



Development of Android-Based E-Module Media through Problem Based Learning on Environmental Change Material to Improve Critical Thinking

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Abstract

This research was motivated by the use of androids in schools after the pandemic, which caused students' learning concentration to be disrupted and the learning model to be less attractive. Students prefer learning models that are more interesting than learning models using the lecture method. One of the interesting learning models is e-module media. E-Module offers easy interactive navigation for its users, which can be applied via Android. The object of this research is the students of Class X, SMA N 12, Semarang. This research is a type of Research and Development (R&D) 4D model, but it is only carried out in three stages: define, design, and develop. The results of this study indicate that the developed e-module media is very suitable for use as a learning medium. This can be seen from the average validation score percentage of media experts of 94.5%, which is a very decent category. The percentage of the average validation score of material experts is 91.5%, which is a very decent category. The results of the readability test questionnaire were 88.1% in the very decent category. There is an increase in students' critical thinking through the N-gain test of 9% in the low category, 31% in the medium category, and 60% in the high category, where as many as > 80% of students get the medium to high category of increased critical thinking or N-gain > 0.3. Based on the results of this study, it can be concluded that the android-based e-module through problem-based learning is very feasible to use and can improve students' critical thinking on environmental change material.

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INTRODUCTION

Education has an important role in learning, and in the era of globalization, education has its own challenges to improve students' thinking skills. Learning is a process that helps someone learn something new. This causes many people and institutions to try a science that can be summarized with technological systems, thus facilitating problems in the learning system. Biology teachers, in their learning process, mostly still use a repetitive mindset, even though the curriculum has repeatedly changed. Most teachers still maintain the learning model that they believe in (Suharno, 2013). The direct learning model that is often taught by most teachers in the classroom makes an impression in the activities. Learning is centered on the teacher, not on the students. As a result, learning activities do not work properly. This is a reason for using problem-based learning models, or problem-based learning.

Ngalimun (2013:89) stated that problem-based learning is a learning model that involves students solving problems with scientific methods so that they can study problems while solving them. Using a problem-based learning model can enhance critical thinking skills. The ability to think critically helps the student solve problems that arise, so critical thinking skills need to be cultivated in the learning process (Haryanti, 2017). PBL characteristics start with problems; students or individuals actively group up to solve problems as well as find solutions. (Suardana, 2019). Problem-based learning encourages authentic problems to become the focus of learning aimed at enabling students to solve problems associated with them as well as helping train them to have high literacy, numeration, and critical thinking. (Masliah *et al.*, 2023).

Learning activities require reducing the lecture method, which is often used in classroom learning; moreover, current learning activities emphasize process skills and active learning. One of the learning resources that can activate students in the learning process is using e-modules. An e-module is an electronic version of a module that has been printed and can be read on certain software, such as Android and computers, in which an animation can be given. The use of animated media combined with audio and text will create a superior learning environment compared to learning environments that use simple images and text (Cahyaningrum *et al.*, 2022). Electronic modules are also ICT-based modules. The advantages of electronic modules are that they are interactive, easy to navigate, contain images, sound, video and animation as well as testing processes and kis that allow for quick feedback. The use of e-modules can increase student interest and motivation in learning science (Emilda *et al.*, 2023). Critical thinking skills are important. Students who think critically are students who are able to evaluate, give arguments, and identify arguments in solving problems (Rustina, 2016). Critical thinking skills include making decisions, concluding, providing clarifications, providing explanations, and making estimates, as well as increasing abilities (Nuryanti *et al.*, 2018).

Suardana (2019) states that the advantages of problem-based learning are that students are very enthusiastic and have a broad perspective on problem solving. Weaknesses of using problem-based learning models include: the teacher must play an active role in learning activities such as presenting material because not all learning materials can apply the problem-based learning model; and the many levels of diversity of students in class make it difficult to determine groups to form discussion groups based on real problems (Rahmadani & Anugraheni, 2017). The PBL steps proposed by Rusman in Mufangati & Juarsa (2018) are: a) Orientation of students to problems; b) Organizing students in learning; c) Guiding students both individually and in groups; d) Developing works; e) analyzing and evaluating the problem.

Often, in the learning process, it is found that some students do not understand the lessons conveyed by the teacher both in class and outside the classroom. This condition was found in SMA 12, where after the COVID-19 pandemic, educational activities were disrupted, especially in the use of Android. This is because previous learning, which was carried out directly at school and accompanied by teachers, was diverted to independent learning from home without teacher monitoring, which is called online learning, which makes the learning process not run optimally (Soesilo *et al.*, 2022).

With the use of an Android-based e-module containing animated videos, it is expected that students can study biology more actively so as to improve their learning abilities and critical thinking. Meanwhile, in the material, many students do not understand the complex material of environmental change, namely environmental changes due to human factors and environmental changes due to natural factors. This material

requires media that can help students visualize learning using animated videos and text so that it can be described clearly and students can enjoy learning. The purpose of this study was to analyze the feasibility of *e*-module learning media and to determine the increase in critical thinking of students after learning using android-based *e*-modules through *problem based learning* learning on environmental change material.

RESEARCH METHOD

This research was conducted at SMA Negeri 12 Semarang, which is located on Jalan Raya Gunung Pati Plalangan, Gunung Pati District, Semarang City, Central Java. The research subjects were students in Class X-11 for the 2022–2023 Academic Year. This research was conducted using the R&D (Research and Development) method, which involved steps in creating new media and perfecting the media (Hanafi, 2017). Research and development (R&D) is currently a type of research that is widely carried out in the world of education, especially in Indonesia. R&D is a type of research that can bridge the gap between basic and applied research (Husamah *et al.*, 2022). Data collection techniques include observation, validation sheets, and questionnaires. This type of research is development research (4D), which includes: define, design, develop, and disseminate (Arkandiatika, 2020). The define stage is carried out to find out the needs of schools regarding problem-based learning, this data is obtained from observation and interviews. The next stage is the design stage at this stage the researcher makes an android-based *e*-module planning design in the form of drafting and layout. The last stage is the develop stage, the data at this stage is obtained from the assessment questionnaire scores from teacher and student validators, as well as the n-gain test. This model research was only carried out until the development stage because the purpose of this research was limited to developing and producing a proper learning medium.

RESULTS AND DISCUSSION

The results obtained in this study demonstrate the feasibility of android-based *e*-module media in improving students' critical thinking skills after learning to use android-based *e*-modules through problem-based learning on Environmental Change material.

E-Module Qualification

The feasibility of the *e*-module was assessed by media and material experts, supported by a questionnaire from students. An analysis of the final *e*-module feasibility results by media and material experts can be seen in Table 1.

Table 1. Analysis of the Final Feasibility Results of E-Module Media by Media Experts and Material Experts

Validator	Aspek yang dinilai	Persentase (%)	Kriteria Kelayakan
Media Expert	Graphic characteristics	95	Very Worth it
	E-module design	90	Very Worth it
	Characteristics of e-modules	95	Very Worth it
Ahli Materi	Content eligibility	91	Very Worth it
	Presentation eligibility	92	Very Worth it

Based on the expert assessment of the developed *e*-module media, validation results were obtained with very feasible criteria, and validation from material experts obtained validation with very feasible criteria. This proves that the *e*-module media used are very feasible to be used as a learning medium.

Student responses were carried out to determine the readability level of the *e*-module filled out by 32 respondents. The student response questionnaire consists of 20 questions. An analysis of the results of the student response questionnaire can be seen in Table 2.

Table 2. Student Readability Test Results

No	Number of Students	Percentage (%)	Category
1.	8	25 %	Worthy
2.	24	75 %	Very Worth it

In Table 2, it can be seen that the average results of the readability test through student response questionnaires show that android-based e-modules through problem-based learning on environmental change material have appropriate criteria and are easily understood by students with student response questionnaires in the appropriate category of 8 children and a very feasible category of as many as 24 children. The response of students to learning aims to find out the impressions and opinions of students after participating in learning using the e-module.

Product Trial Results

The developed media-module is then tested to find out the increase in students' critical thinking. The increase in students' critical thinking was measured by using pretest and posttest questions. The increase in students' critical thinking is measured by the N-gain test (normalized gain) to determine the increase before and after learning using e-module media. The e-module media is said to increase if $> 80\%$ of the number of students achieves an N-Gain value of > 0.3 in the medium to high category. The questions tested consisted of 10 multiple choice questions for the pretest and 5 essay questions for the posttest. The increase in students' critical thinking can be seen from the N-Gain score obtained in Table 3.

Table 3 Results of N-Gain analysis

N-Gain	Category	Frequency	Percentage (%)
$g > 0,30$	Low	3	9
$0,30 < g \leq 0,70$	Currently	10	31
$g > 0,70$	Tall	19	60

Based on Table 3, as many as 9% of students got the low N-Gain category, 31% of students got the medium category, and 60% of students got the high category. From these results, it can be concluded that learning using Android-based e-module media has a positive impact on students, whereas in the results of the N-gain test that has been carried out, as many as 91% of students get medium to high categories. This shows that the Android-based e-module media through Problem-Based Learning on environmental change material improves students' critical thinking.

The results of students' thinking ability tests were analyzed based on indicators of critical thinking, which consisted of 5 essay questions with indicators consisting of formulating the subject matter, expressing facts needed in solving problems, choosing logical arguments, detecting new points of view, and determining the consequences of an action. statement taken. The average results of product trials based on the ability of students to think critically were analyzed based on indicators of critical thinking skills that had been carried out on 32 students in Class X-11 SMA N 12 Semarang, as can be seen in Table 4.

Table 4. Average Percentage of Students' Critical Thinking Ability Indicator Scores

Critical Thinking Indicator	Score percentage	Category
Formulate the main problem	89 %	Very high
Disclose the facts needed in solving the problem	70 %	Tall
Choose logical arguments	86 %	Very high
Detect based on a new point of view	73 %	Tall
Determine the result of a statement taken	48 %	Enough

Based on the data in Table 4, the results of the essay test with five indicators of questions were developed according to the indicators of critical thinking. Each student received an assessment score, with the highest score of 95 and the lowest score of 60. Based on the results obtained, it shows that the ability of students' critical thinking levels is in the moderate to high category. There were 32 students who were categorized into high and very high critical thinking, students who obtained sufficient or moderate critical thinking skills, and 10 students who obtained critical thinking skills in the low category.

The lowest level of critical thinking indicators is the one determining the effect of a statement. Indicators formulate the main issues in answering indicators and are improved through observation, discussion, and reading. This is often done by teachers to train students in implementing classroom learning.

By determining the main issues that exist, students will understand the essence of the problem to be conveyed.

Indicators reveal the facts needed in solving problems with high critical thinking categories, describing reality as it is regarding the things, events, and circumstances that really happened to solve a problem. Indicators are able to choose arguments that are logical and relevant to the very high category. This indicator will make students look for the right reasons to express their opinion on an issue relevant to the main idea, and students will behave regularly and systematically with parts of the whole problem. In the measurement of this indicator, students are faced with problems that require logical arguments to solve problems related to environmental sustainability and the reasons that support these arguments.

The ability to detect an indicator based on a new point of view obtains a high category in critical thinking. Students are able to detect problems from a new perspective and examine problems using certain methods and techniques. Students are able to estimate new points of view from facts, representations, and data. With the existence of indicators based on a new point of view, students will provide a new perspective by looking for alternatives to an existing problem as well as evidence and explanations that can strengthen the point of view.

Indicators reveal the facts needed to solve problems and obtain a high category in critical thinking. Disclosing facts is a statement that describes reality as it is regarding things, events, and circumstances that really happened to solve a problem. Indicators of being able to choose logical, relevant, and accurate arguments will make students look for the right reasons to express their opinion on a problem; they will remain relevant to the main idea in a problem; and they will behave regularly and systematically with parts of the whole problem. In the measurement of this indicator, students are faced with problems that require logical arguments to solve problems related to environmental sustainability and the reasons that support these arguments.

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Students who are less able to think critically because, in the learning process, they still use rote methods and understand the material. The way to improve students' critical thinking skills is to apply computational critical thinking, namely students' critical thinking processes in solving complex problems in various ways (Lestari & Annizar, 2020).

CONCLUSION

Based on the results of the analysis and discussion of the research conducted on the development of Android-based e-module media through problem-based learning on Environmental Change material, it is suitable for use as a learning medium and can improve the critical thinking of X-11 class students at SMA Negeri 12 Semarang.

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