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Developing Problem Based Biodiversity Modules to Enhance 4C Skills and Scientific Literacy in Islamic Vocational High School

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Abstrak

Tujuan penelitian ini adalah untuk mengetahui kevalidan, kepraktisan, dan keefektifan modul pembelajaran biologi terhadap keterampilan Critical Thinkings, Creativity, Communication, dan Collaboration (4C), dan kemampuan literasi biologi siswa. Jenis penelitian ini adalah penelitian pengembangan dengan menggunakan pengembangan model Analyze, Design, Develop, Implement, and Evaluate (ADDIE). Subjek penelitian ini 30 Siswa kelas X SMA Al Ulum Medan. Hasil penelitian ini adalah kevalidan modul pembelajaran berbasis model berbasis masalah dalam meningkatkan keterampilan 4C dan kemampuan literasi biologi peserta didik termasuk dalam kategori valid, sehingga modul pembelajaran yang dikembangkan sudah memenuhi indikator kevalidan. Kepraktisan modul pembelajaran berbasis maalah dalam keterampilan 4C dan kemampuan literasi biologi peserta didik termasuk dalam kategori praktis. Keefektifan modul pembelajran keterampilan 4C dan kemampuan literasi biologi peserta didik berbasis model berbasis masalah memeruhi kriteria keefektifan.

Kata Kunci: *Keterampilan 4C, Literasi Sains, Pengembangan Modul, Pembelajaran Berbasis Masalah,*

Abstract

The purpose of this study was to determine the validity, practicality, and effectiveness of the biology learning module on Critical Thinkings, Creativity, Communication, and Collaboration (4C) skills, and students' biological literacy skills. This type of research is development research using the Analyze, Design, Develop, Implement, and Evaluate (ADDIE) model development. The subjects of this study were 30 students of class X of SMA Al Ulum Medan. The results of this study are the validity of the problem-based learning module in improving 4C skills and students' biological literacy skills are included in the valid category, so that the developed learning module has met the validity indicators. The practicality of the problem-based learning module in 4C skills and students' biological literacy skills is included in the practical category. The effectiveness of the 4C skills learning module and students' biological literacy skills based on the problem-based model meets the effectiveness criteria.

Keywords: 4C Skills, Science Literacy, Module Development, Problem Based Learning.

A. Introduction

21st-century learning is student-centred and teacher-facilitated. The Problem-Based Learning (PBL) paradigm is advocated for 21st-century student-centred learning. PBL uses issues to teach students critical thinking, creativity, and problem-solving, as well as apply their knowledge to their lives and explore their curiosity (Suryaningsih, 2023). PBL is an effective strategy for generating a positive learning environment and teaching students to think critically and analytically and discover utilizing many sources ((Herzon, H. H., Budijanto, & Utomo, 2018). Critical thinking, problem-solving, and self-learning are the core goals of the PBL approach (Farisi, A., Hamid, A., 2017). In addition to student-centred learning models and practices, 21st-century success depends on instructors' and students' ownership of instructional materials. Teaching resources help instructors and students grasp the content (Simanjuntak, E. B., & Khairina, 2019). Teaching tools may save instructors time, alter their position from teachers to facilitators, and make learning more effective and participatory (Silaban, R., Panggabean, F. T. M., Sitompul, S. M., Simarmata, P. R. S., & Silaban, 2019).

In reality, many Indonesian instructors utilize ready-made instructional materials without planning, preparing, or compiling them (Fitri, E. R., & Pahlevi, 2021). Such behaviour dulls instructional materials and makes the classroom boring. Publisher-provided teaching resources usually consist of explanations, examples, and student tasks, making them less effective in developing 4C skills and scientific literacy (Wasis, Rahayu, Y. S., Sunarti, T., & Indana, 2020).

A preliminary study at SMA Islam Al-Ulum Terpadu Medan found that biology teachers and students only used handbooks (packages) and LKS, which contained descriptions of materials and practice questions that students had to work on individually. Students' books and LKS did not teach them to think critically, creatively, communicatively, and collaboratively because the materials and practice questions were focused on rote memorization rather than understanding and application and did not foster 4C skills and scientific literacy. Interviews with various students indicated that current books didn't engage students since the language and sentences were still difficult to grasp, making them less interested and slow to read and learn the information (Farisi, A., Hamid, A., 2017).

The aforementioned issues necessitate the creation of problem-based learning (PBL) modules on biodiversity for grade X SMA. Module-based teaching materials were chosen because they are systematically arranged in a language that students can understand according to their level of knowledge and age, allowing them to learn independently with minimal teacher guidance (Puspitasari, 2019). Modules are standalone learning experiences that help students reach preset objectives (Imran et al., 2021) and may be utilized alone or in groups, such as a class ((Kibtiah, I., Hilmiyati, F., 2020) . We chose biodiversity because it is difficult for students to understand. According to (Barus, E. M., Ritonga, I. S., & Siregar, 2018), pupils are less interested in challenging biology materials using intricate scientific jargon. (Yunanda, I., Susilo, H., & Ghofur, 2020) said that students still struggle to compare gene and species diversity and develop practical remedies to biodiversity degradation. (Tamimu, S., Nurlia, & Kenta, 2022) reported that students scored low on biodiversity material because the teacher still used a direct and teacher-centred learning model, which made students bored, sleepy, and less focused on learning.

PBL was selected because it is advocated in student-centred 21st-century learning. PBL has also been shown to improve students' thinking skills (Ariani, 2020), science understanding (Rahman, A.,

Khaeruddin, & Ristiana, 2020), problem-solving (Rachmawati, N. Y., & Rosy, 2021), and learning outcomes. (Darwis, D., Latif, M., & Rahman, 2020) found that blended-PBL improves students' critical thinking. Setyasih et al. (2022) found that PBL improves students' scientific literacy. (Nuzula, N. F., & Sudibyo, 2023) found that PBL improves pupils' scientific literacy. Several previous researchers have developed PBL-based teaching materials, including (Asma, Z., 2018). Previous research has shown that PBL-based teaching resources (LKPD, e-LKPD, and e-modules) are viable, practical, and beneficial in enhancing students' skills. As said, PBL-based instructional resources have been extensively researched and developed.

This state-of-the-art study is unusual because no PBL-based biodiversity modules have been innovated to promote students' 4C abilities (critical thinking, creativity, communication, and cooperation) and scientific literacy. Student life skills after graduation depend on 4C and scientific literacy; therefore, improving these is crucial. Everyone, especially kids, needs 4C abilities to meet 21st-century challenges, issues, and professions. Entering the increasingly competitive global market requires 4C talents. Students will profit from 4C skills in life, especially when they participate in society, since they are life capitals that may create knowledge individually and socially ((Rudianto, R., Diani, R., Subandi, S., & Widiawati, 2022).

Every student must understand scientific literacy in community life because it helps them link science concerns to their beliefs as citizens. Science literacy helps students apply science ideas meaningfully, think critically, and make balanced and sufficient judgments on real-world challenges. Science literacy also involves collaborative abilities, self-development via communication, and clear and convincing reasoning in social scientific challenges (Marpaung, C. P., & Suyanti, 2023).

Researchers carried out a study named "Development of Problem-Based Learning Modules for Biodiversity Material to Improve 4C Skills and Science Literacy of Class X Students of SMA Islam Al-Ulum Terpadu" to tackle the issues related to the importance of 4C skills and science literacy in student-focused learning for the 21st century. The selected research and development seeks to provide effective teaching modules that improve students' 4C abilities and scientific literacy. We design educational materials and learning media using the ADDIE approach (Analysis, Design, Development, Implementation, and Evaluation). ADDIE's sequential and logical design includes review and modification at each level, demonstrating a reciprocal connection.

B. Research Method

This type of research includes research and development, or research and development (R&D), which is a process used to develop and validate educational products (Setyosari, 2016) and test the effectiveness of these products (Sugiyono, 2018). The product developed is a biology module based on PBL material on biodiversity for class X of high school with innovation to improve 4C skills and students' scientific literacy. The reason this research was conducted is because it still uses conventional learning modules carried out by schools, where researchers conducted research in the form of modules that are specific to understanding the

material so as to improve students' scientific skills and literacy. This research was conducted at SMA Al-Ulum Medan, Jl. Tuasan, No. 35, Sidorejo Hilir, Medan Tembung District, North Sumatra. The time the research was conducted was in the even semester of the 2024/2025 academic year. The subjects in this study were all students of class X of SMA Al-Ulum Medan. The selection of high school students of class X of SMA Al-Ulum Medan was 30 students. The research focuses on the application of 4C skills and scientific literacy through the problem-based learning model. The research instrument is 4C skills and scientific literacy based on the problem-based learning module. The module development model used in this study refers to the type of teaching material development and the ADDIE development model proposed by (Amthari, W., Muhammad, D., & Anggereini, 2021). This ADDIE development consists of five steps, namely: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation. The following are the systematic stages as follows;

Analysis

At this stage, the activities carried out are analyzing the needs for developing new learning methods and analyzing the feasibility and requirements for developing new learning methods.

Design

At this stage, teaching and learning activities are planned. This activity is a systematic process that starts from determining learning objectives, designing scenarios or teaching and learning activities, designing learning modules. The design of this learning method is still conceptual and will underlie the development process.

Development

Based on the development procedure, implementation at this development stage is the start of product creation so that it produces a product in the form of a good final device, then validation will be carried out by experts. Furthermore, revisions will be made based on input from experts and data obtained from implementation in the field.

Implementation

Implementation is carried out to obtain input from the learning devices developed in order to see their effectiveness, improving 4C skills and scientific literacy of the Problem Based Learning model and student responses.

Evaluation

Evaluation is a process to see whether the learning devices that have been prepared have been successful or in accordance with initial expectations or not. Evaluation can be carried out formatively or summatively.

C. Result and Discussion

Data analysis and research results obtained at each stage of development are presented as follows:

Analysis

The analysis stage is when researchers assess the necessity of a learning development model, its feasibility, and its needs. Student needs, character, and curriculum analyses were performed in this research. The student needs analysis. Based on early observations of student learning at SMA Islam Al Ulum, it was discovered that the PBL learning model was not employed in the classroom, thereby influencing poor 4C skills and student literacy. SMA Islam Al Ulum pupils were analyzed for their cognitive development, academic talents, and social skills connected to learning themes, media, formats, and languages. I joined the official operational stage of SMA Islam Al Ulum pupils' cognitive growth. This research examined the SMA Islam Al Ulum Class X sequence and series content by analyzing textbook curriculum and comparing it to student needs and the 2013 curriculum.

Design

The purpose of this stage is to design learning media so that a prototype (initial design of learning media) is obtained for the material on biodiversity. Activities at this stage are making storyboards, arranging learning materials, making learning implementation plans, making teaching modules.

Development

Realizing the basic concept into a product suitable for implementation. This stage implements all the frameworks from the design stage into a PBL-based biodiversity module for grade X high school that is ready for expert validators to evaluate until a feasible final product is achieved.. The following are the modules that have been developed:

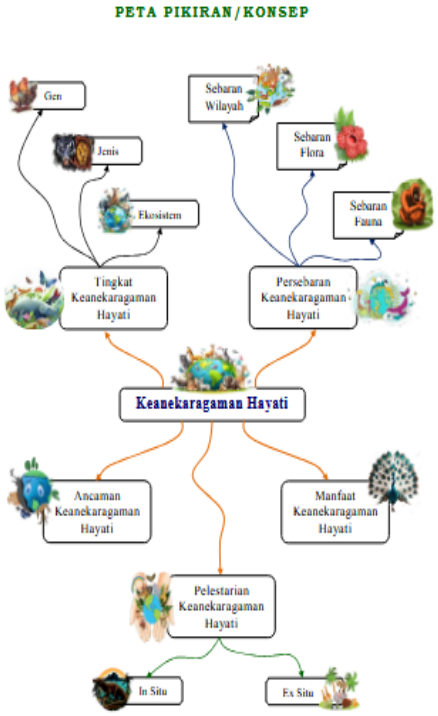

Figure 1. Learning Module Display

Table 1. Validation Results

No	Aspect	Average	Category
1	Learning Module	4,8	Valid
2	Science Literacy	4,5	Valid
3	4C Skills	4,5	Valid

The module titled "4 C skills, science literacy" has a total average "valid" score of 4.5, as seen in Table 1. Descriptive statistical analysis was used to assess the data that was collected for this investigation. According to Sheskin (2004), descriptive statistics is a method of analysis that is used for the aim of summarizing data without drawing conclusions or making predictions. Descriptive statistics primarily uses tables, graphs, diagrams, and calculations to determine the size of the centre and spread of data. Descriptive statistics employs a general technique.

Implementation

After the developed learning model has met the validity criteria (draft II), the research is continued to the implementation stage. The learning model in the form of draft II and all learning devices are tested at the research location, namely class X of SMA Al-Ulum Medan, hereinafter referred to as trial I. If it has reached the research success criteria, the research is terminated. However, if it has not been achieved, the research is continued to trial II after improvements are made. The research is declared complete if all predetermined success indicators are achieved

Based on the learning implementation criteria, it can be concluded that the implementation of the learning device in the first trial has a learning implementation level at the IO = 3.0, moderate ($4 \leq IP < 5$). In the second trial, the learning implementation level is at the IO = 3.8, high ($4 \leq IP < 5$). In general, in Thus, the learning device has met the empirical practical criteria.

In this study, students' learning completeness is reviewed from the 4C skills and students' scientific literacy which are tested using a test that has been developed in the form of multiple choices. The description of the results of students' 4C skill abilities in trial I is shown in Table 2

Table 2 Description of the Results of 4C Skills Ability in the Trial

Interval	Category	Pretest		Posttest	
		Number of students	Presentation	Number of students	Presentation
76-100	Very Good	4	13,3 %	12	40%
51-75	Good	15	50%	17	56 %
26-50	Quite Good	11	36,6%	1	3 %
0-25	Not Good	0	0%	0	0%
Total		30	100%	32	100%

Based on table 2 ,it shows that before being given treatment, there were 4 students (13.3%) in the very good category, 15 students (50%) in the good enough category, 11 students (36.6%) in the fairly good category, and 0 students (0%) in the less good category. Meanwhile, after being given treatment, there were 12 students (40%) in the very good category, 17 students (56%) in the good enough category, and 0 students (0%) in the less good category.

This study used pretest and posttest to 30 students of class X to see the improvement of scientific literacy skills. The description of the results of the biology critical thinking ability test is shown in table 3.

Table 3. Level of Mastery of Biological Literacy Skills

No	Value Interval	*Pretest*		*Posttest*		Category
		Number of students	Presentation	Number of students	Presentation	
1	90 ≤ KLS ≤ 100	0	0%	8	26,67%	Very High
2	80 ≤ KLS < 90	8	26,67%	20	66,67%	High
3	70 ≤ KLS < 80	9	30,00%	2	6,67%	Fair
4	60 ≤ KLS< 70	13	43,33%	0	0%	Low
5	0 ≤ KLS < 60	0	0%	0	0%	Very Low

From Table 3 it is obtained that in the pretest there were no students who obtained the very low category, the sufficient category was 9 students (30%), the good category was 8 students (26.67%) and there were no students who obtained the very high category. However, in the posttest, the results showed that there were no students who obtained the very low and low categories, the sufficient category was 2 students (6.6%), the high category was 20 students (66%) and the very high category was 8 students (26%).

Evaluation

This evaluation stage aims to assess the quality of the learning module developed in the learning process. In this stage, researchers identify the level of success of learning, recommend improvements to devices and learning with a similar scope.

Discussion

Since the n-gain value for the ASOR group shows a moderate increase, we can conclude that using problem-based learning with learning modules is very effective for improving scientific literacy among ASOR participants. Therefore, we don't need to consider different student groups based on their abilities when using this method. Therefore, there is no need to take into account student groups based on their capabilities in using problem-based learning via the utilization of modules (Yuristia, F., Hidayati, A., & Ratih, 2022). This is due to the fact that, as

stated by (Marpaung, C. P., & Suyanti, 2023), every student unquestionably has the right to be given the chance to develop academic performance that is adequate. Furthermore, according to (Abdurrahman, 2017), in order for instructors to successfully generate competitions among people, it is essential that individuals be provided with equal opportunities to both lose and win and that the competitions be carried out for the purpose of providing enjoyment and entertainment.

D. Conclusion

The validity of the problem-based learning module in improving 4C skills and students' biological literacy skills is included in the valid category, so that the developed learning module has met the validity indicators. The practicality of the problem-based learning module in 4C skills and students' biological literacy skills is included in the practical category. The effectiveness of the problem-based learning module for 4C skills and students' biological literacy skills based on the problem-based model meets the effectiveness criteria.

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