



Development of Android-Based Augmented Reality Learning Media on the Human Respiratory System to Improve Student Learning Outcomes

Yusuf Rosyid Ridho^{1*}, Novi Setyasto¹

¹ Primary School Teacher Education, State University of Semarang, Semarang, Indonesia

Received: January 22, 2024

Revised: April 18, 2024

Accepted: May 25, 2024

Published: May 31, 2024

Corresponding Author:

Yusuf Rosyid Ridho

yusufrosyid17@students.unnes.ac.id

DOI: [10.29303/jppipa.v10i5.7024](https://doi.org/10.29303/jppipa.v10i5.7024)

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Abstract: This study aims to develop Android-based augmented reality learning media for the science subject, specifically on the human respiratory system for grade V students at SDIT Sultan Agung 05. This research employs a Research and Development (R&D) approach using the Borg and Gall development model. The subjects of this study include validation test subjects consisting of material experts and media experts, and trial subjects consisting of grade V teachers and 27 grade V students. Data collection techniques used are observation, interviews, questionnaires, documentation, and tests (pretest and posttest). The results indicate that the Android-based augmented reality learning media is rated "very feasible" by both material and media experts. The responses from teachers and students are very positive, with an average percentage of 88%, indicating practicality. The pretest and posttest scores showed an average increase of 33.37 with an N-gain of 0.73, categorized as high. This indicates that the Android-based augmented reality learning media is feasible, practical, and effective in improving student learning outcomes in the science subject of the human respiratory system.

Keywords: Augmented reality; Android; Learning outcomes; Science

Introduction

The development of technology has had a significant impact on the field of education. Technological advancements can transform the way we learn and teach. This change not only affects students and teachers but also the entire education system. In line with technological advancements, Ministerial Regulation No. 16 of 2022 by the Ministry of Education, Culture, Research, and Technology explains that quality learning experiences can be achieved by applying material based on real-world problems or contexts, encouraging active participation of students, optimizing the use of resources, and utilizing information and communication technology. One way to provide quality learning experiences is by using information and communication technology as a learning medium. The use of learning media can motivate students to learn and

increase their interest in lessons. It can also help students become more active in learning activities (Amri & Kartono, 2023; Hardiansyah, 2022). The integration of technology with learning media can aid in enhancing 21st-century skills development through the teaching and learning process (Fakhriyah et al., 2022; Oktasari et al., 2019).

However, in practice, the use of technology-based learning media still faces challenges and shortcomings. Previous research findings indicate that many teachers have not effectively utilized learning media (Fitriyanti et al., 2021). This is supported by the fact that many teachers have not used learning media due to a lack of skills in developing technology-based learning media (Alfian et al., 2022; Rahma et al., 2023). The use of conventional and non-interactive learning media makes students less focused and unmotivated in following

How to Cite:

Rosyid, Y. R. R., & Setyasto, N. (2024). Development of Android-Based Augmented Reality Learning Media on the Human Respiratory System to Improve Student Learning Outcomes. *Jurnal Penelitian Pendidikan IPA*, 10(5), 2503–2510. <https://doi.org/10.29303/jppipa.v10i5.7024>

learning activities (Ayu Mawardhani et al., 2023; Rejekiingsih et al., 2023).

Based on observations and interviews conducted at SDIT Sultan Agung 05 with fifth-grade teachers, several issues were identified, such as learning resources and media not being used optimally. Consequently, the material delivered relies solely on the teacher's and students' books. Facilities like LCDs, projectors, and Wi-Fi available in each classroom are also underutilized by teachers. The rapid advancement of technology has led students to become dependent on gadgets. Survey results from fifth-grade students at SDIT Sultan Agung 05 indicate that the average gadget use is 4-6 hours per day. Students use gadgets mainly for social media and gaming, rarely for beneficial activities like studying. This dependency can affect their learning outcomes, as seen in the low performance in the science subject (IPAS). Out of 28 students, 20 (71.5%) have not met the passing grade in IPAS, while only 8 students (28.5%) have.

A solution to address these issues is to develop innovative and creative technology-based learning media that can capture students' attention. One such development is Augmented Reality (AR) technology. Augmented Reality is a technology that integrates 3D objects into the real environment, directly or indirectly (Yusa et al., 2023). AR can help teachers explain or demonstrate concepts directly to students by displaying virtual objects in real environments. This can aid in improving students' learning outcomes (Ployjiw & Michel, 2023; Setiawan et al., 2023). AR can also make students more active and motivated to participate in learning activities. Additionally, AR can transform typically dull learning experiences into more enjoyable ones for students (Whatoni & Sutrisno, 2022; Yusa et al., 2023).

Augmented reality learning media can be developed using the Android platform to enhance more interactive and enjoyable learning experiences (Setiawaty et al., 2023; Syawaludin et al., 2019). Utilizing the Android platform as a learning medium supports the teaching and learning process both inside and outside the classroom. The use of Android-based augmented reality learning media makes it easier for students to learn anywhere and anytime according to their needs (Pahlifi & Fatharani, 2019).

Previous research indicates that augmented reality learning media is innovative, practical, and effective for use in learning activities (Ramadhanti et al., 2021). Other studies also state that augmented reality learning media is effective in delivering information to students (Akhsan et al., 2023; Majid et al., 2023). Android-based augmented reality learning media can also improve students' learning outcomes (Listiyani et al., 2021; Yusa et al., 2023). Based on these findings, it can be concluded that Android-based augmented reality learning media

can be used to improve students' learning outcomes in elementary science subjects. The advantage of Android-based augmented reality learning media is its ability to virtually visualize abstract concepts through 3D objects, making it a more effective learning medium. Therefore, this research aims to develop Android-based augmented reality learning media about the human respiratory system to enhance the learning outcomes of fifth-grade students at SDIT Sultan Agung 05. It is expected that augmented reality media can improve students' understanding of the human respiratory system in science subjects.

Method

The type of research used is Research and Development (R&D), which results in the creation of Android-based augmented reality learning media to improve learning outcomes in the human respiratory system for fifth-grade students at SDIT Sultan Agung 05. In the research and development of Android-based augmented reality, the researchers refer to the steps outlined by Borg and Gall, which consist of 10 steps: (1) potential and problems; (2) data collection; (3) product design; (4) design validation; (5) design revision; (6) product testing; (7) product revision; (8) usage trial; (9) product revision; (10) mass production. Due to time and cost constraints, the research and development of this augmented reality media are limited to step 8, which is the usage trial. The research scheme can be seen in Figure 1.

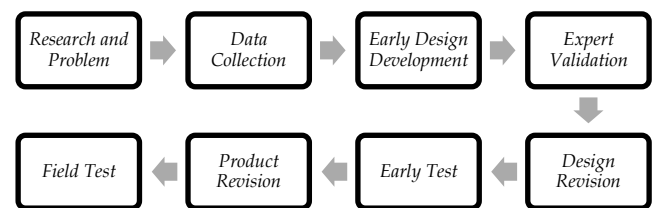


Figure 1. Modified from Borg & Gall Model

The potential and problems stage is carried out to identify the potential and issues present in the field by conducting observations, interviews, questionnaires, and documenting data in the form of learning outcomes of fifth-grade students at SDIT Sultan Agung 05. The next stage involves collecting data and information by distributing questionnaires to both teachers and students to identify any problems found. The data and information obtained are then analyzed to plan the product to be developed.

The next stage involves the researcher designing the product according to the problems found in the field. The material and product design are adjusted to the

learning achievements (known as CP) and the learning objectives to be achieved, namely for students to simulate using images/charts/tools/simple media about the human organ system (respiratory/digestive/circulatory systems) related to how to properly maintain the health of their organs. Once the product is designed, it is validated by expert validators who are competent in their fields, namely subject matter experts and media experts. The expert validators fill out a validation sheet prepared by the researcher in the form of a Likert scale. The product evaluated by the expert validators is then revised according to the comments and suggestions provided by the expert validators.

The next stage involves testing the revised product on a small scale with VC class students consisting of 12 students using purposive sampling techniques based on different cognitive abilities. During the small-scale trial stage, students take a pre-test before the learning activities begin, then engage in learning activities using the prepared product, and take a post-test after the learning activities are completed. After the learning activities, teachers and students are asked to fill out response questionnaires regarding the use of the android-based augmented reality learning media. The response questionnaire results are then analyzed, and if there are suggestions, they are used as revision material for large-scale trials.

In the final stage, a large-scale trial of the developed product is conducted. The researcher conducts trials on class VA consisting of 27 students. In the large-scale trial stage, students take a pre-test before the learning activities begin, then engage in learning activities using the prepared product, and take a post-test after the learning activities are completed. After the learning activities, teachers and students are asked to fill out response questionnaires regarding the use of the android-based augmented reality learning media. The pre-test and post-test results are then analyzed to determine the effectiveness of the developed product based on the students' learning outcomes. The response questionnaire results obtained are also analyzed to determine the practicality of the developed product.

Data in this research and development study uses qualitative and quantitative data. Qualitative data in this study was obtained from the results of observations, interviews, and questionnaires conducted at SDIT Sultan Agung 05. Quantitative data in this study was obtained from the learning outcomes of fifth-grade students at SDIT Sultan Agung 05 in the science subject and from the pre-test and post-test assessments conducted.

The data collection techniques in this research and development study use both test and non-test techniques. The test technique consists of 30 multiple-

choice pre-test and post-test questions, while the non-test technique includes observations, interview results, questionnaires, and document data. To determine the product's feasibility, product validation was carried out by subject matter experts and media experts using a Likert scale. To determine the product's practicality, teacher and student response questionnaires were used after using the developed product. To determine the product's effectiveness, data analysis was conducted using the n-gain test based on the students' pre-test and post-test scores on a large scale

Result and Discussion

Potential and Problems

Based on the observations, several problems were found at SDIT Sultan Agung 05, namely that the learning media used by teachers were still conventional and had not utilized technology such as Wi-Fi, LCDs, projectors, smartphones, and laptops. Additionally, many fifth-grade students' learning outcomes in the science subject had not yet met the minimum mastery criteria (KKM). Of the 28 students, 20 students (71.5%) had not met the KKM in the science subject, while only 8 students (28.5%) had met the KKM.

Initial Data Collection

Data collection in this study used questionnaires distributed to understand the needs of teachers and students regarding learning media. Based on the distributed questionnaires, it was found that the learning media used by teachers in teaching activities were still conventional. This caused many students to have difficulty understanding the material and lack motivation in learning activities. Teachers need learning media that applies technology to help students understand the material on the human respiratory system. Learning media should be developed attractively with the use of images, videos, and 3D objects to increase students' motivation to learn.

Teachers need android-based augmented reality learning media with material and language adjusted to students' levels of understanding. The android-based augmented reality learning media is equipped with images and videos to enhance students' understanding of the human respiratory system material. Additionally, this learning media is also equipped with 3D objects to increase students' interest in learning.

Product Design

Android-based augmented reality learning media was developed according to the learning outcomes to be achieved. Augmented reality was developed according to the characteristics of elementary school students with a concept consisting of images, audio, video, writing and

3D objects. Augmented reality is created by preparing the necessary materials. The images were designed via the Canva application, while the 3D objects were taken from the Sketchfab website. The prepared materials are then combined into one with the help of the Assemblr Edu platform. The final results will be saved on the Assemblr Edu platform and to access them students need a link or barcode, so they need internet access to use them. The Android-based augmented reality learning media section consists of:



Figure 2. Cover



Figure 3. Material page



Figure 4. Learning videos



Figure 5. Source

Feasibility of Android Based Augmented Reality Products Design Validation

The learning media that has been developed will be validated to test the suitability of the product. Validation was carried out by material and media expert validators, namely elementary school teacher education lecturers. After the product is developed, the researcher will revise the product developed according to the suggestions given by the expert validator.

Table 1. Expert Validator Assessment Results

Feasibility Aspect	Validation Index (%)	Information
Page	85	Valid
Content	84	Valid

Table 1 shows that the product being developed has valid results because it obtained a score above 75% which is included in the "very feasible" criteria. Android-based augmented reality learning media is declared valid as a whole both in terms of content and appearance and is ready to be tested. This is in line with research carried out by Permana (2021) which states that the media developed received a validation score of 86% by material experts and 82.5% by media experts, so that the media developed is suitable for use as learning media. Research conducted by Arifin (2020) also obtained a validity percentage of 91% (very feasible) by media experts and 93% (very feasible) by material experts for the media being developed. Other research also states that the validity results obtained have an average r-count of 0.85 and are declared valid, while for the feasibility test the average value is 82.14%, which shows that the Android-based augmented reality developed is suitable for use (Sari et al., 2023).

Design Revision

Products that have been developed are revised according to suggestions provided by material and media experts. The advice given by the material expert is a conceptual justification for the definition of the human respiratory system and information about the lungs. The advice given by media experts is to adjust the cover appearance and menu appearance.



Figure 6. Cover after revision



Figure 7. Menu after revision



Figure 8. Material page after revision



Figure 9. Material page after revision



Figure 10. Learning videos



Figure 11. Source

Practicality of Android-Based Augmented Reality (Product Trial)

A small-scale trial was carried out on 12 VC class students by selecting them based on the students' ability level, namely 4 students with the highest scores, 4 students with medium scores, and 4 students with the lowest scores. After learning activities with the products that have been developed are completed, teachers and students will be given a response questionnaire with a Likert scale that must be filled in based on their experience using the products that have been developed by the researcher. The response questionnaire distributed to teachers and students to test the practicality of the product has 2 assessment aspects, namely material and media quality. The response questionnaire assessment criteria are: (1) 76%-100% with very positive criteria; (2) 51%-75% with positive criteria; (3) 26%-50% with negative criteria; (4) 0%-25% with very negative criteria. To calculate the percentage of responses to the questionnaire responses are as follows (Formula 1).

$$NP = \frac{R}{SM} \times 100\% \tag{1}$$

Table 1. Results of Small-Scale Teacher and Student Responses

Respondent	Assessment	Information
Teacher	85 %	Very Positive
Student	87 %	Very Positive

Table 2 shows that the product being developed had a very positive response on a small scale because it received a score above 75%. The Android-based augmented reality learning media is stated to be practical as a whole both in terms of material and media quality and ready to be used in learning activities.

Table 3. Results of Large-Scale Teacher and Student Responses

Respondent	Assessment	Information
Teacher	90 %	Very Positive
Student	92 %	Very Positive

Table 3 shows that the developed product has received very positive responses on a large scale as it has obtained scores above 75%. The android-based augmented reality learning media is declared practical overall, both in terms of content and media quality, and is ready to be used in learning activities. This is in line with research conducted by Setyawan (2019), which explains that the developed AR learning media received positive responses from students, thus making students enthusiastic about participating in learning. Research conducted by Novit (2023) also explains that the developed product received an average score of 86, which can be considered very practical.

Effectiveness of Using Android-based Augmented Reality Products

A large-scale trial was conducted to determine the effectiveness of using android-based augmented reality learning media in the science subject regarding the human respiratory system based on students' learning outcomes. The research design used was a one-group pretest-posttest design, which includes a pretest before treatment and a posttest after treatment.

Table 4. Pretest and Posttest Results of Students on a Large Scale

Test Type	Average	Average Difference
Pretest	53.44	33.37
Posttest	86.81	

Table 4 shows that the average student learning outcomes showed an increase of 33.37 in large-scale product trials. From these data, it shows that there are

differences in learning outcomes before and after using Android-based augmented reality learning media in science and science subjects on the human respiratory system. To determine the average increase in pretest and posttest, an N-gain test was carried out.

Table 5. Average Test Results (N-gain)

Average Difference	N-gain	Information
33.37	0.73	High

Table 5 shows that the average difference in students' learning outcomes is 33.37 with an N-gain of 0.73, which falls into the high criteria. From this data, it is evident that android-based augmented reality learning media in the science subject, particularly on the human respiratory system, for fifth-grade students at SDIT Sultan Agung 05, is effective in improving students' learning outcomes. This is consistent with previous research which explains that in the experimental group, an N-gain of 73% was obtained, while the control group obtained an N-gain of 50%, proving that the use of augmented reality can facilitate students in understanding the material (Pramuditya et al., 2022; Pujiastuti & Haryadi, 2020). Research conducted by Ropawandi (2023) also explains that student learning achievement can be enhanced with augmented reality-assisted media.

Conclusion

Based on the results of the research conducted, it can be concluded that android-based augmented reality learning media can improve the learning outcomes of fifth-grade students at SDIT Sultan Agung 05 in the science subject, particularly on the human respiratory system. This is evidenced by the product validation assessment results obtained by media experts at 85% with the category "very feasible" and by subject matter experts at 84% with the category "very feasible". The responses provided by teachers and students indicate very positive responses. The results from the pretest and posttest scores increased with an average difference of 33.37 and an N-gain of 0.73, which falls into the high criteria. This indicates that android-based augmented reality learning media is suitable, practical, and effective in improving students' learning outcomes in the science subject, particularly on the human respiratory system.

Acknowledgments

The author would like to thank the school principal and the school community of SDIT Sultan Agung 05 for granting permission to conduct the research process. Thanks to the supervising lecturer who guided the research and article

writing process to completion. Thanks to family and friends for their support in completing this article.

Author Contributions

Yusuf contributed to data collection, product development, data analysis, and article writing. Novi Setyasto served as the supervisor in the research process up to article writing.

Funding

This research was funded by the author's personal funds and did not receive funding from external sources.

Conflicts of Interest

The authors declare no conflict of interest.

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