words — < 1%
13	www.ijmra.us Internet	27 words — < 1%
14	avesis.deu.edu.tr Internet	26 words — < 1%
15	search.shamaa.org Internet	26 words — < 1%
16	www.ijere.com Internet	26 words — < 1%
17	e-journal.ivet.ac.id Internet	25 words — < 1%
18	j-innovative.org Internet	25 words — < 1%
19	ejournal.ust.ac.id Internet	24 words — < 1%
20	hj.diva-portal.org Internet	24 words — < 1%
21	openjournal.unpam.ac.id Internet	24 words — < 1%

22	simpeg.unja.ac.id Internet	23 words — < 1%
23	journalstkippgrisitubondo.ac.id Internet	22 words — < 1%
24	jurnal.um-palembang.ac.id Internet	22 words — < 1%
25	pubs.ufs.ac.za Internet	20 words — < 1%
26	journal-center.litpam.com Internet	18 words — < 1%
27	ejournal.unsri.ac.id Internet	17 words — < 1%
28	so10.tci-thaijo.org Internet	17 words — < 1%
29	academic-accelerator.com Internet	16 words — < 1%
30	jurnal.unka.ac.id Internet	15 words — < 1%
31	ijesty.org Internet	14 words — < 1%
32	jdisabilstud.org Internet	14 words — < 1%
33	journal.iaincurup.ac.id Internet	14 words — < 1%
	library.hbcse.tifr.res.in	

34	Internet	11 words — < 1%
35	worlddatabaseofhappiness.eur.nl Internet	11 words — < 1%
36	repositori.usu.ac.id Internet	10 words — < 1%
37	www.journals.uchicago.edu Internet	10 words — < 1%
38	proceedings.ums.ac.id Internet	9 words — < 1%
39	www.gjournals.org Internet	9 words — < 1%
40	data.editlib.org Internet	8 words — < 1%
41	file.scirp.org Internet	8 words — < 1%
42	jman-upiyptk.org Internet	8 words — < 1%
43	journal.amikveteran.ac.id Internet	8 words — < 1%
44	journals.uran.ua Internet	8 words — < 1%
45	repository.iainkediri.ac.id Internet	8 words — < 1%
46	tused.org	

Internet

8 words — < 1%

47 www.ieeca.org
Internet

8 words — < 1%

48 www.moe.gov.ae
Internet

8 words — < 1%

EXCLUDE QUOTES	OFF	EXCLUDE SOURCES	OFF
EXCLUDE BIBLIOGRAPHY	OFF	EXCLUDE MATCHES	OFF