

Development of Android-Based Green Ecology Learning Media to Improve the Environmental Care Character of High School Students in the City of Mataram

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Abstract. This research aims to develop green ecology learning media products based on Android and their influence on the environmental care character of students. This research is development research using the design instructional ADDIE model. The research subject is high school students in Mataram City. The research design used a non-equivalent control group design. The data collection technique used a validation questionnaire to assess the feasibility of Android-based green ecology learning media, teacher and student response questionnaires to assess the implementation of learning using the developed product and learning achievement tests and environmental care character questionnaires to measure the effectiveness of product development. Data analysis techniques in this study were carried out using descriptive statistics using percentages (%) and inferential statistics using ANCOVA (Analysis of Covariance) at a significance level of 5% ($p < 0.05$). The results showed that: (1) the android-based green ecology learning media developed was valid (91.0%) and practical (82.9%), (2) the implementation of android-based green ecology learning media showed environmental care character outcomes better compared to conventional learning, and (3) the results of the ANCOVA test (Analysis of Covariance) show that android-based green ecology learning media influences students' environmental care character ($\text{Sig. } 0.000 < 0.05$). Thus, the developed android-based green ecology learning media can improve the environmental care character of high school students in Mataram City.

1 Introduction

Formation of an attitude or character of caring for the environment in students is one of the goals in facing 21st-century education, which includes four important components, one of which is attitude or character. The components of 21st-century education, especially attitudes or characters, really need to be emphasized and strengthened through six domains, namely mindfulness, curiosity, courage, resilience, ethics, and leadership. On the other hand, the current environmental conditions can be said to be getting worse, and it is feared that this

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will affect the survival of the community. Thus, to align the needs and phenomena around us, we need an attitude or character of caring for the environment towards environmental problems. Based on the Regulation of the Minister of National Education Number 22 of 2006 concerning content standards, the objectives of subjects, especially Biology for senior high school, are to increase awareness and participate in preserving the environment. This means that learning biology is not only aimed at developing students' potential but also fostering a caring attitude towards the environment.

Environmental awareness is part of character education that is ignored by most students [1]. The character of caring for the environment has an emotional side that is still being ignored [2,3]. The attitude of caring for the environment of students is very important and related to students' cognitive abilities.

The world is currently entering the era of the Industrial Revolution 4.0 where technology is developing rapidly in various aspects of life, and education is not an exception [4]. The implementation of technology in learning activities using the Internet is based on considerations according to the perspective of constructivism theory [5]. Transfer of knowledge and learning experience to students in learning requires learning media. However, because it is currently more focused on optimizing technology, the learning media used must be technology-based. Some research results state that the use of instructional media was effective in increasing students' environmental care attitudes [6-8].

Biology learning so far has only been based on textbooks as a means of learning media that is not technology-based, so the learning carried out becomes less meaningful for students. This is supported by our previous finding, which revealed that 54.77% of high school students throughout Lombok Island experienced difficulties with the subject matter being taught at school [9]. In general, the achievement of student learning outcomes in the cognitive aspect is closely related to the affective aspects of students [10]. Especially now, the phenomenon of environmental problems has become a global trend. Therefore, it is necessary to develop green ecology learning media based on Android to improve students' environmental care character.

2 Methodology

This work is research and development (R&D) by adopting the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model [11]. The ADDIE model is a relevant method for developing learning programs [12]. The research design is divided into five stages, namely analysis, design, development, implementation, and evaluation [13].

Analysis Stage

The analysis stage aims to identify needs and collect information from various relevant sources needed at the time of planning the development of android-based green ecology learning media. The needs analysis stage is intended to map the school's carrying capacity for product development. Data collection was carried out through observation, in-depth interviews, and observations of various supporting factors for product implementation at the school where the research was conducted.

Design Stage

The design stage is intended to produce development products, including in the form of Android-based green ecology learning media. In addition, at this stage, an instrument was also designed to measure the character of caring for the environment based on several indicators of the character of caring for the environment. If the planning stage is successful, then proceed to the product development stage for Android-based green ecological learning media products.

Development Stage

The development stage aims to carry out the development of android-based green ecology learning media that has been planned at the design stage. The validation stage is intended to test the validity/feasibility of product development, which consists of subject matter validation and media validation. This process is carried out through Focus Group Discussion (FGD) activities involving development experts and education practitioners. The result of this activity is an android-based green ecological learning media product that enhances the character of caring for the environment.

Implementation Stage

The implementation stage aims to implement green ecological learning media based on Android as a result of the development of environmental care character instruments for high school students in Mataram City. The research design used was a non-equivalent control group design [14].

Evaluation Stage

The evaluation stage aims to assess aspects of the needs, feasibility, practicality, and environmental care character of the high schoolers in Mataram. So, the advantages and disadvantages of Android-based green ecological learning media are known when used during learning. Then, repairs and improvements are made based on the analysis of deficiencies in the teaching materials developed.

Research Instruments

To obtain initial information regarding the carrying capacity of schools for the development of green ecology learning media based on Android, a needs analysis instrument is needed using a teacher needs questionnaire (%). The validity of the instrument is intended to obtain the opinion and assessment of the validator's expert on the product being developed. The results of the validity assessment were used as a basis for decision-making in improving and perfecting the product according to the validator's suggestions for improvement. Android-based green ecology learning media is said to be valid if it meets the minimum product validity criteria ($62.5\% \leq V_a \leq 81.25\%$) [15]. Observation sheet instruments in the form of teacher response questionnaires and student responses were used to obtain product practicality values. The criteria for teaching materials are said to be practical if 1) the average teacher response is in the good category ($62.5\% \leq R_g \leq 81.25\%$), and 2) the average student response is in the good category ($62.5\% \leq R_s \leq 81.25\%$) [15].

Data analysis technique

Data analysis of this development research used the N-gain score test and inferential statistics. Pretest and posttest data of students' environmental care characteristics were analyzed descriptively to find out the measurable increase in environmental care characteristics. This increase is known based on a comparison of the average pretest score with the average posttest score. Meanwhile, inferential statistical analysis used Ancova (Analysis of Covariance) with the pretest as the covariate [16]. This is intended to determine the effect of the application of Android-based green ecology learning media.

3 Results and Discussion

The development of android-based green ecology learning media during the process requires basic information that can be used as support for development. It is anticipated that the results of the mapping of needs using a questionnaire analyzing the needs of teachers can be included in the Android-based green ecology learning media which was developed based on several aspects of the assessment in Table 1.

Table 1. Results of Needs Analysis for the Development of Android-Based Green Ecology Learning Media

Assessment Aspects	Description
Learning Resources	The learning resources used in the biology learning process make more use of textbooks and sometimes the environment.
Instructional Media	In general, biology learning uses PowerPoint media, visual aids, and so on to facilitate the learning process in class. Students have never used digital-based learning media, especially Android. Meanwhile, the biology teacher at the school where the research was conducted had never developed an Android-based learning application.
Student Affective Assessment	The focus of teacher assessment on biology learning prioritizes cognitive and psychomotor assessment. While effective assessment is only limited to measuring attitudes such as honesty, responsibility, discipline, and so on, this assessment has not yet developed environmental aspects.
Smartphone Android	Almost all students have an Android smartphone, although only a few people have smartphones that are not based on Android. However, its use is limited as a means of communication.

The need analysis among high school biology teachers in the city of Mataram shows that some teachers rarely or even never develop android-based biology learning media. Most teachers use learning media that are integrated with technology only in the form of PowerPoint commonly known as PPT (PowerPoint). Meanwhile, current demands require teachers and students to be technologically literate.

Feasibility of Android-Based Green Ecology Learning Media

In general, green ecology learning media based on Android shows a percentage of 91.0% in the "Very Eligible" category. The validation results of each aspect and assessment indicators are presented in Table 2.

Table 2. Validation Results of Android-Based Green Ecology Learning Media

Expert Validator	Assessment Aspects	Assessment Indicator	Average score
Subject matter	Aspects of Content Quality and Purpose	a. Compatibility with Core Competencies and Basic Competencies	5.0
		b. Presentation and accuracy of the subject matter	5.0
		c. Provide examples and solutions	4.5
		d. Update the target of learning media development	4.5
		e. Completeness of the subject matter	4.5
		f. The breadth of subject matter with learning objectives	4.5
		g. Depth of subject matter	4.5
		h. Accuracy and suitability of evaluation questions with competence	4.5
	Linguistic Aspect	a. Readability of messages	4.5
		b. Logic using language	4.5
c. The use of language that is easy to understand and follow good and correct Indonesian language rules		4.0	
d. Use communicative and interactive language, not assertive		5.0	

	e.	Use language appropriate to the stages of development of senior high school level students	4.5	
	f.	The sentences used are clear and easily understood by students	4.5	
Media	Presentation Aspect	a. Systematic consistency of presentation	4.5	
		b. Sequential of presentation	4.5	
		c. The systematics and attractiveness of Android-based green ecology learning media can increase student learning motivation	4.0	
		d. Conformity and accuracy of illustrations with the subject matter	4.5	
	Display Organisation	a.	Display of charts, tables, diagrams, and pictures can support the content of learning media	5.0
		b.	Order and systematic arrangement	4.5
		c.	Placement of interesting scripts, pictures, and illustrations	4.5
		d.	Display compositions of learning media	4.5
		e.	Button placement of learning media	4.0
	Attractiveness	a.	Compatibility of color combinations, images (illustrations), shapes, and font sizes	4.5
		b.	Placement of the stimulus in the form of a picture or illustration, bold, italic, underlined, or color	5.0
		c.	Assignments and exercises are packaged in such a way that students are more interested in doing them	4.5
		d.	Background of learning media	4.5
		e.	Animation setting	4.5
		f.	Ease of use	4.5
Font Shape and Size	a.	The shape and size of the letters are easy to read according to the needs	5.0	
	b.	Comparison of proportional letters	4.5	
	c.	The use of capital letters follows good and correct rules of the Indonesian language	4.5	
		Percentage	91.0%	
		Criteria	Very eligible	

The Practicality of Android-Based Green Ecology Learning Media

The results of the practicality test of Android-based green ecology learning media showed that the percentage of teacher responses was 87.8% with the criteria "Very Practical," and the percentage of student responses was 78.0% with the criteria "Practical." The results of the practicality test of Android-based green ecology learning media based on the responses of teachers and students are presented in Table 3.

Table 3. Practical Test Results of Android-Based Green Ecology Learning Media

User Subject	Assessment Aspects	Average Score
Teacher	Flexibility in the use of learning media	4.0
	Ease of delivery of aspects of knowledge to students	4.5
	Encouraging active and independent student learning engagement	4.5
	Ease of understanding the content of the subject matter presented	5.0
	Growing and increasing interest in learning	4.5
	Use of communicative language	4.5
	Ease of finding information	4.0
	Time efficiency in understanding the content of the subject matter presented	4.0
	The presentation of learning media is short, concise, and clear	4.5
	Percentage	87.8%
	Criteria	Very practical
Students	Clarity of writing	3.9
	Ease of selecting menus	3.8
	Button usability	3.6
	Color integration	4.2
	The attractiveness of the display	3.9
	Clarity of subject matter	3.9
	Clarity of language	4.0
	Ease of understanding the subject matter	3.8
	The attractiveness of the subject matter presentation	4.0
	Percentage	78.0%
	Criteria	Practical

Based on Table 3, it is known that the average percentage value of practicality of Android-based green ecology learning media based on teacher and student responses shows a percentage value of 82.9% with the "Very Practical" criterion.

Environmental Care Character

The results of the implementation test to determine the effectiveness of green ecology learning media based on Android on students' environmental care characters were obtained based on the results of ANCOVA (Analysis of Covariance) assisted by the SPSS application version 17.0. The results are presented in Table 4.

Table 4. ANCOVA Test Results (Covariance Analysis)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	15685.418 ^a	2	7842.709	33.256	.000
Intercept	14082.366	1	14082.366	59.714	.000
PRETEST	2299.415	1	2299.415	9.750	.002
KELAS	5880.473	1	5880.473	24.935	.000
Error	36553.380	155	235.828		
Total	599090.710	158			
Corrected Total	52238.798	157			

a. R Squared = .300 (Adjusted R Squared = .291)

Based on the output in Table 4, the value of Sig.0.000 <0.05 is obtained so that Ho is rejected. This means that the Android-based green ecology learning media has a significant effect on the environmental care character of students. The resulting significant influence can be caused by several factors that strengthen the learning process through the implementation of green ecology learning media based on Android developed in this study.

Learning media as a learning tool for students has contributed to empowering environmental care characters [7,17,18]. Smartphone-based mobile learning makes it easier for students to interact with the material they are studying and transfer knowledge more effectively and efficiently [6]. Interactions that exist between students can form patterns of interaction, such as sharing information about students' self-development needs.

Android-based green ecology learning media can empower students' environmental care characteristics. This is reflected in the improvement based on the mapping of learning outcomes and environmental care character questionnaires. The substance of green ecology material also contributes to the development of students' environmental care character. Material information presented in learning media ultimately influences the decision-making process about something that is considered right or wrong. Appropriate decision-making will be reflected when a person has adequate capacity, especially capacity for matters relating to the surrounding environment. Emotional and cognitive or affective-cognitive processes can be intertwined when both can be raised by learning materials that are integrated with multimedia [19]. The affective element in question can be in the form of sympathy, anticipation, empathy, and the process of transmitting emotions.

The implementation of biology learning using green ecology learning media based on Android can make a positive contribution to increasing the character of caring for the environment. Generation Z students are authentic digital natives, namely the hypercognitive generation with a different profile than before [20]. The use of technology can add value to the teaching and learning experience that many students use to improve or accelerate their academic process. Thus, learning using Android-based learning media effectively makes a positive contribution to achieving learning objectives.

The environmental care characters identified as having increased are reflected in the students' arguments detailed in the learning outcomes and the mapping of environmental care character indicators based on the distribution of questionnaires. Some of the attitudes in question include (1) self-awareness to plant one type of tree in the surrounding environment and the school environment, (2) trying to sort waste based on its characteristics, namely organic and inorganic waste, (3) initiatives to provide education through simple campaign activities about sorting organic and inorganic waste, (4) showing environmental care behavior by not allowing waste to be burned, (5) determining attitudes to hoard waste in the environment instead of burning it, and (6) efforts to reuse items that are generally discarded to become useful items. In classes that were not taught using Android-based green ecology learning media, some of the indicators referred to decreased, or it could be said that the character of caring for the environment in these indicators was not reflected. The indicators in question are (1) self-awareness to plant one type of tree in the surrounding environment and the school environment, (2) efforts to sort waste based on its characteristics, namely organic and inorganic waste, (3) initiatives to provide education through simple campaign activities on waste sorting organic and inorganic, and (4) efforts to reuse items that are generally discarded to become useful items.

The developed learning media can generate self-awareness of environmental concerns through planting trees in the environment. This is because in this Android-based green ecology learning media, various illustrations and data or facts are presented that describe the environmental impact of an increase in the earth's temperature. This gives each student awareness to be more concerned with environmental conditions. Various opinions also state

that increasing environmental care attitudes can use various learning media [21-23]. E-learning-based learning, especially, can foster motivation and inspire someone to reach their potential [24]. Various attempts have been made to increase students' environmental care attitude, one of which is by applying Android technology, which can sort waste such as smart waste [25]. This tool is a form of technological innovation in the 21st century.

Caring for the environment is an attitude and action that seeks to prevent damage to the natural environment and the surrounding environment, as well as development efforts to repair natural damage [26]. This attitude is reflected in students who have previously studied using Android-based green ecology learning media. This form of effort is realized through simple campaign activities to sort organic and inorganic waste. The benefits obtained are not only intended for other people but also for individual students.

4 Conclusion

The development of learning media always contributes to achieving optimal learning objectives. The development in this study focuses on green ecology learning media based on Android on environmental change material. The conclusions obtained from this development research are: (1) classic android-based green ecology learning media has a percentage of 91.0% with the criteria of "Very Eligible," (2) the practicality of android-based green ecology learning media has a percentage of 82.9% with the criteria "Very Practical," and (3) The application of Android-based green ecology learning media has a significant effect on increasing students' environmental care character (Sig.0.000<0.05).

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