



Science Module Development Problem-Based Learning for Biodiversity in Junior High School

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Abstract: This study aims to develop a problem-based science learning module in biodiversity material for grade VII students of SMP Muhammadiyah Ambon. This research uses a 4-D development model from Thiagarajan, which consists of the stages of defining, designing, and developing. This study was conducted by involving 25 seventh grade students as a research sample at SMP Muhammadiyah Ambon. Data was collected through module validation, practicality questionnaires, and effectiveness questionnaires. The results showed that the modules developed were very valid, with a percentage of validation from material experts of 88%, media aspects of 85%, and language aspects of 80%. The practicality test shows that this module is very practical, reaching a percentage of 97%. Meanwhile, student responses to modules and learning activities showed a high level of effectiveness, with an average total response of 93.29%. Post-test results also showed a high level of effectiveness, with a percentage of 84%. Also indicated by a greater n-gain value equal to 0.8 in the high category. Based on the results of this study, it can be concluded that the problem-based science learning module on biodiversity material for grade VII students at SMP Muhammadiyah Ambon is suitable for use in the learning process.

Keywords: Biodiversity; Problem-based learning (PBL); Science Module

Introduction

Science education plays an important role in shaping a great generation. Learning science not only helps students understand their surroundings but also helps them develop important life skills, such as the ability to communicate, stay organized and focused, and even form their own opinions based on observations (OECD, 2008). In addition, science also helps students develop their curiosity and encourages them to seek answers to their questions (Hadzigeorgiou & Schulz, 2019). Thus, it is important for us to continue to innovate in science education to prepare students for future challenges (Weinstein et al., 2018; Ballard & Mooring, 2021; Bi et al., 2019). One effective approach in science learning is problem-based learning (PBL), which encourages students to actively participate in solving real-world problems through the use of scientific

knowledge (Zheng et al., 2023; Rusmono, 2012; Marlina, 2018; Asmara & Septiana, 2023; Rubin & Sunarsi, 2016; Cahyani & Setyawati, 2017; Lestari & Suyono, 2018; Mardiyah et al., 2022; Syamsidah & Suryani, 2018; Bayuningsih, et al. 2017).

Based on the results of observations at SMP Muhammadiyah Ambon, the use of less interesting textbooks and conventional learning are still challenges. This is in line with Manurung et al. (2021) who stated that there are still challenges in developing interesting and motivating science learning for students. In addition, a curriculum that focuses solely on cognitive knowledge, and the conventional learning methods used, may not be able to optimally activate students in understanding biodiversity material (Yli-Panula et al., 2018; Chin & Chia, 2004; Gray et al., 2009; Dikmenli, 2010).

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Based on previous studies, Problem-Based Learning (PBL) has been known as an effective learning method in science education (Akçay, 2009; Ernawati et al., 2023; Etherington, 2011; Naviri et al., 2021; Nurhayati et al., 2023; Uluçinar, 2023; Sisternans, 2020; Dwi et al., 2013; Cheriani et al., 2015). PBL encourages students to actively participate in the learning process by using real-world problems as a context for in-depth investigation. Research shows that PBL can improve students' academic achievement, conceptual development, and attitudes toward science courses. However, the implementation of PBL in science education still requires more research, especially in specific contexts such as learning biodiversity material. In addition, another challenge is how to create teaching materials that are interesting and motivate students.

Therefore, the development of a Problem Based Learning (PBL) based science module on biodiversity material for grade VII students at SMP Muhammadiyah Ambon is important to improve interesting and effective science learning. PBL-based modules can provide a more interactive learning experience, motivate students, and develop critical thinking skills and problem-solving abilities.

This study aims to develop a PBL-based science module on biodiversity material for grade VII students at SMP Muhammadiyah Ambon, and to test its effectiveness in improving students' understanding and involvement in science learning. In addition, this study is also expected to contribute to the development of curriculum and learning methods at SMP Muhammadiyah Ambon, as well as provide input for teachers and schools in improving the quality of science learning.

Method

This research was conducted for 1 month at SMP Muhammadiyah Ambon. The type of this research is research and development (R&D). This research uses the 4-D model from Thiagarajan. The stages in this research consist of the definition, design and development stages. The population and sample of this research were 25 students of class VII of SMP Muhammadiyah Ambon. The data collection technique in this research used a module validation questionnaire, a module practicality questionnaire and a module effectiveness questionnaire. The data analysis technique in this research includes (1) module validation questionnaire analysis (2) module practicality questionnaire analysis (3) and module effectiveness questionnaire analysis consisting of student response data analysis and student learning outcome analysis. Validation, practicality and effectiveness analysis based on student responses were

carried out using a Likert scale with the criteria that the module is declared feasible if the percentage reaches >61.

Result and Discussion

The module was developed with the aim of testing the level of validity, practicality and effectiveness. The module was developed through several stages including defining, design and development stages. At the define stage, researchers collect the information needed such as facts, expectations and alternatives to choose the teaching materials to be developed. While the design stage is the stage where researchers prepare the framework of the teaching materials to be developed by referring to the results obtained from the define stage to design the teaching materials.

After going through the define and design stages, the developed module was validated before being tested. Validation was carried out by three validators from the aspects of material, media and language. Each validator is a lecturer with a Masters degree. The results of expert validation are shown in Table 1.

Table 1. Xpert Validation Results

Aspects	Percentage (%)	Categories
Subject matter	88	Very worthy
Media	85	Very worthy
Language	80	Worthy

Table 1 presents the validation results for module development. It covers three aspects, namely material, media, and language. The results of the material validation received a percentage of 88% categorized as very feasible. Media received a value of 85% also categorized as very feasible. While the results of the language validation obtained a validation percentage of 80%, categorized as feasible. Thus, expert validation shows that the material and media aspects of the module are very suitable for further development. Although, the language aspect is also considered feasible, it may require some improvements to achieve the same level of suitability as other aspects.

Table 2. Recapitulation of Module Implementation Results Data

Observed Aspects	Score Obtained
Implementation of learning syntax	25
Social interaction	25
Reaction principle	13
Availability of supporting devices	10
Total scores obtained	73
Total of maximum score	75
Percentage (%)	97
Criteria	Very practical

Table 2 provides a summary of the module implementation data, focusing on the various aspects observed during the study. The aspects observed included the syntax of learning implementation, social interaction, reaction principles, and availability of supporting devices. The total score obtained for all aspects combined was 73 out of a maximum of 75, indicating a high level of implementation effectiveness. The overall percentage score for implementation was 97%, indicating a very practical approach in implementing the module. The total scores for each aspect provide a clear indication of the strengths and weaknesses in the implementation of the module. High scores for aspects such as the syntax of learning and

social interaction imply that these areas are well implemented. A slightly lower score for the reaction principle may point to areas that could be improved in future implementation. The availability of supporting devices also played a significant role in the overall effectiveness of the module. The high percentage score and the categorization of "Very practical" indicate that the implementation of the module was successful and efficient. A detailed breakdown of scores for each aspect allows for targeted improvements in specific areas for future iterations of the module. Overall, the table highlights the importance of considering the various aspects of implementation to ensure the effectiveness of educational modules.

Table 3. Recapitulation of Data on Student Responses to the Effectiveness of the Module

Number of students	Response to	Percentage (%)	Average (%)	Response categories
25	Module	93	92.66	Positive response
25	Learning Activities	94	93.92	Positive response
Total average			93.29	Positive response

Table 4 presents data on student responses to the effectiveness of the module. The average percentage of student responses to the module was 92.66% indicating a positive response. For learning activities, the average percentage of student responses was 93.92%, also indicating a positive trend. The overall average percentage of student responses was 93.29%, reflecting a

positive perception of the effectiveness of the module. The high average percentage of 93.29% for both aspects indicates that the module is effective in engaging students and facilitating learning. Positive responses indicate that the module is well received by students, highlighting its effectiveness in an educational context.

Table 4. Recapitulation of Pre-test and Post-test Results

Test Results	Number of Students	Percentage (%)	Average (%)	N-gain value	Category
Pre-test	25	20	19.68	< 0.2	Low
Post-test	25	84	84.44	≥ 0.8	High

Table 4 presents the pre-test and post-test results for a group of 25 students. The pre-test results showed an average percentage score of 19.68%, with an N-gain value <0.2, categorized as "Low". The post-test results showed a significant increase, with an average percentage score of 84.44%, an N-gain value ≥0.8 categorized as high. The post-test scores showed a substantial increase from the pre-test scores, indicating the effectiveness of the intervention or learning module. The n-Gain value indicates that students made significant progress in their learning, especially between the pre-test and post-test assessments. The categorization of n-Gain as "High" for the post-test highlights the positive impact of the teaching method or intervention on student learning outcomes.

After collecting data from the validation results of media, material, and language experts, as well as conducting an evaluation of the module's implementation and student responses, the interpretation of the results showed a high level of validation for all aspects, with each reaching the "very

feasible" category. In addition, the results of the module's implementation showed a presentation of 97% with the "practical" category, indicating that the module had been successfully implemented in the learning context. Student responses to the effectiveness of the module were also very positive, with 93.292% of students considering the module "very effective" in supporting their understanding of science material. This finding is supported by the results of the N-gain test which showed a score of more than or equal to 0.8 with the "High" category, indicating a significant increase in student understanding after using this PBL-based module.

This study supports previous findings showing that Problem-Based Learning (PBL) improves students' understanding of biodiversity material (Akçay, 2009; Ernawati et al., 2023; White, 1996; Serin, 2019; Qurniati et al., 2015; Nieminen et al., 2010; Dewi & Rahayu, 2023; Allchin, 2013). The module developed in this study, which is highly valid and practical, has been shown to be effective in increasing students' engagement and

learning outcomes, with high n-gain indicating significant improvements in conceptual understanding (Etherington, 2011; Siregar & Harahap, 2020; Alhazmi & Quadri, 2020; Bahtaji, 2023; Malau-Aduli et al., 2013; Dewi et al., 2022). This is in line with research by Naviri et al. (2021) and Uluçinar (2023), which also found that PBL not only strengthens conceptual understanding but also promotes positive attitudes towards science learning, which is important for the development of critical thinking and problem-solving skills in the future.

The impact of the results of this study on theory and practice is very significant. This study provides an important contribution to the development of the 4-D model in the context of science learning in secondary schools. The implications of the results of this study also include practical aspects, where PBL-based modules can be adopted and implemented in daily learning in various schools. This provides a more interactive and relevant alternative for teachers and students in teaching and learning science materials.

Although the results of this study provide significant contributions, it must be acknowledged that there are several limitations in this study. For example, limitations in the study sample or the time of data collection may affect the generalizability of the results. This needs to be considered in the interpretation of the results and the relevance of the findings, as well as being a consideration for further research.

Suggestions for future research include further development of this 4-D model for other science materials or in different school contexts. In addition, further research could involve a more in-depth analysis of the factors that influence the effectiveness of PBL-based modules, as well as exploring the use of digital technology in science learning in this increasingly digitalized era.

The social implications of the findings of this study include improving the quality of science learning in schools, which can have a positive impact on students' ability to understand and apply science concepts in everyday life. Meanwhile, ethical implications involve efforts to ensure that the use of digital technology in the development and implementation of PBL-based modules pays attention to aspects of fair access and minimizes risks related to student privacy and data security.

Conclusion

Science learning module based on Problem-Based Learning (PBL) for biodiversity material has been proven effective in improving students' understanding, validation of materials, media, and language showed a very good level, and students' responses to this module

were also positive. The post-test results showed a significant increase in students' understanding.

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Author Contributions

Writing original draft and analyzes data, C.P.; editing and evaluation, F.K. and J.R.; review and supervision, T.S.K.

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Conflicts of Interest

All author declares that there is no conflict of interest.

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