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Development of Project Based Learning with STEAM Approach Model Integrated Science Literacy in Improving Student Learning Outcomes

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Abstract: In preparing students who have the skills to respond to the challenges of the times and face the demands of 21st century learning, teachers need to develop students' science literacy and design learning in accordance with the characteristics and learning outcomes of students. The purpose of this study is to develop learning with PjBL with STEAM approach model integrated science literacy. Research is carried out through the stages of needs analysis, product design, product development, product implementation and evaluation. The research object was grade X students of SMAN 2 Selong totaling 35 students with 25 female students and 10 male students. Research instruments include needs analysis questionnaire guidelines, product validation guidelines, product practicality guidelines, teacher response guidelines and learning outcomes tests on ecosystem materials. The collected data was analyzed using descriptive analysis. Data analysis showed that the product developed was classified as valid with an average score of validation by 3 experts, namely linguists, material experts and learning technology experts respectively 83.91, 84.64 and 83.73. The product is also classified as practical with an average practicality score of 82.63. The product is classified as effective with an effectiveness percentage of 88.57%. The developed product has high potential in improving student learning outcomes on ecosystem materials with an N-Gain of 0.76.

Keywords: Project Based learning; Science literacy; STEAM

Introduction

The rapid development of science and technology in the 21st century is very influential in public life. Currently, the world community is entering a new era, an era of accelerating changes in various aspects or fields including education. The demands of 21st century learning require every teacher to make changes in managing and implementing learning. Facing the challenges of the 21st century and the implementation of an independent curriculum, students are required to have scientific literacy skills. In building a young generation that has a strong scientific attitude, adequate scientific literacy skills are needed so that they are able to communicate scientific results to the public. The PISA study shows that the science literacy ability of Indonesian students is still low when compared to the average Asian and International scores (Toharudin, 2011). Indonesia's ranking in PISA is ranked 57 out of 65 with a score of 383 in 2009. Ranked 64th out of a total of 65 countries with a current score of 382 in 2012 and ranked 64th out of 72 participating countries with a score of 403 in 2015 (OECD, 2015). This shows that the science literacy ability of Indonesian students is still far below international and even Asian standards. One of the factors of students' low science literacy ability is that the learning process carried out by teachers has not provided opportunities for students to be actively involved and develop reasoning skills. The results of the 2015 PISA study show that in general formal education in Indonesia still emphasizes low-level thinking aspects and has not provided opportunities for students to use higher-order thinking skills in dealing with various learning problems and solving real problems in everyday life (Yanti, 2019).

Teachers need to develop learning strategies and science literacy skills to face the demands of 21st century learning according to learning characteristics and outcomes so that learning focuses on real experiences. Literacy skills are fundamental things that must be

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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 that students have in understanding, communicating and applying science skills in solving real problems. Science literacy can be viewed as the scientific skills and knowledge that students possess in identifying and acquiring new knowledge, explaining scientific facts and drawing conclusions. With regard to science literacy, students are expected to be able to understand the characteristics of science, be aware of how science and technology shape the environment and culture, as well as the willingness to care and be directly involved in solving issues related to science (OECD, 2016). A student is said to have scientific literacy if he has the ability to solve real problems using various concepts of knowledge obtained from the learning process, able to recognize technological developments and the impact they cause, able to use technology to solve problems so as to be able to make the right decisions based on values and culture in society (Toharudin, 2011). Meanwhile Harlen (2004), mentions science literacy contains elements (1) concept i.e. understanding the scientific aspects of the real world so as to be able to relate what is known with new experiences gained; (2) process, namely the ability that students have infinding, interpreting and using real experience to explore knowledge and understanding; (3) attitude or disposition, namely the belief in students to be directly involved in investigations to explore knowledge; (4) understand the nature of scientific knowledge. With their science literacy, students have concern in participating in solving global problems in facing the demands of scientific development, namely becoming innovative, competitive, strong and collaborative students.

The learning atmosphere in the classroom is strongly influenced by the management and learning strategies carried out by the teacher (Kilinc, 2018). In learning, weneed to design fun learning so that students are actively involved and excited about learning (Mbhiza, 2021; Öztürk, 2020; Tsakeni, 2021). Learning with PjBL allows teachers to provide opportunities for students to complete projects given by teachers (Wena, 2014). Through PjBL, teachers provide students with opportunities to explore knowledge and conduct investigations on important topics that must be resolved (Grant, & Michael, 2003). PjBL is a learning process where students can collaborate and explore various knowledge needed and teachers facilitate students in exploring knowledge and conducting investigations (Julie, 2003). In learning with PjBL, students are required to design and develop various strategies obtained through the investigation process as solutions to solve real-world problems (Sababha, 2016). PjBL is a strategy in which students engage in complex assignments to acquire concepts, knowledge and skills that will be used in solving problems (Movahedzadeh, 2012). PjBL facilitates each student to be actively involved in discussions by using the established syntax to implement and develop projects (Baker, 2004). PjBL is a series of activities based on complex and real problems that involve students in preparing schedules and project design and problem solving, providing opportunities for students to work on solving problems independently and in groups (Fitriyani, 2018). PjBL is one of the appropriate and effective learning in developing students' science literacy skills (Tasiwan, 2015). Through PjBL with a series of systematic learning, studentswill have better learning outcomes compared to students who use conventional learning (Çakici, 2013). Through PjBL, teachers have the opportunity to motivate and facilitate students, develop appropriate project schedules, design projects and solve real problems faced with the selected project design. Student-centered learning such as PjBL can make students more critical and creative, collaborative and interactive in conducting research (Farida, 2017). Learning with PjBL emphasizes the relationship between concepts acquired through projects and real experiences so that students can relate concepts gained from experiences they already have before with new knowledge . Characteristics of PjBL according to Kosasih (2014): (1) the existence of activities where a product is produced; (2) there is a relationship between the concepts in the material studied with real problems faced by students; (3) the learning process can be carried out inside and outside the classroom; (4) students design products according to the material studied; (5) holistic assessment, which is carried out starting planning activities, processes until it produces poyek. Meanwhile Tiantong (2013) mentioned that, PjBL is very effective for teachers to improve student learning outcomes. Through PjBL, students can gain knowledge through the process of exploration, discussion in groups, and students are more responsible in learning and producing products.

In learning, a teacher's challenge is to design learning so that it creates a hug for students to relate their knowledge and skills to real experience. These opportunities will not be created if skills, knowledge and experience are separated in a learning. Pfeiffer (2013) states that in learning with the STEAM approach, between skills, knowledge and experience are used simultaneously by learners. Learning with the STEAM approach uses various disciplines, using thinking skills and creativity in solving problems faced by students. STEAM is an integration between the fields of science, technology, engineering, art and mathematics in learning certain materials (Buonincontro, 2018). The STEAM approach is a multidisciplinary learning approach where teachers teach science, technology, engineering and mathematics in a certain learning container and each disciplinary material is no longer separate but is learned and treated as a dynamic whole material (Mariale, 2019). STEAM products not only contain cognitive aspects, but will contain several other aspects, namely affective and spicomotor that can be developed in general. 21st century learning demands the ability of various fields and STEAM learning is a preparation to face it (Wijaya, 2015).

This research is urgent to be carried out as a solution in developing students' science literacy skills as one of the abilities that must be developed in the implementation of an independent curriculum in schools. From this research, it is expected to increase teachers' knowledge about learning strategies that need to be done in today's 21st century learning.

Method

This research uses the type of Borg & Gall model development research with the development sequence including: (1) needs analysis; (2) product design; (3) product development; (4) product implementation and evaluation (Borg, 2007). In the needs analysis conducted 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. In this study, the research project was grade X students of SMAN 2 Selong, East Lombok totaling 35 students with 10 male students and 25 female students 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: (a) indicators of goal formulation; (b) content indicators; (c) indicators of the language used; and (d) indicators of time. Meanwhile, the guidelines for the practicality of implementing the developed product contain indicators of (a) students' feelings of pleasure in the learning process; (b) assessment of the novelty of the product developed in learning; (c) 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) determining the problem; 2) explore the problem; 3) plan solutions in solving problems according to the completion strategy that has been selected and prepared; 4) implement plans; 5) examine solutions; 6) evaluate (Winarti, 2017).

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 with an integrated STEAM project based learning approach of science literacy is measured based on product validity, product practicality and product effectiveness. Product validation indicators are shown 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	The material is clearly described in the developed learning design

The product developed in the form of a learning design with an integrated STEAM Project based learning approach in science literacy 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 are learning with a project-based STEAM-based approach to integrated science literacy using criteria such as Table 2 (Waluyo, 2020).

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 that has been developed is measured 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 integrated STEAM project based learning approach in science literacy, 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 the form of learning designs with an integrated project-based learning-based STEAM approach, science literacy is carried out by analyzing the scores of students' higher-order thinking 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 posttes scores and pretests of student learning outcomes on ecosystem materials.

Result and Discussion

Needs Analysis

Before conducting research as a basis for developing products, researchers conducted a needs analysis by conducting interviews with biology teachers at the Secondary School related to the application of the learning strategies used and providing questionnaires to students about students' feelings after participating in biology learning. Interviews with 3 biology teachers can be concluded that (1) Teachers conduct learning with conventional and monotonous strategies, 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, so that teachers have not been able to utilize technology adequately in learning; (4) The support of schools in facilitating teachers in increasing knowledge and insight into innovative learning is needed so that teachers can make changes in learning.

While the results of observations on 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) 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, it 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

PjBL learning design with an integrated STEAM approach to science literacy is developed with syntax, namely: 1) starting with providing real and challenging problems, students are asked to analyze using their science literacy skills; 2) students do project planning, selection of strategies in solving problems with science literacy skills; 3) compile a project completion schedule; 4) the teacher facilitates and observes the completion of the project; 5) assesses the project produced by the student; 6) evaluates the implementation of the project completion. This step is in line with the research Muskania & Wilujeng (2017) that PjBL starts by providing real problems related to the results of student projects. Furthermore, in groups, students design and complete projects. Teachers facilitate and guide students during student designing projects and motivate students to explore completions from various literatures. In designing and completing projects, the important thing that students do is to collaborate in groups to complete the project. In learning with PjBL, one of the characteristics is collaboration where students can help each other, exchange ideas and practice communication. Meanwhile, Astawa (2017) stated that in PjBL, students are trained to be active and creative students, collaborating in teams to complete project tasks.

Product Development and Evaluation Stage

At this stage, validation of the product draft that has been developed is carried out. Validation is carried out by learning material experts, learning technology experts and learning practitioners to obtain input and suggestions related to the initial product and then product revisions are carried out based on expert advice and input. The results of product validation by 3 experts are presented as 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
Selection of 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

From Table 4, an average score of 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 in the form of a learning design with an integrated project-based learning-based STEAM approach in science literacy 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.

Practicality

At this stage, a practicality test of the product was developed using practicality guidelines by 3 experts and and teacher responses to the implementation of learning on ecosystem material using previously established practicality criteria. The practicality test by experts is presented as in 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

Referring to the results of product practicality in table 5 above, it shows that the product is in the form of a PjBL learning design with an integrated STEAM approach, practical science literacy. Meanwhile, teacher responses related to the implementation of learning using developed products are 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 products developed on ecosystem materials for 3 meeting showed that the teacher's response to the implementation of the lesson design was included in the practical category at both 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 learning learning with an integrated project-based learning-based STEAM approach to science literacy 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.

Product Effectiveness

At this stage, the effectiveness of the product that has been developed is tested by calculating N-Gain based on pretest and posttes scores on ecosystem material. 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 are 91.43% 91.43% or 32 students scored ≥ 75 and there are 8.57% or 3 students who get a score of < 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 with PjBL with STEAM approach model integrated science literacy of at least 85%. Based on this, the product in the form of learning with PjBL with STEAM approach model integrated science literacy is effectively used.

Furthermore, to test whether the product developed has the potential to improve students' biology learning outcomes on ecosystem material is determined based on the N-Gain value, namely the difference in postes and pretest scores on ecosystem materials after going through trials of learning learning with PjBL with STEAM approach model integrated science literacy. 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 learning with PjBL with STEAM approach model integrated science literacy has high potential in improving the learning outcomes of the biology of the ecosystem material of High School students. The results of this study are in line with research Fatimah (2018) states that PjBL allows teachers to provide opportunities for students to use their thinking skills and explore various solutions and establish appropriate solutions in completing projects and in a significant way can improve students' science literacy skills.

Learning with PjBL with STEAM approach model integrated science literacy begins with the provision of challenging questions that are associated with real everyday problems and students are asked to conduct an analysis of the problem. Furthermore, with their science literacy skills, students design projects, discuss in groups and conduct experiments, then each group presents the results of the project. The series of learning carried out above is believed to be able to create student curiosity and improve students' science literacy skills. Learning with PjBL with STEAM approach model integrated science literacy needed in order to provide answers to essential and challenging questions given by teachers and provide decision solutions to these questions (Insyasiska, 2015). 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' ideas and The learning with PjBL with STEAM approach model integrated science literacy also has a high potential effect in improving learning outcomes on ecosystem materials as indicated by an N-Gain score of 0.76 in solving the problems encountered in various ways that are found. In learning with PjBL with STEAM approach model integrated science literacy, students are provided with issues related to ecosystems. The projects produced by students are solutions to the ecosystem problems faced. Students are divided into six groups where each group is facilitated and guided to find various strategies and choose the right strategy to solve a given ecosystem problem. Learning with PjBL with STEAM approach model is believed to be able to create curiosity and increase students' science literacy (Nuraini, & Waluyo, 2021). Nita (2021) states that the application of PjBL can improve student learning outcomes and science literacy. Through PjBL with the integration of science literacy, students can identify the problems faced, explore solutions from various sources and use their abilities and knowledge to solve the problems faced (Yamin, 2020). PjBL with the integration of science has also facilitated students in developing themselves by exploring various knowledge to get solutions to everyday problems (Husamah, 2015). Sasson et al. (2018) in his research stated that PjBL is an innovative learning that is student-centered and is believed to be able to develop students' science literacy skills. By applying learning with PjBL with STEAM approach model integrated science literacy, students will be facilitated in developing their science literacy skills in dealing with contextual problems (Chen, & Yang, 2019). By applying learning with PjBL with STEAM approach model integrated science literacy, students are given the opportunity to discover ideas and ideas by conducting exploration from various sources through completed projects (Ririn, 2021). By implementation learning with PjBL with STEAM approach model integrated science literacy, learning is carried out through direct practice, namely through projects that must be completed according to the material learned. 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 (2016) showed that learning with PjBL can improve students' scientific literacy skills.

Integrated PjBL science literacy encourages students are actively involved in learning, collaborating in groups to find various solutions and knowledge through drafted projects. By learning with PjBL with STEAM approach model integrated science literacy, students can explore knowledge through real experiences and conduct experiments both in groups and between groups that can improve their science literacy skills. By learning with PjBL integrated science literacy model, student learning outcomes are better than the learning outcomes of students who learn conventionally (Siwa, 2013). Integrated PjBL science literacy is useful in designing effective learning so that it has the potential to meet its demands. Integrated science literacy PjBL assists students in (1) develop skills and knowledge acquired through the challenging task at hand; (2) explore knowledge from various sources through the process of inquiry; and (3) explore and develop knowledge through real experience and take place in collaborative work in groups. Wijanarko (2017) states 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. By learning with PjBL with STEAM approach model integrated science literacy starting with real experience, it allows students to practice exploring solutions, collecting evidence, and then solving real problems based on the ideas obtained so that they have the potential to improve students' science literacy skills.

PjBL learning integrates science literacy, allowing students to be given the opportunity to develop science literacy skills through the process of student discussion in groups. 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). Literacy integrated PjBL learning, encouraging students to reflect on what they have done so that they are disadvantages and advantages possessed (Murniyati, 2018). 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 product in the form of learning with PjBL with STEAM approach model integrated science literacy was developed based on needs analysis and developed using the Borg & Gall development design. The learning PjBL with STEAM approach model integrated science literacy developed, based on validity, practicality, and effectiveness tests has met the criteria that determined. The validation results by 3 experts, each expert in terms of language, experts in the field of material, and experts in the field of learning technology show that the product in the category of valid and worthy of continuation in the field trial stage. Based on the practicality assessment carried out by ahi, products in the form of learning with PjBL with STEAM approach model integrated science literacy also meet the practicality category. Similarly, after conducting trials in class for 3 meetings, the results of observations showed that the implementation score of learning application at meetings 1, 2, and 3 was included in the practical category. Meanwhile, the product in the form of a learning with PjBL with STEAM approach model integrated science literacy developed is an effective category indicated by the percentage of students who obtain a learning outcome score on the ≥ 75 ecosystem material of 88.57%, higher than the set effectiveness indicator of 85%. The learning with PjBL with STEAM approach model integrated science literacy also has a high potential effect in improving students' science literacy skills as indicated by an N-Gain score of 0.76. The implications of this research, in today's 21st century learning, teachers are not only spectators of technological developments but teachers are also expected to be actors who are able to use technology in learning. In learning, teachers are expected to be able to use various student-centered learning strategies and continue to develop students' science literacy skills. Teachers need to make changes by continuing to develop pedagodic competencies and designing and implementing student-centered learning, specially learning with PjBL with STEAM approach model integrated science literacy.

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