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Android-Based Biology Learning Media: A Breakthrough to Improve Senior High School Students' Learning Outcomes

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Abstract: This study aims to develop an Android-based biology learning media and determine its effectiveness in improving the learning outcomes of 11th-grade high school students on the circulatory system material. The research method used is Research and Development (R&D) with the ASSURE development model. The trial subjects consisted of 6 students for the small group and 18 students for the large group. Validation results from material and media experts indicated that the media was in the "Highly Feasible" category. Teacher and student assessments also showed positive responses with a "Feasible" category. Students' learning outcomes increased significantly after using the developed learning media, as evidenced by the comparison of pretest and posttest scores.

Keywords: Android, Learning media outcomes, System circulatory

A. Introduction

Learning outcomes are changes that occur in students as a result of the learning process, including cognitive, affective, and psychomotor aspects. These changes can be observed in the development of

students' knowledge, attitudes, and skills. Learning outcomes reflect behavioral changes in students after participating in learning activities, which are influenced by various factors such as the physical and psychological conditions of the students, family environment, school environment, and social environment (Haryadi, 2021).

That learning outcomes can be seen when students experience a change from not knowing to knowing, or from not understanding to understanding. Learning outcomes reflect changes within students as demonstrated through their mastery of knowledge, attitudes, and skills in accordance with instructional objectives. These three domains cognitive, affective, and psychomotor are key components in evaluating learning outcomes. Their achievement is significantly influenced by the strategies, models, and media employed during the learning process (Nurhasnah et al., 2023). One approach to improving learning outcomes is through the use of appropriate learning media. Learning media can help students understand concepts more effectively, increase learning motivation, and make learning more enjoyable (Wahyuningtias et al., 2020). When learning media are tailored to the characteristics and needs of students, learning outcomes tend to improve significantly.

However, the reality in the field shows that there are still obstacles in the learning process that can affect students' learning outcomes. Based on initial observations at SMAN 14 Kota Jambi, it was found that the school is undergoing facility construction, resulting in the learning activities being divided into two shifts: morning and afternoon. Consequently, the lesson time was shortened from 45 minutes to 25 minutes. In addition, learning facilities such as printed books are still very limited. The books are only available at school and cannot be taken home, so students do not have sufficient access to study independently at home.

The limitation of printed book media directly impacts students' learning outcomes. Those who do not have full access to learning resources tend to experience difficulties in understanding the material. Printed book media that cannot be accessed independently by students can limit their exploration of the subject matter, hinder concept comprehension, and reduce learning motivation (Akbar, 2017). The use of printed books as learning resources poses challenges when students lack adequate guidance or access. Their reliance on teachers to understand the book content results in low learning autonomy, limited material exploration, difficulty in grasping concepts, and ultimately a decline in learning motivation (Solong et al., 2024). When learning media is less supportive, information transfer does not run optimally, ultimately resulting in low learning outcomes.

Interviews with two biology teachers at SMAN 14 Kota Jambi also revealed that an unconducive classroom environment and low student motivation pose significant challenges. The teachers have attempted to use learning media such as YouTube videos and presentations, but there has been no utilization of Android application-based media. In fact, from a survey conducted with 129 students, almost all are active Android smartphone users. About 53.5% of them stated that the circulatory system material is difficult to understand due to many unfamiliar terms, and they need interactive and easily accessible learning media.

Currently, the development of digital technology offers various solutions to learning challenges, one of which is through Android application-based learning media. Mobile learning media can increase learning flexibility because it can be accessed anytime and anywhere. Besides providing attractive visual displays, this media also allows the integration of audio, video, text, images, and interactive quizzes that can help students understand the material comprehensively (Kartini et al. 2020). That digital learning media

can encourage active participation, critical thinking, and collaboration between students and teachers (Ciric et al. 2021).

Therefore, teachers are expected to effectively utilize learning media to motivate students, so that learning objectives and outcomes can be achieved (Tafonao, 2018). In today's digital era, the use of smartphones as learning media is highly potential. Smartphones have become multifunctional devices supporting communication, information searching, and learning (Choi et al. 2016). Android, as the most widely used operating system among students, provides ease in developing and accessing learning applications (Annisa et al., 2017). One of the main benefits of Android is its use as a learning media platform. This research provides a novelty in the form of Android-based biology learning media specifically developed to address the unique learning challenges faced by students in a dual-shift school with limited access to textbooks.

B. Methods

This development research uses the R&D (Research and Development) method, which is a research method used to produce a specific product and to test the effectiveness of the resulting product. These products are not limited to books, modules, or learning aids in classrooms or laboratories, but can also include educational games that motivate students (Amir, 2019). Research and development methods constitute a scientific system aimed at updating or even producing a new product by analyzing, researching, designing, producing, and testing the product's validity (Sugiyono, 2019). The R&D method is very popular in the development of media and learning tools because this approach allows the developed product to be thoroughly tested in the field and be relevant to user needs.

The development model used in this study is the ASSURE model, which focuses on lesson planning for actual classroom learning situations. This model leverages media and technology, which have become essential tools to assist students in achieving learning objectives (Smaldino et al., 2024). The stages in developing learning media using the ASSURE model include several components, namely: (A) Analyze Learner Characteristics; (S) State Objectives; (S) Select Method, Media, or Materials; (U) Utilize Media and Materials; (R) Require Learner Participation; (E) Evaluate and Revise.

Figure 1. ASSURE Step

The determination of the validity of the media and the validity of the learning materials to be developed is done by examining the results of a questionnaire consisting of 16 questions regarding the feasibility of the product, to analyze the calculations using:

Table 1. Validation Assessment Categories for Media Experts and Content Experts

Score Scale	Score Range	Percentage (100%)	Description
4	52 – 64	81.2 – 100	Very Feasible
3	40 – 51	62.5 – 79.7	Feasible
2	28 – 39	43.7 – 60.9	Not Feasible
1	16 – 27	25 – 42.1	Very Not Feasible

The determination of validity based on small group testing was conducted with 6 students, and large group testing was conducted

with 18 students from class XI Science 2 at SMAN 14 Kota Jambi, representing different levels of academic achievement (high, medium, low). The method for determining students' perceptions in the small group test, using a total of 16 questionnaire items, is as follows:

Table 7. Assessment Categories for Small Group Testing

Score Scale	Score Range	Percentage (100%)	Description
4	312 – 384	81.3 – 100	Very Feasible
3	240 – 311	62.5 – 80.1	Feasible
2	168 – 239	43.7 – 62.2	Not Feasible
1	96 – 167	25 – 43.5	Very Not Feasible

Table 8. Assessment Categories for Large Group Testing

Score Scale	Score Range	Percentage (100%)	Description
4	1,560 – 1,920	81.3 – 100	Very Feasible
3	1,200 – 1,559	62.4 – 80.2	Feasible
2	840 – 1,199	43.8 – 62.3	Not Feasible
1	480 – 839	25 – 43.7	Very Not Feasible

The N-Gain test is an analytical method used to measure the effectiveness of a learning intervention by comparing the increase in scores between the pretest (before learning) and posttest (after learning). The formula for calculating the N-Gain is as follows:

$$\text{N-Gain} = \frac{Postest\ Score - Pretest\ Score}{Maximum\ Score - Pretest\ Score}$$

Remarks:
Pretest Score: the score obtained before the treatment

Posttest Score: the score obtained after the treatment
Maximum Score: the highest possible score that can be achieved

Figure 2. The Formula for Calculating The N-Gain

With the N-Gain criteria as shown in the table below:

Table 4. N-Gain Score Criteria

Score	N-Gain Criteria
N-Gain > 70%	High
30% ≤ N-Gain ≤ 70%	Medium
N-Gain < 30%	Low

C. Results and Discussion

Analyze Learner

A general analysis was conducted to identify the fundamental problems encountered during the classroom learning process. Based on field interviews with the biology subject teacher for class XI Science, it was found that students are still using the K13 curriculum, face shortened learning time allocations, and lack adequate learning facilities. As a result, students experience difficulties in understanding several biology topics during the learning process. These challenges can affect the quality of students' learning processes, making them less optimal.

Competency analysis was conducted to determine the competencies needed by students in the learning process. The identification of students' initial abilities was based on interviews with the biology teacher, who stated that students were not very conducive during the learning process. This was supported by the results of a student needs questionnaire, which showed that students were interested in new learning media, and 53.5% of them found it difficult to understand the sub-topic of blood circulation due to its abstract

nature and the presence of many unfamiliar terms. Therefore, appropriate learning media are needed.

Learning styles are an important factor in improving academic achievement and the quality of learning in education. Learning styles are related to an individual's personality, which can be influenced by innate traits, experiences, education, and developmental history through the senses (Surur, 2020). The analysis of students' learning styles was obtained from questionnaire results distributed to students of classes XII1, XII2, XI1, and XI2. The results showed that 70.5% of students were interested in interactive learning media and found it easier to understand learning materials presented in digital media format. This study is limited to the circulatory system material and was conducted only in one school setting. Future research may expand to other biology topics and a broader population to validate generalizability.

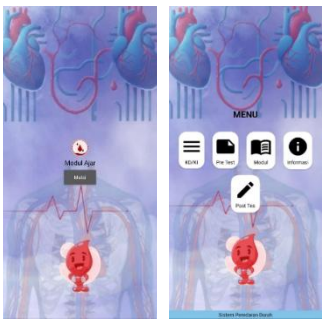
State Standards and Objectives

The second stage is determining the targets or standards and objectives, which are derived from the lesson syllabus aligned with the core competencies and basic competencies in the 2013 curriculum. After analyzing the Core Competencies and Basic Competencies, the next step is to formulate learning objectives for the topic of blood circulation, specifically the sub-topic of the lymphatic system. The learning objectives are as follows: (1) Students are able to accurately analyze the blood classification system in the human body; (2) Students are able to analyze the relationship between the blood classification system and blood transfusion accurately; (3) Students are able to correlate the lymphatic system with its functions in detail; (4) Students are able to conclude the relationship between organ tissues and components of the lymphatic system and their functions in depth; (5) Students are able to analyze the advantages and disadvantages of applying

various technologies to address blood circulation problems accurately**.**

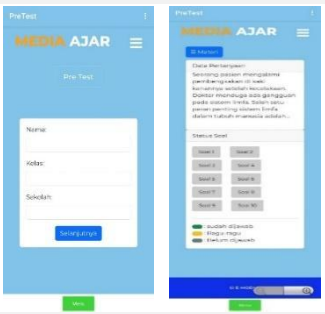
Select Strategies, Technology, Media, and Materials

The selection of strategies, technology, media, and teaching materials is an essential component to support students in achieving the learning objectives more easily. The methods used in this development are question-and-answer and discussion. The learning media developed is an Android-based learning application that can be accessed using an Android smartphone. There are six components included in the application-based learning media product, as follows figure 3:

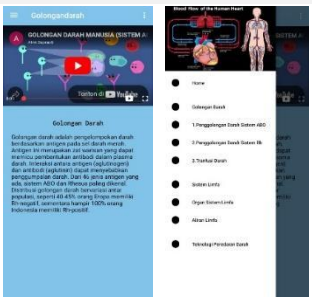


(a) Home page of the application

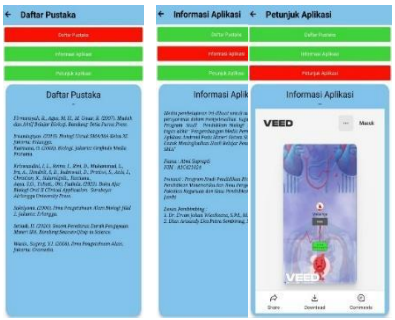
(b) Core & basic competencies



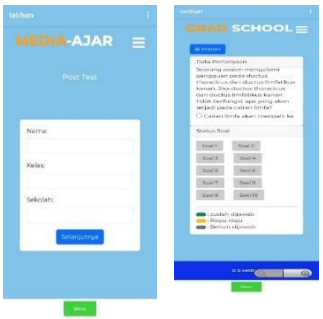
(c) Pretest



(d) Module/material



(e) Application information



(f) Posttest

The use of this learning media can be applied to all learning methods because it utilizes technology in the form of an application accessed via smartphone. The media serves as a tool to deepen understanding and encourage students to be active in their education, in addition to functioning as a means of disseminating information in the context of modern education (Nurazizah, 2024). The Android application is designed for offline access after download and can be provided to students by the teacher for independent learning at home.

Utilize Technology, Media and Materials

Before being used as a learning medium, several validations from experts are needed to determine the feasibility and suitability of the learning media to be developed. This Android application-based learning media will be developed and validated by material experts twice. After validation, suggestions and comments will be obtained to improve the product so that the quality of the final product will be maximized. The results of the material validation and the suggestions and comments provided by the validators are as follows:

Table 5. Validation Results for Material Expert Aspect

No	Indicator	Validation Round

		Validation 1	Validation 2
1	Competency	58.3%	91,6%
2	Content	59.3%	96,8%
3	Language	70.0%	100%
	Average (%)	**57.8%**	**98,8%**
	Category	**Feasible**	**Very Feasible**

The results of the material expert validation showed an increase in percentage from the first validation stage to the second, based on the assessment aspects. In the first stage, the validation by the material expert obtained a percentage of 57.8% with the category "Feasible." After making improvements, a second validation was conducted, resulting in a percentage of 98.8% with the category "Very Feasible." These validation results indicate that the developed learning media product is suitable for field testing. It can be concluded that the quality of the developed product meets the expected indicators, which were continuously improved in terms of basic competencies, learning objectives, content, and language aspects.

According to Marisa et al. (2023), after receiving feedback and suggestions from validators, the researcher revised the product based on the analysis results. The developed learning media fulfilled the validity criteria based on the established indicators.

This Android-based learning media will be developed and validated by media experts in three stages. After each validation, suggestions and comments will be gathered to improve the product so that the quality of the final product can be optimized. The result are follows:

Table 6. Validation Results for Media Expert Aspect

No	**Indicator**	**Validation Round**		
		Validation 1	**Validation 2**	**Validation 3**
1	Appearance	72.7%	79,5%	100%
2	Programming	70.0%	90%	95%
	Average (%)	**71.8%**	**82,8%**	**100%**

Category	Feasible	Very Feasible	Very Feasible

The results of the media expert validation showed an increase in percentage across the first, second, and third validation stages based on the assessment aspects. In the first stage, the media expert validation obtained a percentage of 71.8% with the category "Feasible." Improvements were then made to the media, and the second validation was carried out, resulting in a percentage of 82.8% with the category "Very Feasible." Further improvements were made based on suggestions, and the third validation achieved a perfect score of 100% with the category "Very Feasible". It can be concluded that the quality of the developed learning media product aligns with the predetermined indicators, which were continuously improved in terms of basic competencies/indicators/learning objectives, content, and language aspects.

These improvements were made to ensure the product is attractive and feasible for field trials. This is in line with Hanin & Lutfi (2023), who stated that the product validation stage is conducted to assess whether the developed interactive learning media is appropriate to be implemented as one of the learning resources for students.

Require Learner Participation

The Android-based learning media that has been validated by media and material experts and declared feasible for field testing was subsequently given to the biology subject teacher at SMAN 14 Kota Jambi for evaluation. The teacher's evaluation of the media was conducted by providing a questionnaire to gather opinions, suggestions, and comments regarding the product being tested.

Table 7. Teacher Evaluation Results

No	Indicator	Score
1	Content Feasibility	78.5
2	Language	68.7

3	Presentation	75.0
4	Graphics	66.6
Average (%)		**71.8%**
Category		**Feasible**

Based on the table, the evaluation result obtained a score of 46 out of a maximum score of 64, resulting in a product quality percentage of 71.8% with the category "Feasible." The teacher's assessment indicates that the developed learning media product is feasible to be tested in the field.

The small group trial was conducted by distributing questionnaires to 6 students selected based on high, medium, and low levels of learning ability. The results of the small group trial on the developed learning media product are as follows.

Table 8. Small Group Testing

No	Indicator	Score
1	Feasibility	86.1
2	Language	89.5
3	Presentation	83.3
4	Appearance	85.4
Average (%)		**85.9%**
Category		**Highly Feasible**

The small group trial was conducted on 6 students from grade XI IPA. This trial involved completing an evaluation questionnaire consisting of 16 items in a single session. Based on the small group results table, the total score percentage of 85.9%, which is categorized as feasible to proceed with a large-scale trial.

Table 9. Large Group Testing

No	Indicator	Score
1	Feasibility	87
2	Language	87.5
3	Presentation	84

4	Appearance	86.8
	Average (%)	**81.2%**
	Category	**Highly Feasible**

The large group trial was conducted on 18 students from grade XI IPA by completing an evaluation questionnaire consisting of 16 questions. The large group trial was carried out in a single session, resulting in a total percentage of 81.2%, which is categorized as highly feasible for development.

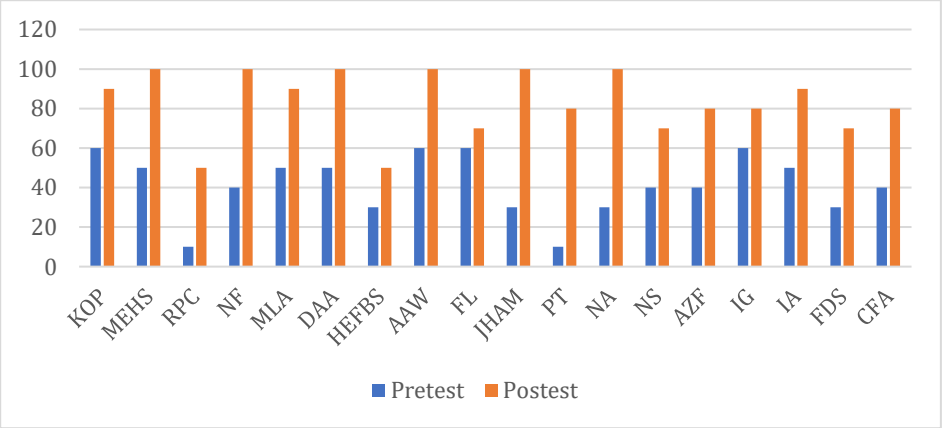
Normality testing was used to check whether the data were normally distributed. If the significance value is > 0.05, data is normal; if < 0.05, it is not (Rizka et al., 2023). The pretest-posttest learning data had Asymp. Sig. (2-tailed) = 0.048 < 0.05, indicating the data were not normally distributed. Therefore, a non-parametric test, the Mann-Whitney test, was used. The Mann-Whitney test resulted in Asymp. Sig. (2-tailed) = 0.000 < 0.05, indicating a significant difference between pretest and posttest scores. Thus, the Android-based Biology Learning Media significantly influenced student learning outcomes.

The Mann-Whitney test result indicated a significant difference in student learning outcomes, which supports the conclusion that the developed media had a real impact on improving students' understanding.

Table 10. N-Gain Score

	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
NGain Score	24	.25	1.00	.7292	.23341
NGain Persen	24	25.00	100.00	72.9299	23.341111
Valid N (listwise)	24				

Figure 4. Large Group Testing Pretest & Posttest Diagram



The N-Gain score calculation showed an average of 72.93%, categorized as "Effective" based on the N-Gain effectiveness interpretation table. This suggests that the Android-based Biology Learning Media effectively improves student learning outcomes.

The large group trial was conducted by distributing questionnaires to 18 students selected based on high, medium, and low learning abilities. This trial was carried out on students of grade XI at SMA Negeri 14 Kota Jambi, who were then given a questionnaire in the form a consisting of 16 questions. The product trial with 18 students (large group) using a questionnaire showed an assessment score of 81.2%, categorized as "Very Feasible," supported by an increase in learning outcomes from a pretest average of 41.1% to a posttest average of 83.3%, an improvement of 42.2%.

This demonstrates that the developed learning media positively impacted student learning and is suitable as an instructional aid to facilitate classroom learning. Teachers assess learning outcomes through various methods and tools to gauge students' achievement of competencies (Mahdiansyah, 2018). Appropriate learning media

aligned with student abilities and conditions supports the success of the learning process (Marbella et al., 2024).

Based on the results obtained**,** there was a good evaluation from the teacher and a positive response from the students. This is evidenced by the average teacher evaluation, which falls into the "good" category, and the student responses, which are categorized as "very good." Likewise, the significant improvement in pretest and posttest scores indicates that the developed media product is feasible to be used as a learning aid and can facilitate the teaching and learning process in the classroom.

Evaluate and Revise

The revision stage was carried out after each validation cycle by implementing the suggestions given by the experts, especially regarding competency formulation, content structure, and programming design to optimize the quality of the media. The advantages of this android-based learning media are that it can be accessed anywhere due to its flexibility.

The use of this learning media is easy and practical, so students do not need special skills to access it. There are evaluation questions useful for measuring students' level of understanding of the material presented. The drawbacks of this android-based learning media are that the application only focuses on the sub-material of the blood circulation system. Before using the application, the app file must be downloaded. Accessing the app requires an online connection, so often the process is hindered by internet speed. During the learning process, students' attention is easily distracted by other applications.

D. Conclusions

Based on the research and discussion on the biology learning media developed as an Android-based application, the conclusions are; The development process used the ASSURE model consisting of six stages: analyzing learner characteristics, stating objectives, selecting methods/media/materials, utilizing media and materials through expert validation, involving learners via trials with biology teachers and students, and evaluating and revising based on expert feedback.

The Android-based learning media on the blood circulation system for 11th-grade science students is feasible for use in learning. This is supported by expert validation results with 96.8% (material experts) and 98.4% (media experts), both categorized as "Highly Feasible". Biology teachers rated the media with a feasibility score of 71.8%, categorized as "Feasible," indicating it can be used as an alternative learning media. Student responses were positive, with small group trials scoring 85.9% and large group trials scoring 81.2%, both in the "Highly Feasible" category. Student learning outcomes improved significantly after using the media, demonstrated by an average increase of 42.2 points from pretest to posttest scores.

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