

# Project Based Learning Modules to Improve Scientific Literacy and Problem-Solving Skill

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## ABSTRAK

Penelitian ini dilaksanakan karena kurangnya penggunaan bahan ajar yang bervariasi, sehingga menyebabkan kurangnya kemampuan literasi sains dan pemecahan masalah siswa dalam pembelajaran. Penelitian ini bertujuan untuk menganalisis rancang bangun, validitas, kepraktisan, dan efektifitas modul berbasis project based learning untuk meningkatkan literasi sains dan pemecahan masalah pada materi perkembangan tumbuhan. Penelitian ini merupakan penelitian pengembangan dengan menggunakan model 4D (Four D Model). Subjek penelitian ini adalah ahli materi, ahli media, pendidik, dan siswa kelas III SD. Metode pengumpulan data yang digunakan yaitu wawancara, dokumentasi, dan penyebaran angket. Jenis instrument yang digunakan berupa kusioner tertutup. Teknik pengumpulan data yang digunakan yaitu teknik analisis kualitatif dan teknik analisis kuantitatif. Hasil penelitian ini menunjukkan hasil perhitungan uji efektivitas terhadap kemampuan literasi sains secara keseluruhan menggunakan N-gain dengan diperoleh nilai g sebesar = 0,74 dengan tingkat efektivitas tinggi. Hasil uji efektivitas terhadap kemampuan pemecahan masalah secara keseluruhan menggunakan N-gain dengan diperoleh nilai g sebesar = 0,71 dengan tingkat efektivitas tinggi. Maka, modul berbasis project based learning yang dikembangkan dengan model 4D valid, praktis, dan efektif untuk digunakan sebagai bahan ajar. Implikasi dari penelitian ini yaitu modul berbasis project based learning yang dikembangkan valid, layak, dan efektif untuk digunakan dalam pembelajaran.

## ABSTRACT

This research was carried out due to the lack of use of varied teaching materials, causing a lack of scientific literacy and problem-solving skills of students in learning. This study aims to analyze the design, validity, practicality, and effectiveness of project-based learning-based modules to improve scientific literacy and problem solving in plant development materials. This research is development research using the 4D model (Four D Model). The subjects of this study were material experts, media experts, educators, and third grade elementary school students. Data collection methods used are interviews, documentation, and questionnaires. The type of instrument used is a closed questionnaire. Data collection techniques used are qualitative analysis techniques and quantitative analysis techniques. The results of this study indicate the results of the calculation of the effectiveness test on the overall scientific literacy ability using N-gain with a g value of = 0.74 with a high level of effectiveness. The results of the effectiveness test on overall problem-solving ability using N-gain obtained a g value of = 0.71 with a high level of effectiveness. Thus, the project-based learning module developed with the 4D model is valid, practical, and effective to be used as teaching materials. The implication of this research is that the project-based learning module developed is valid, feasible, and effective for use in learning.

## 1. INTRODUCTION

Learning is an effort made to create learning conditions that are able to maximize students in the implementation of the learning process. The learning process must provide opportunities and understanding to apply knowledge that has been received to students. Students should be able to understand learning and use it in everyday life, not only mastering a collection of knowledge in the form of facts, concepts, or principles, but also a principle of discovery so as to create learning conditions that are

able to maximize students in the learning process (Khoirudin, 2019; Suryani et al., 2020). Based on this, the learning process should provide in-depth understanding and indeed understand what is meant. It is necessary to provide an initial understanding through scientific literacy and apply the knowledge gained through problem solving exercises in order to form problem solving abilities in students.

Scientific literacy is the ability of each individual to understand the concepts and processes of science and utilize science to solve problems in everyday life involving cultural diversity, explain scientific phenomena based on technology and draw conclusions from information obtained based on the sources and methods used (Fuadi et al., 2020; Sutrisna, 2021). Scientific literacy is very important for students because nowadays students are required to develop the competence to think, act, and live in a world which is a 21st century skill (Widayati et al., 2020; Yusnia, 2019). 21st century skills are required to have theoretical knowledge and mastery scientific ideas. Processes are needed to participate in the digital environment (Fortuna & Fitria, 2021; R. Rahayu & Ismawati, 2019; Salmia & Yusri, 2021). Students are expected to be able to sort and find answers that come from their curiosity and are related to life. Students are able to describe and guess phenomena. Moreover, they are able to carry out social discussions by involving conceptual knowledge. Then students are able to identify scientific and technological problems. Students are able to test scientific information based on sources and methods. And finally, students are able to draw conclusions and arguments and evaluate them (Aditya & Indana, 2022; Sakti et al., 2021). Thus, by mastering scientific literacy skills, students can examine information about contextual issues and apply it in everyday life to overcome personal and public problems.

The development of students' scientific literacy will certainly affect students' problem solving abilities (Habibati et al., 2019; Samsu et al., 2020). Problem solving ability is an individual's ability to use his thinking process to solve a problem through collecting facts, analyzing information, compiling various alternative solutions, and choosing the most effective problem solving from the problems at hand, so that it is expected to be able to be applied in everyday life (Rahma et al., 2020; Suryani et al., 2020). Problem solving ability refers to efforts in solving problems and is developed through learning by using references (Permana et al., 2021; Putri et al., 2019). Through problem solving students have meaningful basic abilities in thinking, and are able to create settlement strategies to deal with further problems. With this ability, students are expected to have the ability to manage all existing information and solve existing problems. However, data obtained from the 2018 PISA survey results show that the average scientific literacy for Indonesia is still below the low category compared to other countries. Where Indonesia is still ranked 73 out of 79 countries with a score of 396 in the field of scientific literacy (Aiman, 2020; Lubis et al., 2021). This indicates that Indonesia is still low in scientific literacy and problem solving skills. This is due to learning activities that have not been oriented to the development of scientific literacy, the selection of methods and teaching models by teachers is monotonous, and in learning the teacher never orients students to a daily problem that is close to students' lives and then does not pay attention to students' problem solving abilities (Suryani et al., 2020; Sutrisna, 2021). Learning activities that are too monotonous make students bored and affect student learning motivation.

This is evidenced by the results of observations and interviews conducted at SDN 1 Batur after the initial measurements of scientific literacy and problem solving were carried out with the results of students' problem solving abilities. The results from 40 students found that the average problem-solving ability of each indicator was still lacking. After being put into the category of measuring problem solving abilities, it is known that most of students are in the low category. After being given several questions in accordance with the scientific literacy indicators to 40 students, the results showed that many students' scientific literacy skills were still in the poor category. This is due to several things, including some of the learning materials delivered during school hours are only limited to basic understanding, not yet in the application of the material, so there is still a need for teaching materials that provide opportunities for students to apply their understanding. Students have not been able to independently solve the problems faced which make students have to receive instructions first. Very few teachers develop their own modules. This happens because ready-to-use teaching materials have been provided so that teachers are not obliged to develop teaching materials. Judging from the results of tests, observations and interviews conducted, broadly speaking, the obstacles faced during learning were that students' problem-solving abilities and scientific literacy were still lacking. Students still need to get directed guidance in managing information and solving existing problems. In addition, the time available at the school is very short, which is limited to being used for the delivery of material without the opportunity to apply the material.

The solution to overcome these problems is to provide supportive teaching materials in addition to student teaching materials outside of class hours that provide opportunities to apply the knowledge provided by the teacher. One of the teaching materials that can be used as an additional learning resource apart from the theme book is a module in the form of teaching materials. A module is a printed teaching material that is systematically arranged which contains learning materials, methods, and learning

objectives that are used by students as learning resources that aim to make students able to learn independently. This module can also be studied anytime and anywhere, which plays a role in training students to learn actively and can also support the effective achievement of learning objectives (Al Azka et al., 2019; Sari et al., 2020). Learning through modules aims to enable students to learn independently so as to increase the efficiency and effectiveness of learning in schools (Ariana et al., 2020; Imran et al., 2021). The use of learning modules can make students more active and independent in learning because in the module there are instructions for use so that learning activities can be carried out without the presence of the teacher. Thus, the use of the module is expected to create quality learning.

In order for the use of the module to be more effective, its use can be collaborated with a learning model that is in accordance with the interests and circumstances of the students. One of them is by using a project based learning model. Project based learning is an innovative learning model centered on student activities in developing and improving students' skills in managing resources or materials to complete assignments and increasing student collaboration to be more active in learning, while the teacher acts as a facilitator and evaluator (Eliza et al., 2019; Mulyono & Agustin, 2020). Project based learning emphasizes complex learning and involves students directly to solve problems encountered in an activity/project that produces a product (Rezki et al., 2021; Sakti et al., 2021). With the development of a project-based learning module, it can make learning interesting and effective. So with the project-based learning module, it will be able to improve students' scientific literacy and problem solving abilities. This is because the Project Based Learning-based module will provide opportunities for students to apply the knowledge that has been known through project activities in accordance with the steps contained in project based learning which will give a positive impression to students in doing it.

The findings of previous studies which state that project-based learning modules can improve students' learning abilities (Ramadhani et al., 2021; Rezki et al., 2021). This statement is reinforced by the findings of previous research which states that the use of modules can improve students' scientific literacy and problem solving skills (Khotimah et al., 2020; Santoso et al., 2020). The difference between this study and previous research is that previous research developed modules to improve student learning outcomes, while this study developed project-based learning modules to improve students' scientific literacy and problem solving skills. Based on the explanation that has been delivered, the researchers are interested and want to develop additional teaching materials in the form of project-based learning modules. This study aims to analyze the design, validity, practicality, and effectiveness of project-based learning modules to improve scientific literacy and problem solving in plant development materials for third grade elementary school students.

## 2. METHOD

This research is a research and development research using the 4D research model (Four D Model) which consists of four stages, namely definition, design, development, and dissemination. Definition stage is process of the determination of learning requirements including conducting a needs analysis, determining learning objectives, determining the content and sequence of learning materials, and determining suitable media for use in learning. The design stage is the determination of the module writing format that is adapted to the predetermined learning objectives. The development stage is the manufacture of products in the form of learning modules. Last, the dissemination stage is promoting product development. The flow of the development stages is presented in Figure 1.

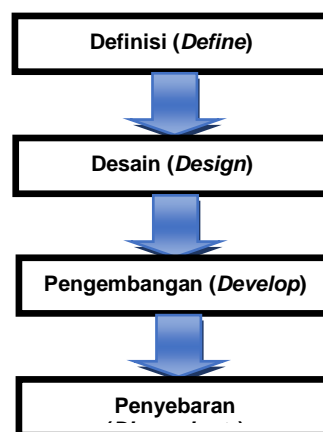


Figure 1. Product Development Procedure

The subjects of this study consisted of media validation and product testing experts. The subject of media experts in this study consist of one material and language expert and one learning media expert. Then for the product trial subjects involving third grade teachers and third grade students. Data collection methods used in this study consisted of interviews, documentation, and questionnaires. The instrument used in this study was a closed questionnaire. The data analysis technique used in this research is using qualitative analysis techniques and quantitative analysis techniques. Qualitative analysis techniques are used to analyze the results of interviews and the input provided by expert validators when conducting validation tests. While the quantitative analysis technique was used to examine the validation sheet data filled in by the material expert validator, linguist validator, and graphic expert validator, the practicality of the module, as well as the responses of educators and students. Furthermore, to test the effectiveness of the module using a one case shot study, this test takes one class directly as a sample and given treatment. Analysis of the effectiveness test data was carried out using statistical analysis using gain-test to find out there was an increase between the pretest and the posttest. Then the results of the N-Gain calculation are interpreted using the classification presented in [Table 1](#).

**Table 1. Effectiveness Criteria**

<b>G Score</b>	<b>Effectiveness Level</b>
$g > 0,7$	High Effectiveness
$0,3 < g \leq 0,7$	Medium Effectiveness
$g \leq 0,3$	Low Effectiveness

### 3. RESULT AND DISCUSSION

#### Result

The results of this development research discuss the design of modules based on Project Based Learning and the results of data analysis. The design and development of project-based learning-based modules uses a 4-D development model (Four D Model) which consists of four stages, namely the definition, design, development and deployment stages. The first stage is the definition stage. This definition stage is carried out by analyzing needs, determining learning objectives, determining the content and sequence of learning materials, as well as selecting and determining media. In the needs analysis stage, the researcher conducted interviews with the third grade homeroom teacher at SDN 1 Batur, and observed learning activities. Based on interviews and observations, it can be seen that the learning process that has taken place at the third grade is still using learning activities by delivering material in the form of distributing things in the theme book directly and there is no material application process. This makes students only guess and imagine the problems that exist during the learning process. Furthermore, the analysis of learning objectives is that students are able to determine plant reproduction. The content of the material is about plant reproduction, which includes the understanding of reproduction, as well as the plants reproduce system. Based on the results of the analysis, the researcher develops teaching materials in the form of Project Based Learning-based modules.

The second stage is the design stage. At this stage, the project-based learning module design is developed. The developed module uses A5 paper size, 1.5 spacing, 12 fonts for the material, 10 fonts for captions and image sources, 14 fonts on the sub-discussion titles, 28 fonts on the front cover of the module as the title size, the type of font used Arial, Bookman Old Style, Castellar. The module was created using Microsoft Word 2016. It consists of an initial section, a module content section, and a closing section. The third stage is the development phase. At this stage, the process of making products that have been designed in the previous stage is carried out, followed by testing the validity of the module and the level of practicality of the module. The descriptions of the modules developed for the initial part are presented in [Figure 2](#), the content sections are presented in [Figure 3](#), and closing sections are presented in [Figure 4](#).

The fourth stage is the dissemination stage. At the dissemination stage, the practicality of the module is tested to meet the reference of a quality module. But before that, the developed module was applied first in classroom learning activities. After the module is applied in learning, then practical testing is carried out by distributing questionnaires to students and teachers. The results of data analysis on the development of Project Based Learning modules will be presented three things related to the results of product evaluation, which consist of analysis of the results of the validity, practical analysis, and analysis of the effectiveness of module development based on Project Based Learning. The results of the validity of learning modules by experts are presented in [Table 2](#).

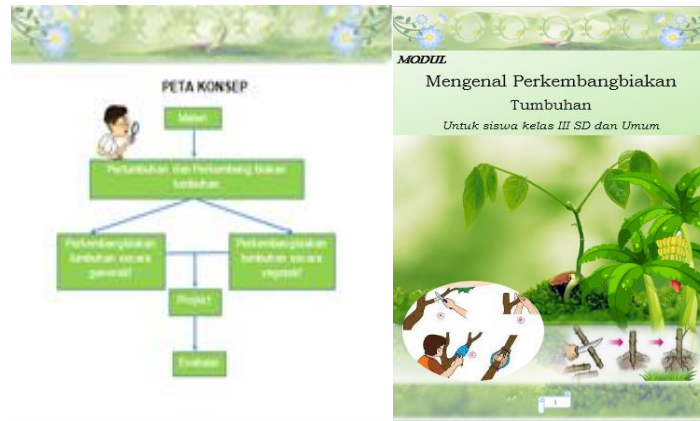


Figure 2. Initial part of Module



Figure 3. Content Sections of Module

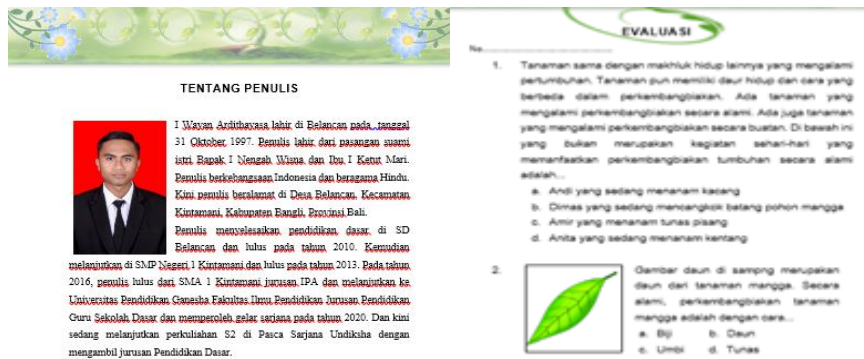


Figure 4. Closing Sections of Module

Table 2. Validity Results of Project Based Learning Module Development

Trial Subject	Material Expert		Validation Average	Criteria
	Validator 1	Validator 2		
Material Expert	91	95	93	Very valid
Media Expert	95	100	97	Very valid
Language Expert	100	75	87	Very valid

Based on Table 2, it can be seen that the results of the validity of the project-based learning module development as a whole obtained very valid criteria. After the expert test to determine the validity level of the module was obtained and declared valid, the next step was to test the module in the field to determine the practicality of the product and the responses from educators (teachers) and students regarding the developed module. The results of the practical analysis and the responses of teachers and students related to the development of project-based learning modules are presented in Table 3.

**Table 3.** Results of Practical Analysis and Product Response

N Component	Teacher (3 People)		Students (40 People)		
	Interesting	convenient	Interesting	convenient	Practical
Very good	3	3	27	26	8
Good	0	0	13	14	32
Moderate	0	0	0	0	0
Poor	0	0	0	0	0
Very Poor	0	0	0	0	0

Based on **Table 3**, overall the project-based learning modules developed are practical, interesting, and easy to use. The effectiveness of the project-based learning-based module development is obtained from the test results before learning using the developed module and the test after learning with the developed module. The effectiveness test was determined using the N-gain score. The effectiveness results obtained are divided into 2, namely the results of the effectiveness test related to scientific literacy skills in the form of overall effectiveness and individual student effectiveness. Based on the results of the calculation of the effectiveness test on the overall scientific literacy ability using N-gain with a total posttest score = 512, a total pretest score = 255, and a total maximum score = 600, the g value = 0.74 with a high level of effectiveness, so it can be concluded that overall the Project Based Learning module provides high effectiveness on students' scientific literacy skills on plant reproduction materials in third grade elementary school. Meanwhile, individual calculations using N-gain calculations from 40 respondents can be seen as many as 19 students with moderate effectiveness levels and 21 students with high effectiveness levels. Based on the results of the calculation of the effectiveness test on overall problem solving ability using N-gain with a total post-test score = 528, a total pre-test score = 354, and a total maximum score = 600 obtained a g value of = 0.71 with a high level of effectiveness, so it is concluded that the overall Project Based Learning module provides high effectiveness on students' problem solving abilities on plant reproduction materials in third grade elementary school. Meanwhile, individual calculations using N-gain calculations from 40 respondents who were tested were 20 students with moderate effectiveness levels and 20 students with high effectiveness levels. So, overall it can be concluded that the project-based learning module developed is effective for use in learning, especially on plant breeding materials for third grade elementary school students.

## Discussion

This development research produces a product in the form of a Project Based Learning module to improve scientific literacy and problem solving skills in plant breeding materials for third grade elementary school students. The developed module aims to improve scientific literacy and problem solving skills through the stages and facilities in the module. Scientific literacy is the ability to understand scientific concepts and processes and use science to solve problems in everyday life (Fuadi et al., 2020; Sutrisna, 2021). Meanwhile, problem solving ability is a skill to find solutions regarding to problems encountered so that they can be resolved which can later be applied in everyday life (Elita et al., 2019; Suryani et al., 2020). In this study, the smooth implementation of development is due to the use of the right model, namely by using the 4D development model. This 4D model is suitable for use because this model has the advantage of developing learning tools and the distribution is carried out in detail and systematically (Lesmono et al., 2021; Ulfah et al., 2021). In addition to using the right model, the effectiveness of the developed module is based on several factors.

First, the project-based learning module that was developed obtained very valid criteria. This is evidenced by the results of the validity test by experts who overall obtained very valid criteria. The validity of the results was obtained because the modules developed have attractive design, the learning materials were in accordance with the basic competencies and learning objectives, followed by the selection of the right language. The attractiveness of the design of a media consisting of clarity and linkage of indicators, basic competencies, learning objectives, presentation of material, use of language, and the suitability of the evaluation with the learning objectives. It have a positive impact on student learning outcomes, thus learning objectives will be achieved maximally (Dwiqi et al., 2020; Geni et al., 2020). This is supported by the findings of previous studies which state that the preparation of teaching materials and learning aids meets the module feasibility indicators, namely the material that is easy to understand, the language used is easy to understand, the presentation of the module content is interesting and fun, as well as illustrations provide a real picture of the material being studied (Ilahiyah et al., 2019; Imran et al., 2021). Based on this, it can be concluded that the development of module needs to pay attention to suitability of the material with the indicators, competencies and learning objectives, the use of language that is easy to understand, and the attractiveness of the module display.

Second, the project-based learning module developed is practical and easy to use. This is proven based on the results of practicality tests that have been carried out. The practicality of the product is shown by, attractive packaging according to the characteristics of students. Content of the module is simple, clear and contains the important points of learning that students must learn. This makes students easy, comfortable, interested, and does not cause confusion. The ease of use of teaching materials greatly affects the practicality, intention and interest of users in using teaching materials that make learning process carried out more meaningful (Damayanti & Kristiantari, 2022; Geni et al., 2020). The use of modules that are in accordance with the characteristics and needs of students is effectively used to improve student learning outcomes (Nisrina et al., 2021; Rezki et al., 2021). This shows that the practicality of the module makes it easy and comfortable for students to use it so that it can affect their learning outcomes.

Third, the project-based learning module developed is effective to be used in improving scientific literacy and problem solving. The project-based learning-based module that was developed proved to be effective in improving students' scientific literacy as seen from the results of the N-gain test, obtained a g value of = 0.71 with a high level of effectiveness. Project-based learning modules enable students to easily understand the material presented in the module so that students can identify questions, and draw conclusions based on facts as presented in the module. The use of modules for scientific literacy can provide opportunities for students to understand aspects of science and assist students in achieving the learning objectives that have been formulated. Moreover, it can train students to find their knowledge by proceeding independently even though they are still under the guidance of the teacher (Ariana et al., 2020; Utomo, 2018). This is supported by the findings of previous research which states that the use of modules can improve scientific literacy skills effectively and significantly (Kimianti & Prasetyo, 2019; Wati et al., 2019). In addition, the results of the product effectiveness test related to problem solving abilities showed that the developed project based learning module was effectively used in honing students' problem solving skills as seen from the N-gain test results obtained a g value of = 0.71 with a high level of effectiveness. This is because the project-based learning modules developed are made systematically with well-packaged problems, therefore students can use the modules easily. The module is designed considering the indicators of understanding the problem, planning strategies, implementing strategies, and re-examining the correctness of solutions. With such design, it will stimulate students and make students compete to solve problems so that they can improve students' problem solving abilities (Gumilang et al., 2019; O. Rahayu et al., 2021). The use of modules effective to improve students' problem solving skills (Permana et al., 2021; Sormin & Sahara, 2019). So, the use of modules in learning can improve students' scientific literacy and problem solving abilities.

Fourth, the project-based learning module is suitable for use in learning activities. Project based learning module has several advantages such as simple packaged, systematic, attractive, and practical way to use. The impact of module can increase students' learning motivation, train students' literacy and problem solving skills. Students' scientific literacy skills are very important to be trained, scientific literacy continues to develop following the direction of science development and social interaction so students need to have the ability to understand the latest issues related to science and technology (Pratiwi et al., 2019; Syofyan & Amir, 2019). In addition beside of scientific literacy skills, another skill that is no less important for students is problem solving skills. Problem solving skills have a role to improve analytical skills and help students handle various situations in real life (Harefa & Laia, 2021; Nurhasanah & Luritawaty, 2021).

This finding is in line with the findings of previous research which states that the development of an effective learning project-based module can attract students' attention and be able to increase students' understanding of the subject matter (Ramadhani et al., 2021; Rezki et al., 2021). Other research findings also state that Project Based Learning can improve students' scientific literacy skills (Khotimah et al., 2020; Sakti et al., 2021). In addition, the findings of previous studies also state that the problem-based learning model can increase students' learning motivation and problem solving abilities. (Putri et al., 2019; Santoso et al., 2020). Based on the research results from several relevant studies, the development of project-based learning modules for third grade elementary school students animal breeding materials have never been developed before. The results of this research become one of the novelties of research related to module development for third grade elementary school children. In addition, the results of this study and the results of relevant research indicate that the project based learning module is effective, feasible and valid to be used in the implementation of classroom learning because this module can make students interested and motivated to take part in learning.

The contribution of this research is the project-based learning module developed is proven to be valid, practical, and effective, which can be used by teachers in the implementation of learning in the classroom, so the results of this study can be used as a reference for the use of teaching materials or other

learning media to support the implementation of learning. In addition, this study has advantages when compared to previous studies. Previous research did not cover aspects of increasing scientific literacy and problem solving, so this research is one of the new studies that examines the development of modules to improve students' scientific literacy and problem solving. However, this study also has limitations, this module is only made for plant breeding material, so the author recommends that further research can create modules with a wider scope of material.

#### 4. CONCLUSION

This study succeeded in designing a project-based learning module using a 4D model that is valid and practical to use. In addition, this study also shows that the project-based learning module is effectively used to improve scientific literacy and problem-solving abilities of third grade students as seen from the results of the N-gain calculation which obtains a high level of effectiveness for scientific literacy skills and problem solving abilities. Based on this, the authors have suggestions for further research so that product development in the form of modules can be adapted to the analysis of student needs that make the results will be right on target.

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