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The Practicality of *Augmented Reality Digestive System* (ARDis) Media Based on *Hyperlipidemia* Research as an Accentuation of Students' Science Literacy

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Abstract

One of the factors causing the current low scientific literacy is the limited learning media that has not been able to bridge scientific concepts with empirical reality. The coverage of scientific literacy indicator content in existing media tends to be unbalanced because it only emphasizes theoretical aspects without real-life context. This study aims to develop a ARDis media based on the research "*Hyperlipidemia*" on the digestive system material that is practical to improve students' scientific literacy. This study uses the Research and Development method with the Alessi & Trollip model which includes the planning, design, and development stages. The research subjects consisted of Biology teacher and students of SMAN 13 Semarang. Data collection instruments included questionnaires and tests. The practicality of the product was assessed through teacher and student responses, while the improvement of students' scientific literacy was assessed through pre-tests and post-tests. The results showed that the ARDis media has very practicality based on the results of assessments by teacher with a score of 98% and students 87.14%. The effectiveness of the ARDis media is demonstrated through students' classical completeness with a score of 94.4% and the results of the *N-gain* test of 0.66 (moderate category). Thus, it can be concluded that the ARDis media based on the research "*Hyperlipidemia*" is practical and effective to use as a learning media to improve students' scientific literacy in biology learning, especially in the digestive system material.

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INTRODUCTION

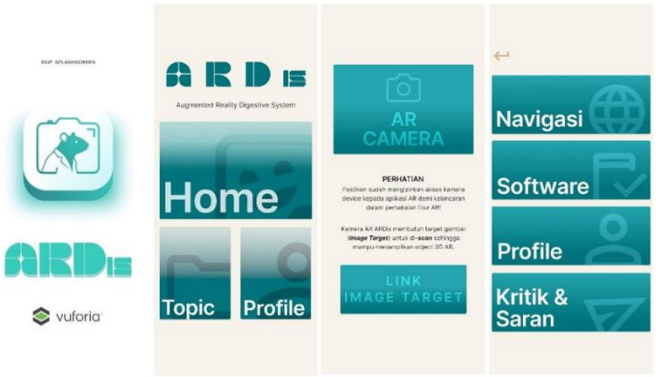
Biology learning on the Digestive System material requires teachers to be creative in implementing the learning process in the classroom so that the Learning Objective Flow can be achieved. One effort that can be done so that the learning process can achieve the Learning Objective Flow, namely by using learning media. The use of learning media in teaching and learning activities must be adjusted to the material (concepts and subconcepts), learning models, methods, and locations where the learning process is carried out (Vahdila, 2023). Based on the characteristics of current students who enjoy using technology and based on the suitability of learning media with the subjects being taught, the researcher chose interactive learning media *with Augmented Reality* (AR) technology called ARDis (*Augmented Reality Digestive System*). The ARDis learning media designed will contain material related to the analysis of the relationship between organ structures in the Digestive System and their functions, abnormalities or disorders that appear in the organ system equipped with photos of digestive system organs in hyperlipidemia mice based on research results as an example of an image that occurs when the digestive system is disturbed, as well as recognizing the digestive mechanism process that occurs in the body. *Augmented Reality* (AR) is able to present learning with new innovations, is more informative, attracts students' interest, and can present virtual objects in 3D in real form, so that it can present abstract concepts to look more real (Nining & Purnamasari, 2022).

ARDis as an interactive learning media will display 3D objects from the human digestive system and the digestive system of experimental animals based on research results that can be projected through media in the form of markers or markers directed at the camera, so that students can see complex visualizations of the human digestive system and the digestive system of experimental animals in real time which are applied to Android mobile devices. 3D visualization in ARDis (*Augmented Reality Digestive System*) will display the shape of organs in the human digestive system and the digestive system of experimental animals from various angles. The Independent Curriculum assesses scientific literacy skills as a key component in the learning process, so educators must have the ability to design and develop appropriate and suitable learning media to strengthen students' scientific literacy skills (Syazali & Putra, 2023). Scientific literacy is the ability to understand scientific concepts and processes and the use of science to solve problems that occur in everyday life. PISA defines or details that scientific literacy consists of four interrelated aspects: context, knowledge, competency (process), and attitude. PISA also identifies indicators of scientific literacy which include: 1) Knowledge of science; 2) Scientific investigation; 3) Science as a way of thinking; and 4) The interaction of science, technology, and society. By strengthening Biology learning using ARDis (*Augmented Reality Digestive System*), it is hoped that students will be able to develop a high sense of concern for themselves and their environment in facing daily life problems and in making decisions based on the scientific knowledge that has been understood by students.

RESEARCH METHOD

This study uses a quantitative approach with a Research and Development (R&D) or Dick and Carey development research type. This study uses the Alessi & Trollip (2001.p.408-413) development model, which is a structured software development model consisting of three stages, namely the planning stage, the design stage, and the development stage. In the planning stage, the researcher uses two steps: Define the Scope and Identify Learner Characteristics. The ARDis media developed focuses on a single topic: the digestive system, which includes the relationship between the structure of digestive system organs and their functions, disorders of the digestive system accompanied by photos of digestive system organs in hyperlipidemia rats based on research findings, and an understanding of the digestive process occurring in the body, supplemented by a QR Code AR scanner camera to view 3D images of human and white rat digestive organs (*Rattus norvegicus*). In the design phase, the researchers used four steps: Develop Initial Content Ideas, Prepare a Prototype, Create Flowcharts and Storyboards, and Prepare Scripts. In this phase, the researchers began creating flowcharts for the interactive learning media to be developed. The flowchart begins with the process of

opening the application, then moves to the application's home screen, and continues to the application's main menu. There are several main menus on the ARDis application screen, including the Home, Topic, and Profile menus. The next stage in the ARDis product design process is to create a storyboard as a general overview of the product to be developed. At this stage, the researcher does not create a product overview using a Storyboard, but instead presents a general overview of the product using a Use Case Diagram. The next step is to create the Application Navigation Structure, which serves to provide an overview of the navigation planning within the menus of the application being developed. The Application Navigation Structure consists of structures that provide an overview of each menu available in the ARDis (*Augmented Reality Digestive System*) application.



The next stage is to create the product's user interface, which consists of an overview of the overall application design, such as the background colors used in the application, the selection of animations and various types of attractive buttons used, the selection of background music that can help students relax and not get bored while using the application, and so on. The development phase in this research consists of 7 steps, namely the Prepare the Text phase, Create the Graphics phase, Assemble the Pieces phase, Prepare Supporting Materials phase, Do an Alpha Test phase, Make Revisions phase, and Make final Revisions phase. The graphic design creation stage of the developed product began with creating 3D designs of human and mouse digestive organs. This stage was carried out using the *Blender* application, starting with a literature review to obtain accurate information regarding the structure and location of human and mouse digestive organs. In addition to creating 3D designs for the ARDis application, the researcher also created an ARDis *Marker Book* design using the *Canva* application. The creation of the ARDis *Marker Book* design was also done through a literature review to ensure that the resulting design was in line with the characteristics and interests of students, so that students would be interested in reading and learning the contents of the *Marker Book* because of its attractive cover design.

The integration of the program into a complete interactive learning media was carried out by paying attention to the flowchart in the process and adjusting the Use Case Diagram, Application Navigation Structure, and User Interface in each slide display. After revising and improving the developed product, the next stage involved testing the development, including testing the practicality and effectiveness of the product. The practicality test is conducted using a questionnaire based on the responses of biology teachers and students who have studied the digestive system material, specifically 11th grade students selected using random sampling techniques. The practicality test aims to obtain evaluations in the form of suggestions, feedback, and input from teachers and students regarding the use of the ARDis application as an interactive learning media in the Biology learning process for the Digestive System material. The ARDis learning media can be considered practical if it achieves a questionnaire response score of ≥ 71% or falls within the "*good*" and "*very good*" criteria. Following the practicality test, the researcher conducted an effectiveness test, which is a large-scale product testing phase conducted on 11th-grade students in class XI F3 at State Senior High School 13 Semarang, selected based on the researcher's considerations and the Biology subject teacher at State Senior High School 13 Semarang.

At this stage, the product is applied as an interactive learning media for the Digestive System material, adapted to the teaching modules that have been prepared previously. The effectiveness of the developed learning media in strengthening students' science literacy skills can be analyzed based on students' classical mastery and through *N-gain* calculations. Student achievement analysis is conducted to evaluate the effectiveness of the developed product in supporting students' collective learning outcomes. A learning media is categorized as effective if ≥75% of students obtain a score above the Minimum Mastery Criteria, which is

75. The results of students' science literacy ability tests in the form of *pre-test* and *post-test* are analyzed using the *N-gain* test to show the difference in students' science literacy abilities before and after using the developed ARDis learning media. Science literacy skills can be said to have improved if 75% of students achieve an *N-gain* score of ≥0.30 or fall into the moderate to high category, with an *N-gain* score percentage of ≥55% or in the moderately effective to effective category.

RESULTS AND DISCUSSION

This research was conducted at SMA Negeri 13 Semarang in the second semester of the 2024/2025 academic year with class XI F3 as the experimental class. The purpose of this research was to develop practical *Augmented Reality* (AR)-based learning media as supporting materials in the learning process for the Digestive System subject. The results obtained from this research include practicality data obtained from the responses of teachers and students of class XI at SMA Negeri 13 Semarang, as well as effectiveness data on the ARDis media in improving students' science literacy skills, as evidenced by the results of pre-test and post-test questions. The practicality test of ARDis media products was conducted to evaluate the extent to which the media has qualities that support the effectiveness of classroom learning implementation. According to (Pustikayasa et al., 2022) the level of practicality of a learning media can be identified through its ease of use, both by educators and students. The practicality of the learning media developed in this research was analyzed through the distribution of instruments in the form of questionnaires, which were used to obtain responses from teachers and students regarding the implementation of ARDis learning media in classroom learning activities. In this research, teacher response data was obtained through a Likert-scale questionnaire instrument consisting of 23 assessment indicator items.

The assessment covered five main aspects, namely the practicality of the material, clarity and appropriateness of language (linguistics), visual quality (attractiveness), ease of use (user usability), and the effectiveness of the media in supporting students' understanding of the concept of the digestive system. In this research, student response data was obtained through a small-scale pilot test conducted in class XI F3 at SMA Negeri 13 Semarang. A questionnaire was administered to 12 students selected using random sampling to obtain an overview of responses to the ARDis learning media developed. The questionnaire contained 23 statements based on five main indicators: content, language, visual appeal, user usability, and understanding of the content. The ARDis learning media can be categorized as having adequate practicality if the response percentage from teachers and students falls within the range of 61% to 100%. This category indicates that the media has been able to meet the practicality indicators in the context of its use in the field, both in terms of ease of use, effectiveness of material delivery, and time efficiency. To provide a more detailed overview of the estimated practicality level of the ARDis learning media based on the quantitative data obtained, the information can be systematically presented in Table 1.

Table 1. Results of the Estimation Analysis of the Practicality of ARDis Learning Media

Indicator	Score	
	Teacher's Response	**Student Response**
Content	100	87,5
Language	100	85,94
Attraction	100	88,89
User Usability	90	85,42
Understanding	100	87,5
Final Score	**490**	**435,25**
Score Percentage	**98% (Very Good)**	**87,14% (Very Good)**
Total Score Percentage	**92,57% (Very Practical)**	

Based on the results of the analysis of teachers' responses to the ARDis learning media that has been developed, a percentage score of 98% was obtained, which is quantitatively categorized as *very good*. This reflects that the media is very practical and relevant to support the learning process in the classroom. In line with this, students' responses to the use of ARDis learning media also showed positive results, as evidenced by a percentage score of 87.14%, which also falls under the "*very good*" category. When viewed as a whole, the cumulative score from the practicality test involving both groups of respondents—teachers and students yielded a total percentage of 92.57%. This percentage indicates that ARDis learning media falls into the *highly practical* category for use in the learning process. However, the suggestions and feedback provided by teachers and students are important considerations for further refinement and development to enhance the quality and effectiveness of the media in future implementations.

The effectiveness of ARDis interactive learning media was analyzed in two stages: classical student achievement data analysis, which aimed to evaluate the extent to which the developed learning media was able to support the achievement of overall learning objectives, and analysis of improvements in student science literacy through the calculation of *N -gain* scores, which are used to measure the effectiveness of the media in improving science literacy skills before and after the implementation of learning using the developed ARDis media. A learning media is categorized as effective if ≥75% of students achieve scores above the Minimum Completion Criteria. The ARDis learning media is deemed effective based on classical achievement indicators if at least 75% of students achieve a score of ≥75, in accordance with the established achievement criteria. The percentage of classical student completion before (*pre-test*) and after (*post-test*) the use of ARDis learning media in grade XI students of SMA Negeri 13 Semarang is presented in Table 2.

Table 2. Percentage of Students' Classical Mastery Before and After Learning

Assessment Indicators	Class XI F3 (Before)	Class XI F3 (After)	Classical Completion (%)	
			Before	After
Number of Students	36	36		
Students Complete	20	34	55,5%	94,4%
Students Not Finished	16	2		

Based on the *pre-test* results of 36 students, it was found that of the total 36 students who took the test, only 55.5% or 20 students achieved mastery with a score of ≥ 75, while the other 16 students, representing 44.5%, were deemed not to have achieved mastery. The *post-test* results showed a significant improvement, with 94.4% of students achieving the completion criteria with a score of ≥ 75, while only 5.6% or 2 students did not meet the criteria. Based on the classical mastery percentage obtained, the ARDis learning media can be declared effective in improving students' science literacy, as the mastery level achieved has exceeded ≥ 75%. This reinforces that the ARDis learning media contributes positively to enhancing understanding of science concepts and science literacy in general. Additionally, many students achieved average scores in the "*very good*" category, indicating that this media is capable of facilitating science literacy-based learning processes optimally.

The increase in post-test scores does not directly reflect an overall improvement in science literacy. Therefore, further analysis was conducted using the normalized gain (*N-gain*) test to evaluate the extent of improvement in students' science literacy. The *N-gain* test was used as a quantitative approach to measure improvements in student learning outcomes by comparing the difference between *pre-test* and *post-test* scores to a predetermined maximum score. This analysis aimed to identify the level or category of improvement in learning outcomes that occurred during the learning process using the developed learning media (Asjudirja & Ulia, 2025). The *N-gain* analysis results, which were classified as moderate to high, indicate that the product is effective in improving students' science literacy. The results of the normalized gain (*N-gain*) test can be seen in Table 3.

Table 3. Results of the Normalized Gain (*N-gain*) Test

Gain Factor	Category	Number of Students	Percentage
$-1{,}00 \leq g < 0{,}00$	There was a decline	-	-
$g = 1{,}00$	Constant	5	14%
$0{,}00 < g \leq 0{,}30$	Low	-	-
$0{,}30 < g \leq 0{,}70$	Moderate	13	36%
$0{,}70 < g \leq 1{,}00$	High	18	50%
Average		**0,66**	
Criteria		**Moderate / Effective**	

Based on the results of the Normalization-gain (*N-gain*) test analysis, the average *N-gain* score was 0.66, which falls into the *moderate* category with an *N-gain* score percentage of 65.8%. This indicates that the use of the developed learning media provides an effective improvement in student science literacy learning outcomes. The distribution of learning outcomes improvement in students' science literacy shows that 50% of students are in the high category ($0.70 < g \leq 1.00$), while 36% are in the moderate category ($0.30 < g \leq 0.70$). Meanwhile, 14% of students showed a constant gain value ($g = 1.00$), and there were no students who experienced a decrease ($-1.00 \leq g < 0.00$) or were in the low category ($0.00 < g \leq 0.30$). The dominance of the *moderate* and *high* categories in the *N-gain* results indicates that most students in class XIF3 experienced a significant improvement in science literacy skills after participating in learning using the ARDis (*Augmented Reality Digestive System*) learning media that was developed. Based on Hake's (1998) effectiveness criteria, the average *N-gain* value of 0.66 is classified as moderate and effective in improving student learning outcomes on the digestive system material. This also supports the assumption that the use of the developed ARDis learning media can facilitate the achievement of learning objectives on the digestive system material as an optimal accentuation of student science literacy. Generally, science literacy consists of four main indicators: knowledge of science, understanding of the investigative nature of science, science as a way of thinking, and the relationship between science, technology, and society. Each indicator of scientific literacy has sub-indicators that represent the breakdown of each indicator. The percentage achievement of each indicator based on the results of the scientific literacy test for grade XI F3 students is presented in Table 4.

Table 4. Summary of the Percentage of Scientific Literacy Indicators Before and After Treatment

Science Literacy Indicators	Percentage (%)	
	Before Treatment	After Treatment
Knowledge of science	74,3	92,36
The nature of scientific investigation	73,61	89,81
Science as a way of thinking	70	96,11
Interaction between science, technology and society	66,2	90,27

Based on the results of research conducted on the science literacy abilities of students in class XI F3, there was a significant increase in all indicators of student science literacy after using ARDis learning media. This increase included four main indicators of science literacy, namely knowledge of science, scientific investigation, science as a way of thinking, and the interaction between science, technology, and society. Before using the ARDis learning media, the highest achievement percentage was in the scientific knowledge indicator at 74.3%, while the lowest achievement percentage was in the interaction between science, technology, and society indicator at 66.2%. After using the ARDis learning media, all science literacy indicators showed a significant increase, with the highest achievement in the indicator of science as a way of thinking at 96.11% and the lowest achievement in the indicator of science interaction at 90.27%. The increase

in the percentage of science literacy skills across the four science literacy indicators indicates that the use of ARDis as a learning media in the learning process can effectively accommodate the practical and comprehensive needs of science literacy-based learning. *Augmented Reality* technology can enhance students' cognitive and affective engagement in the science learning process, as explained by Arianto et al. (2024) that the use of AR in learning can increase students' active participation and conceptual understanding of complex scientific phenomena. Additionally, according to research by Hermawan and Hadi (2024), the implementation of AR in science education also enables students to build deeper learning experiences through more realistic visual and spatial interactions.

CONCLUSION

Based on the results of research and development of the interactive learning media *Augmented Reality Digestive System* (ARDis) based on *Hyperlipidemia* research used in teaching the Digestive System material to 11th grade F3 students, it can be concluded that the ARDis media has met the criteria for practicality and effectiveness in supporting the improvement of students' science literacy skills. The ARDis media was found to align with its characteristics, scoring 96% based on evaluations by biology teachers at State High School 13 Semarang. The ARDis media is highly practical for use as an educational tool, as evidenced by the very positive responses from biology teachers (scoring 98%) and students in class XI F3 (scoring 87.14%), which collectively indicate a very high level of practicality. The use of ARDis in the learning process was also found to be effective in improving students' science literacy based on the achievement of classical mastery at 94.4% and an N-gain score of 0.66, which falls into the moderate category. Therefore, the ARDis media based on research is deemed practical and effective for use as a supportive tool in the biology learning process, particularly in enhancing students' science literacy on the topic of the Digestive System at the high school level.

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