

Development of Problem-Based Learning Modules on Environmental Pollution Materials to Improve Student Learning Outcomes

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Abstract: This research was classified as a Research and Development (R&D) that aimed to determine the validity, practicality, and effectiveness of developing problem-based learning module to improve students' learning outcomes. The samples consisted of 20 students in class X of SMA Negeri 7 Prasetya Gorontalo. This research was conducted to create module transferred to the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), but it was only limited to the development stage, namely the limited trial development stage. The instruments used were interview, validation sheet, and student response questionnaire, implementation of learning (teacher activity), student activity, and pre-test and post-test. The result of module validation analysis with here validators obtained an average score of 85% (very valid). Meanwhile, the result of practicality analysis was observable from the teacher activity which obtained an average score of 93.3% (very good), the student activity in the small group trial obtained an average score of 90% (very good), and the student responses obtained an average score 88% (very feasible). In the meantime, the result of effectiveness analysis were observable from the result of N-Gain analysis in small group trial which obtained an average score of 0.62% (fairly effective). To conclude, the development of problem-based module on environmental pollution topic intending to improve the students' learning outcomes had met the valid and practical criteria but has not been effective due to it only reached a limited trial. However, the module was feasible to use in the learning process.

Keywords: Effectiveness; Practicality; Problem-based learning module; Validity

Introduction

Learning biology is not only learning about concepts or theories. However, students also learn to observe various natural phenomena in everyday life so that they can formulate life's problems and are also able to provide solutions solving various problems that occur. Learning can be done by giving accurate, direct, and relevant problems to the needs of these students so that they do not just accept and memorize (Ionita, 2020).

The use of the module as a means of independent learning is arranged systematically by the teacher so that

students can learn without having to be accompanied by the teacher (Septina Carolina et al., 2017). Module development aims to clarify and simplify the presentation of material that is the subject of discussion so that it is not too general and verbal and can overcome the limitations of time, space, and sensory power (Handayani et al., 2022).

Environmental Pollution Material is one of the materials related to everyday life. The problem of environmental pollution is regulated in Law No. 23 of 2009 concerning Environmental Protection and Management. According to Article 1 point 14 UUPPLH,

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environmental pollution is any act of introducing living things, substances, energy, or other components into the environment by human activities so that they exceed the established environmental quality standards. This environmental pollution can be observed by students either directly or indirectly (Maspupah et al., 2020). Based on the results of interviews with biology subject teachers at SMAN 7 Prasetya Gorontalo, who are currently carrying out face-to-face learning by implementing the independent curriculum for class X students starting in the academic year 2022-2023. There are several obstacles in it, one of which is that the results obtained sometimes do not match expectations caused by students, which may be due to the presence of some students who still do not understand the material or do not like the material. There are also obstacles because the facilities are inadequate or do not even have an android which is the main requirement of the current learning process.

Based on this, it is necessary to develop teaching materials in the form of modules to increase students' activeness in the learning process so that the results obtained can also be satisfactory for students and teachers (Mukharomah & Hidayat, 2017). One of the teaching materials that can support the achievement of learning objectives is the learning module, in which the module has listed essential points and some problems that must be solved to be able to help students understand and solve their problems because the module is a learning material that is in outline can assist in the learning process both in groups and independently (Munzil et al., 2022).

Method

In developing modules with a problem-based approach using the Robert Maribe Branch development model, the ADDIE model (Analysis-Design-Development-Implementation-Evaluation) has several stages: Analysis, Design, Development, and Implementation, and Evaluation. According to (Barokati et al. (2013), the ADDIE model guides the development of effective, dynamic learning and supports learning.

The research was conducted at SMA Negeri 7 PrasetyaGorontalo, at Jl. Budi Utomo, Kota Tengah District, Gorontalo City. This research involved 20 students of class X2 in SMA Negeri 7 Prasetya, Gorontalo City.

The research instruments used are validation sheets, learning implementation sheets, student activity sheets, student response questionnaires, and pre-test and post-test questions. Validation was carried out by two expert validators, namely lecturers in the biology department at Gorontalo State University. Validator 1 is

Prof. Dr. ElyaNusantari, M.Pd., a permanent lecturer (teacher and researcher) in the UNG biology department. Validator 2 is Dr. DewiWahyuni K. Baderan, S.Pd., M.Sc. She is also a permanent lecturer (teacher and researcher) in the UNG biology department.

Table. 1 Validation Criteria (Yazid, 2016)

Presentation (%)	Criteria
81 - 100	Very Good
61 - 80	Good
41 - 60	Satisfactory
21 - 40	Poor
1-20	Very Poor

$$\text{Validation of teaching materials} = \frac{\text{Total score for each aspect}}{\Sigma \text{highest score}} \times 100\% \quad (1)$$

Table 2. Student Activity Assessment (Kusumayati, 2018)

Evaluation	Score
Very Poor	0%-20%
Poor	21%-40%
Satisfactory	41%-60%
Good	61%-80%
Excellent	81%-100%

$$\text{Student Activity} = \frac{\Sigma \text{Score obtained}}{\Sigma \text{Maximum score}} \times 100 \quad (2)$$

Table 3. Guttman Scale Criteria (Kusumayati, 2018)

Evaluation	Score
Very Poor	0%-20%
Poor	21%-40%
Satisfactory	41%-60%
Good	61%-80%
Excellent	81%-100%

$$\text{Implementation of Learning} = \frac{\Sigma \text{Score obtained}}{\Sigma \text{Maximum score}} \times 100 \quad (3)$$

Table 4. Student Response Questionnaire Score (Kusumayati, 2018)

Evaluation	Percentage of Student Responses
Very Poor	0%-20%
Poor	21%-40%
Satisfactory	41%-60%
Good	61%-80%
Excellent	81%-100%

$$\text{Student response} = \frac{\Sigma \text{Student answer score}}{\Sigma \text{Maximum score}} \times 100 \quad (4)$$

Table 5. N-Gain Effectiveness Criteria (Hake, 2009)

Average N-Gain	Effectiveness Level
0.70 < N-gain	High
0.30 ≤ N-gain ≤ 0.70	Medium
<0.30	Low

Results and Discussion

Analysis of Learning Module Validity Results

Module validation to see the validity of a product being developed. Validation of learning modules that expert lecturers have carried out, both media experts and material experts and practitioners, to determine the validity of the module is measured based on the aspects that are assessed (Yustinaningrum et al., 2019). The validation results of problem-based learning modules by validator 1 are 91.1%, for validator 2 are 88.3%, then for validation results by practitioners, namely 86.1%. Based on the module validated by 3 validators, the average result obtained was 86% with the "very valid" criteria.

Table 6. Results of Validity Analysis

Validator	Average Percent Validation (%)	Criteria
Expert Validator I	91.1	Verygood
Expert Validator II	88.3	Verygood
Practical Validatori	86.1	Verygood

Problem-based modules can be said to be valid if they have gone through a validation process on three validators and get responses that meet the validity criteria with a percentage of 61-80%, this is in line with the opinion of (Ariesta & Kusumayati, 2018). Maker (2020) states that validation is a measuring instrument that is shown to see the extent to which the measuring instrument can measure what will be measured. (Apriliyana & Fitrihidayati, 2012) explains that the product is said to be valid if the product developed is adequate and all components produced are consistently related to each other. A superior product cannot be produced by one person, but is produced through the collaboration of many parties. Therefore, the collaboration of several people or units is very important to produce a superior product or said to be valid (Irman & Waskito, 2020).

Practicality Analysis of Learning Modules

Practicality aims to see whether the products developed are practically used in the learning process. The practicality analysis of the module includes assessing the activities of students and the implementation of learning. The results of the practicality analysis are presented in Table 7.

Table 7. Module Practicality Analysis Results (Hake, 1998b)

Valuation Analysis	Average Percentage (%)	Criteria
Student Activity	90.0	Very Good
Implementation of Learning	93.3	Very Good
Student Response Questionnaire	88.0	Very Good

Practicality aims to see whether the products developed are practically used in the learning process. Practicality refers to the condition of the developed learning modules that can be used easily by students so that learning becomes interesting, meaningful, fun, and valuable and can increase students' creativity. The practicality analysis of the module includes assessing student activity, the implementation of learning, and student responses.

Based on the assessment results of student activities obtained in limited trials, an average score of 90% is in the "perfect" category. This shows that students' learning activities using problem-based modules on environmental pollution material have been carried out very well because the assessment is supported by (Kusumayati, 2018), where the range of values is between 81% -100% in the "perfect" category. The overall results can be seen in table 7. This is because, when presenting the pictures, only a few students seemed enthusiastic in understanding and asking questions about the pictures displayed. This is because some students are afraid to express their opinions for fear of being wrong with the answers that will be conveyed. According to Syamsiah (2022) that students who are active in learning are characterized by having the desire and courage to express their thoughts, feelings, and wishes and participate in learning activities.

The results of learning implementation in the limited scale trials obtained an average score of 93.3% with the "perfect" criteria. This aligns with the opinion of (Kusumayati, 2018), who said the score range is 81% - 100% with the "perfect" criteria. This shows that learning taught using modules has been carried out by the plans in the RPP. This can be seen in several aspects that have not met the standards because the time needed is more than the time available when learning begins. Therefore researchers are expected to allocate more time to carry out the learning process in the classroom.

The results of student responses to the developed modules obtained an average score of 88% in the "very feasible" category. This is supported by (Kusumayati, 2018) if the developed module is said to be feasible if student responses reach a percentage of $\geq 61\%$.

Based on the results of student responses which were distributed to each student in class X2 SMAN 7 Prasetya Gorontalo, where there was 1 student with a score of 85%, 3 students with a score of 88%, 8 students with a score of 90%, 6 students with a score 93%, and 2 students with the highest score of 95%. The presentation of this problem-based module product has an interactive module display because the material presented is explicit and easy to understand, has a good language structure, and contains practice questions that can help students learn both in groups and individually (Nia et

al., 2022). This is in line with research conducted by Artika (2019) who developed a problem-solving module on ecosystem material which said that positive student responses to the developed modules showed that, in general, the developed modules were an exciting and fun learning media alternative that the school could use.

Problem-based modules are said to be practical if they have met the criteria of 61-80% according to (Ariesta & Kusumayati, 2018). Practicality can be generated from the scores obtained from the implementation of learning, student activities, and student responses which contain aspects that become benchmarks in obtaining scores that can be used as a benchmark for whether or not the module developed in the learning process is practical. In line with Gita et al. (2018) as an activity of organizing or arranging the environment as well as possible and connecting it with students so that the learning process occurs, this environment in this sense is not only the learning space, but also includes teachers, teaching aids, libraries, laboratories and so on that are relevant to student activities. According to (Handayani et al., 2022) that the factors that need to be considered when conducting an evaluation are the available time allocation and the time required. According to (Sugawara & Nikaido, 2014) that students who are active in learning are characterized by having the desire and courage to express their thoughts, feelings and desires, and participate in learning activities.

In the learning implementation stage, it is observed by one observer where through an assessment by presenting aspects in helping to obtain a score that is in accordance with the practicality criteria. The module is said to be practical because it has obtained a score above 61-80% of the practicality provisions according to (Ariesta & Kusumayati, 2018) and students can give a positive response to the learning that takes place. This shows that problem-based modules can help students in the learning process to be able to help solve problems when doing the tasks given by the teacher.

In the student activity test, observations were made by observers when students carried out the learning process by referring to the aspects used as a measuring tool for the practicality of the developed module. The results obtained from all aspects observed are in very good criteria where the average is 90%. This is because students take an active role in the learning process using problem-based modules on the material taught. According to Amin (2017) in learning, teachers must facilitate the learning needs of students and strengthen motivation during learning so that the material provided can be understood properly by students so that students' activities can increase during learning. The results of students' responses to the developed module

obtained an average score of 88% with the category "very feasible". This is supported by (Ariesta & Kusumayati, 2018) if the developed module is said to be feasible if the student response reaches a percentage $\geq 61\%$.

Based on the results of student responses distributed to each student in class X2 SMAN 7 Prasetya Gorontalo, it can be concluded that the presentation of this problem-based module product has an interactive module display because the material presented is clear and easy to understand, has a good language order, and contains practice questions that can help students in learning both in groups and individually. This is in line with research conducted by (Artika, 2019) who developed a problem solving module on ecosystem material which said that the positive response of students to the developed module shows that in general the developed module is an alternative to interesting and fun learning media that can be used by schools (Giawa et al., 2022).

Analysis of the Effectiveness of Learning Modules

The results of the analysis of the module's effectiveness consist of the assessment results of the pre-test and post-test questions, which are presented in Figure 1. The results obtained in the pre-test were 45 in the "poor" category, while for the post-test, a score of 80 was obtained in the "good" category, according to (Mawaddah & Anisah, 2015). The following can be seen in the Figure 1.

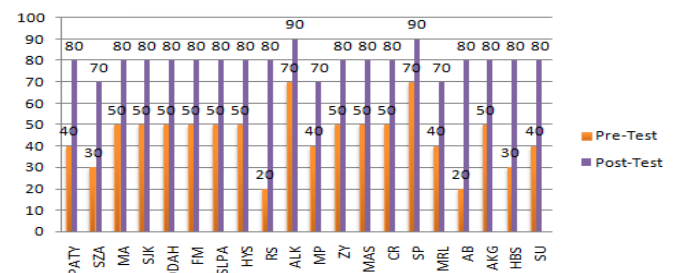


Figure 1. Pre-test and post-test scores (Primary Data, 2023)

Table 8. N-gain Test Results

N-Gain Value	Category
0.62	Medium

According to Arifin (2016) the module's effectiveness can be seen from several components: one of the learning outcomes of students who can exceed the KKM or the minimum completeness criteria that subject teachers have set at school.

The results obtained from the students' pre-test on the limited scale trial obtained an average score of 45. Based on the results obtained, it can be seen that the criteria for students' problem-solving abilities in using the module are included in the "less good" category.

According to Mawaddah (2015), the average value in the range of 40-54 is in the "less good" category.

The learning results of the two tests show that there was a change in grades when the students did the pre-test and post-test. This was because when the students did the post-test, the students did not understand the core points of the material to be studied. When doing the post-test, students already know the material being studied so that they can answer practice questions prepared to become the final evaluation material when they have finished learning about environmental pollution material. According to research conducted by Artinta et al. (2021) several factors influence students' problem-solving abilities, including the learning media used in the learning process. Then according to Maulinda (2022), factors that influence student learning outcomes can be influenced by the surrounding environment; when carrying out tests, many students are influenced by their peers and the noisy atmosphere of the school environment because it coincides with the changing hours of learning.

In the analysis of the N-Gain results in the limited scale trial, an average score of 0.62 was obtained, where the score was included in the "moderate" category, which means that it is in the interpretation of "effective enough." These results are in line with (Hake, 1998a) where the range of scores between $0.30 \leq \text{N-Gain} \leq 0.70$ is in the "moderate" criterion, which means "effective enough," where the range of scores is between 56-75. Based on the N-Gain results obtained in the limited-scale trials, the use of problem-based learning modules on environmental pollution material can effectively improve student learning outcomes (Lestari et al., 2017).

The effectiveness of the module can be seen from the results obtained from the pre-test and post-test, where the ideal score obtained is 55, and with an average N-Gain score of 0.62. These results are in line with (Hake, 1998b) where the score range between $0.30 \leq \text{N-Gain} \leq 0.70$ is in the "medium" criteria which means "moderately effective", where the score range is between 56-75. Based on the N-Gain results obtained in the limited scale trial, it shows that the use of problem-based learning modules on environmental pollution material can be said to be quite effective but cannot be applied in the learning process because it only reaches a limited trial (Setiawan & Aden, 2020).

The learning results of the two tests can be seen that there is a change in value when students do the pre-test and post-test, this is because when students do the post-test students do not understand the core points of the material to be learned (Amin, 2017). Meanwhile, when doing the post-test, students already have knowledge about the material being studied so that students can

answer the practice questions that have been prepared to be the final evaluation material when they finish learning about environmental pollution material (Musfiroh et al., 2012).

According to research conducted by (Fauziyah et al. (2013) there are several factors that influence students' problem solving ability, one of which is the learning media used in the learning process. Factors that affect student learning outcomes can be influenced by the surrounding environment, where when conducting tests many students are influenced by their peers and the atmosphere of the school environment which is noisy because it coincides with the time of changing lessons (Alfiriani & Hutabri, 2017).

Conclusion

Based on the results of research and discussion regarding the development of problem-based learning modules on environmental pollution material to improve student learning outcomes in class X2 at SMAN 7 PrasetyaGorontalo, it has met the eligibility and can be used in class based on 3 aspects which are the research objectives, namely: the validity of the developed learning module obtained an average score of 86% in the "very valid" category. Hence, the module is suitable for use in schools as a reference for teachers and students in learning environmental pollution material. The practicality of the developed learning modules can be assessed by analyzing teacher activities with an average score of 93.3% in the "perfect" category. Then for the results of the activity analysis, students obtained an average score of 90% in the "perfect" category and supported by the analysis of the responses of students who obtained an average score of 88% in the "perfect" category. Based on the three practicality analysis results obtained, the modules developed are practical and feasible to be used in the learning process at school. The effectiveness of the developed module can be seen from the results of the students' learning tests which obtained an average score of 45 for the pre-test in the "poor" category and the results of the post-test with an average score of 80 in the "good" category. Meanwhile, the N-Gain results obtained an average score of 0.62 in the "moderate" category, which means "effective enough" in the N-Gain interpretation. Thus learning through the developed module is quite effective for students in solving problems.

Author Contributions

The author is involved in the overall making of this article

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Conflicts of Interest

The authors declare no conflict of interest.

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