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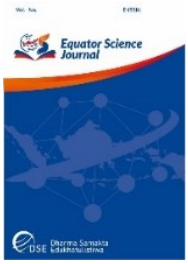

Development of Interactive Multimedia Based on Problem-Based Learning on Ecosystem Material to Improve the Analytical Skills of Senior High School Students

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Interactive Multimedia, Problem Based Learning, Ability to Analyze

ABSTRACT
This research aims to develop interactive multimedia based on Problem Based Learning that can be installed on Android, and test the effectiveness of its use on the ability to analyse students' ecosystem material. This research is a type of Research and Development, this research was conducted at one of the Bogor Regency State High Schools with the research sample, namely IPA 6 class as the experimental class. The novelty of this research lies in the development of interactive multimedia based on Problem-Based Learning (PBL) specifically designed for ecosystem material to improve the analytical skills of senior high school students, which has not been extensively explored in the context of science education. This development research procedure uses the (4D) model consisting of 4 stages, namely Define, Design, Develop, and Disseminate. The field trial implementation used a one group pretest-postest research design. The techniques used were tests (pre-test and post-test), checklist questionnaire sheets, and documentation. The assessment results show that interactive multimedia gets a very feasible category. This is based on the average percentage of assessment from the expert validation team which is 87%. Interactive multimedia based on Problem Based Learning on android is proven to be effective in improving the ability to analyse students, with an

N-gain value of 68.02 included in the medium category. This shows that interactive multimedia based on Problem Based Learning can improve students' analytical skills.

INTRODUCTION

The ongoing development of technology is also influencing the field of education in Indonesia. One example of the implementation of Android-based digital technology in education is an application containing educational material and practice questions, or interactive multimedia, which is installed on Android (Yulina et al., 2022).

The results of observations conducted at the research school revealed that students exhibited limited proficiency in analysing ecosystem-related material. They also demonstrated difficulty in solving practice problems that required problem analysis. The data obtained from the semester daily tests conducted last year on ecosystem material revealed that only 18 students, or 50% of the 36 students who took the test, were able to achieve the minimum passing grade. This indicates that students' analytical abilities remain inadequate and require enhancement. This is because the learning process continues to rely predominantly on conventional methods, such as lectures, which result in students being passive participants in the learning process (Muaziyah et al., 2023). Additionally, the learning media available are limited to PowerPoint presentations containing images and theoretical information.

The objective of this research is to develop an interactive multimedia resource based on Problem Based Learning on ecosystem material, with the aim of enhancing the analytical abilities of high school students, who have been identified as exhibiting a lack of proficiency in this area, as evidenced by their performance in problem analysis questions (Supriyadi et al., 2024).

Despite the success of both interactive multimedia and PBL in isolation, few studies have combined these approaches in a way that addresses the need to improve students' analytical skills—a crucial component of scientific literacy. Analytical skills enable students to break down complex systems, identify relationships, and draw evidence-based conclusions, which are vital for understanding ecosystems.

Students' low analytical skills need to be improved. Ecosystem material supports students to analyse various kinds of problems found in the environment. The process of analysing problems that often occur in the environment supports the achievement of active learning activities (Darwina et al., 2022). The use of interactive multimedia in improving students' analytical skills can be optimised if combined with the right learning model (Grinevich et al., 2022; Parra-Valencia et al., 2023).

Multimedia-mediated content serves as an important component in learning (Putri & Gusnedi, 2023). The use of multimedia elements in creating learning content makes the learning experience more meaningful. It becomes an important component in learning because it provides students with alternative means to have many choices when learning in a student-centred learning environment (Prasetyo et al., 2020; Wahyuni et al., 2020). Based on the description above, interactive multimedia is a learning media that can help students in the learning process with interactive students and can make students learn anywhere and anytime.

The Problem Based Learning learning model is one of the learning models that presents real-life problems (Tambunan et al., 2024) as the centre of learning students can be stimulated directly to learn to analyse these problems so that students can improve their ability to analyse a problem (Arifin et al., 2024). This learning model has stages that can develop students' thinking skills, these stages include orientation, formulating problems, organising students, guiding individual and group investigations, developing and presenting work and analysing and evaluating the problem solving process (Asri et al., 2024).

This research addresses this gap by developing interactive multimedia based on PBL principles specifically tailored to ecosystem material. By combining these two pedagogical tools, the study aims to create a learning environment that not only engages students but also significantly enhances their analytical abilities.

Based on the description above, it is necessary to conduct a study to determine the effectiveness of using interactive multimedia based on Problem Based Learning in class X IPA 6. This study aims to determine the development of interactive multimedia based on Problem Based Learning ecosystem material. Knowing the effectiveness of using interactive multimedia based on Problem Based Learning on ecosystem material in improving students' analytical skills. The uniqueness of this research lies in the development of an Android-based interactive multimedia platform, which enhances its accessibility for a wide range of students. Android's widespread use, especially in educational contexts, allows this platform to reach a broader audience, making it a practical tool for modern learning. This accessibility not only supports students' engagement but also promotes the effective integration of Problem-Based Learning (PBL) in their daily studies.

METHOD

This research is a Research and Development study with the 4-D model (Define, Design, Develop, Disseminate). The product trial in this study was conducted in class X IPA 6 at one of the State High Schools in Bogor Regency with an experimental class of 28 students. The product developed is interactive multimedia on ecosystem subject matter. The interactive multimedia developed refers to the application of the scientific approach or scientific approach. The steps of the 4-D development model are as follows:

The defining stage (Define) includes five steps, including: initial and final analysis, student analysis, concept analysis, task analysis, and analysis of learning objectives. The design stage (Design) consists of four stages, including: test preparation, media selection, format selection and initial design to become the first product. The development stage (Develop) consists of two steps including: Expert validation and development test. Expert validation of interactive multimedia on android consists of instructional studies validated by two lecturers, namely media expert lecturers and material expert lecturers and validated by biology teachers. Interactive multimedia was tested on one class with the Weak Experiment model One group pretest-postest design. The Disseminate stage is the final stage where the product is widely tested. However, this research was only carried out until the Develop stage due to limited time and money. The data analysis technique in the expert validation step is as follows:

$$xi = \frac{\Sigma s}{Smax} x100\%$$

Description:
Smax: Maximum Score
ΣS : Total Score
Xi : Questionnaire eligibility value for each aspect

The population used in this study were all grade X students in one of the Bogor Regency State Senior High Schools in the 2019/2020 school year. The sample determination was carried out using purposive sampling technique, namely sampling based on individual considerations or researcher considerations. Based on purposive sampling, the sample selected for study was 36 students of class X IPA 6.

Data collection on analysing ability was obtained through giving a description test of 10 questions given before treatment (pretest) and after treatment (posttest). The ability to analyse in this study describes from C4, namely the cognitive dimension with each level of questions there are 4 types of knowledge dimensions, C4-factual, C4-conceptual, C4-procedural, and C4-metacognitive. Cognitive dimension analysing ability test items are prepared based on the material that will be used during the research, then the instrument is tested on students to obtain data that will be calibrated.

Before the research was carried out, the instrument of analysing ability test questions was consulted with the supervisor and validated by expert lecturers then tested on students who learned about the material that would be used as research material, namely ecosystem material.

RESULTS AND DISCUSSIONS

Once the multimedia-based, problem-based learning applications have been developed for use in high school biology lessons, the next stage is to validate the product. The results of this validation are presented in Table 1, which shows the findings of the expert team on multimedia-based problem-based learning.

Table 1. Presents the Expert Validation Results.

Number	Aspect	V1	V2	V3	Average
1.	Language	8	6	6	
2.	Material	17	17	18	
3.	View	23	20	22	
	Score	48	43	46	
	$xi = \frac{\Sigma s}{Smax} x100$	92%	82%	88%	87%
	Category	Very Appropriate	Very Appropriate	Very Appropriate	Very Appropriate

Based on the results of expert validation, the score obtained from the media expert was 48 with a percentage of 92%, the total score obtained from the material expert was 43 with a percentage of 82%, the total score of the next validator was given by a high school biology teacher, with a score of 46 with a percentage of 88%. The average score of the three validators obtained a value of 87% with a very feasible category.

The product that has been developed after being said to be valid is then tested on the ability to analyse. The results obtained from the calculation of the analysis of the ability to analyse to determine the percentage category of how effective learning media and technical testing of one-class hypotheses can be seen in Table 2.

Table 2. Percentage of Analysing Ability

Number	Indicator	Number of Students	Persentace
1	Factual Knowledge	28	73%
2	Conceptual Knowledge	28	50%
3	Procedural Knowledge	28	60%
4	Metacognitive Knowledge	28	75%

The ability to analyse indicator shows that in factual and metacognitive knowledge the percentage is almost the same with a value of 73% and 75%. While conceptual and procedural knowledge with a value of 50% and 60%. After the percentage category of analysing ability, students will then be given a post-test to measure the ability of students after learning using interactive multimedia, whether there is an increase in cognitive learning outcomes or not when compared to the pre-test value can be seen in Table 3.

Table 3. N-Gain Pre-Test and Post-Test Calculation Results

Criteria	Experimen	
	Pre	Post
Number of Learners	28	28
Highest Score	30	96
Lowest Score	10	60
Average Value	19	71
Average N-Gain	68,06	
Description	Medium	

Table 3 shows the average N-gain value in the IPA 6 experimental class is 68.06, including in the medium category. In the IPA 6 experimental class, the highest pretest score was 30 with an average of 19. Then in the postest, the highest score of students was 96 and had an average post-test score of 71. The IPA 6 experimental class had an increase in scores from the pre-test and post-test. The increase in value is shown in Figure 1.

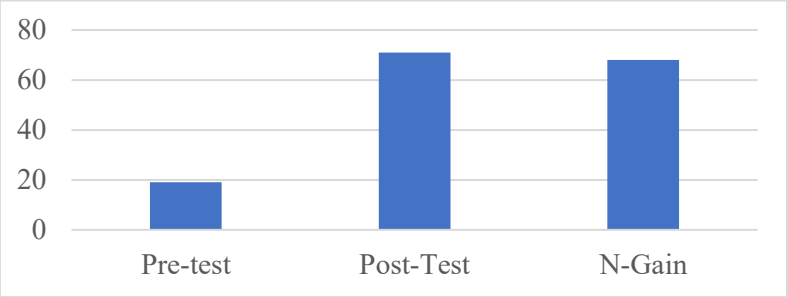

Fig 1. Pretest Postest Score and N-gain of Science Experiment Class 6

The responses of teachers and students to interactive multimedia based on Problem Based Learning can be said to be very good. This is evident from the results of the following questionnaire analysis of teacher and learner responses:

Table 4. Results of Teacher Response Questionnaire Analysis

Total Score	Score Average	NP	Description
47	4,7	94%	Excellent

Table 4 shows the teacher's response to interactive multimedia with a value of 94%. If the questionnaire value is more than 86%, it is included in the very good category.

Table 5. Results of Analysis of Student Response Questionnaire for Science Class 6

Total Score	Score Average	NP	Description
47	47,7	87%	Excellent

Based on the results of the student response questionnaire, interactive multimedia installed on Android received a very good response from students. It can be seen that the average value of the questionnaire analysis obtained is 87%.

Based on the results of the research, it was found that the development of interactive multimedia based on Problem Based Learning installed on Android is expected to help students learn ecosystem material which is considered unable to relate to problems in their environment. The media that has been developed is validated by media experts, material experts, and biology teachers. From the results of validation by experts obtained an average value of 87%.

Table 3 shows the average pretest and post test scores of IPA 6 class were 19 and 71 respectively. The increase in the average pretest and posttest scores means that the use of interactive multimedia can improve students' analytical skills. IPA 6 class has an N-gain value of 68.06 with a medium category. This is because during the learning process, students were treated using interactive multimedia based on Problem Based Learning on Android when learning ecosystem material.

The results of improving analytical skills can be seen in the table presented in table 2. From the table, it can be seen that the highest percentage of student scores after learning is in metacognitive knowledge with a value of 75%, factual knowledge 73%, procedural knowledge 60% and conceptual knowledge 50%. This shows that the learning media is able to influence the highest C4 factual dimension developed with environmental knowledge that is concrete and metacognitive dimensions where students become more aware of their thoughts by analysing a problem and solution on the media.

Interactive multimedia can turn abstract biological material into concrete with the help of visualisation (Amalia et al., 2024). So that students can easily learn biological material (Kong et al.,

2018). In addition, the use of android in the learning process can effectively improve the ability to analyse students (Festiyed et al., 2023; Anggara & Surjono, 2023). Because android can basically help students understand the material quickly, it also motivates students to learn the material (Li et al., 2019; Enachi-Vasluianu & Mălureanu, 2022). That way the ability to analyse students on ecosystem material increases.

The ability to analyse is a thinking process and an important factor in the development of children's intelligence who grow into adults who have critical thinking qualities (Thaneerananon, 2016). Learning using a problem-based model is a learning model that organises learning around questions and problems through the submission of authentic and meaningful real-life situations, which encourage students to conduct investigations and inquiries, and allow for a variety of solutions to the situation (Aqilah & Lathifah, 2023; Putri et al., 2023; Yuniar et al., 2024).

Utilising digital technology in the learning process can increase students' interest and motivation to learn, create a good learning process, and increase students' ability to analyse (Chasanah et al., 2019). With interactive multimedia based on Problem Based Learning installed on Android, it can attract students' interest in learning and can indirectly improve students' learning outcomes (Park, 2017).

This interactive multimedia based on Problem Based Learning also received a good response from a biology teacher at one of the Bogor Regency State High Schools. This can be seen from the value given by the teacher in the multimedia usage response questionnaire, which is 94%. The teacher also added that the interactive multimedia presented has an attractive appearance and material that is needed by students. In addition, the application of digital technology in the learning process can be a feedback or as an evaluation for teachers in planning the next learning process (Agni et al., 2023; Rahmawati & Wachidah, 2023).

Interactive multimedia based on Problem Based Learning that has been developed using the 4-D model has advantages based on trial research and theoretical studies. This interactive multimedia can be installed on Android so that students can learn ecosystem material independently anytime and anywhere. This interactive multimedia already contains videos and several article links that can connect directly to the internet with one click without having to exit first.

Another advantage of interactive multimedia based on Problem Based Learning is that in analysing and evaluating the problem-solving process, matching questions are provided between the problem and the right solution. Similarly, the development of interactive multimedia based on Problem Based Learning obtained good results. Learning media meets the criteria for effectiveness in the learning process and can solve problems derived from the analysis of student activities. Students can learn more about ecosystem material by analysing the problem and its solution. The interactive multimedia also presents quizzes that can be done directly without being connected to the internet and can find out the value directly as well. That way ecosystem material regarding ecosystem components, interactions and energy flows can be conveyed to students in one meeting.

While the Android-based interactive multimedia platform demonstrated potential in enhancing students' analytical skills, several limitations must be addressed. The reliance on mobile devices may exclude students with limited access to smartphones or stable internet, suggesting a need for alternative delivery methods. Additionally, some students struggled with the open-ended nature of Problem-Based Learning (PBL) tasks, indicating that extra support or scaffolding may be necessary. Unexpectedly, difficulties in navigating the multimedia features highlighted the need for improvements in user interface design. Lastly, the focus on quantitative assessment of analytical skills might overlook qualitative insights, recommending future studies incorporate mixed methods for a more comprehensive evaluation of learning outcomes.

CONCLUSION AND SUGGESTION

Based on the results, it can be concluded that the use of interactive multimedia models based on Problem Based Learning in learning, can improve the ability to analyse students. This is evidenced by the results of the N-Gain value of 68.06 which shows moderate criteria. Interactive multimedia based on Problem Based Learning is valid and feasible to use in learning based on the average expert validation score of 87% and the student response questionnaire received a positive response of 87%.

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