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Respiratory system pocket book with android-based augmented reality technology

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Abstract

Biology is an abstract, elusive science, one of which is respiratory material. It requires a media that can visualize objects on a two-dimensional book of biology to a three-dimensional one with a learning video. Research aims to develop, describe kal, and describe the teacher's assessment and student response to the results of the product developed. This research and development using model 4D consists of define, design, foresight, and develop ate. The result of this realization is the production of a medium of pocket books and apps downloaded on android smartphone platforms, able to present in real, tangible, three-dimensional objects to respiratory matter. The media was declared worthy by the validator of materials and media experts with an average rating score on final validation at 84.68% and 93.17%. Trials in the field as practical tests were obtained an assessment result from teachers by 85.36%, student responses of small groups and large groups are 86% and 83.65%. Also, it is also noted that a media pocket book and applications using this augmented reality technology are worthy to be used by students in studying the human respiratory system for grade 11th MIPA SMAN 1 Kota Jambi.

Keywords: Augmented Reality; Pocket Book; Respiratory System; Android.

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INTRODUCTION

The advancement of human civilization is shaped by the existence of technology, which significantly expedites all human endeavors. One area where technology has not failed to make an impact is education, as it has contributed to the enhancement of educational standards. Technology can serve as a tool, either in the form of hardware or software, to assist teachers in their instructional activities with pupils in the classroom. Computers and laptops equipped with application development software can provide support to the field of science (Nento & Manto, 2023). The

benefits of technology, specifically, lie in its ability to enhance the creation of educational resources, serve as a hub of knowledge across many disciplines, and function as an instructional tool (Salsabila et al., 2021). Speaking of educational mechanisms, the main focus that will be realized can support teachers-centric learning activities or teacher center-based learning implemented with the help of technology that provides benefits as a means of facilitating teachers and students to optimize education improvement (Mokalu et al., 2022).

The level of education in Indonesia remains low, as indicated by polls that highlight the urgent need for substantial attention to improve the quality of education. Based on the study conducted by Kurniawati (2022) in 2018, Indonesia ranks 74th out of 79 nations in the Programme for International Student Assessment (PISA) 2019, indicating a low position in the higher secondary education system (SMA). The inadequate education in Indonesia stems from the subpar academic achievements of pupils, which can be attributed, in part, to the teachers' ineptitude in pedagogy and the efficacy of their teaching methods. According to Kemendikbud (2020) the decline in the quality of education among students is attributed to professors who merely act as facilitators and fail to prioritize the development of students' critical thinking skills. Technology has the ability to enhance the quality of education by providing interactive educational technologies, which can serve as valuable resources in the learning process (Sofyan & Hidayat, 2022).

The student utilizes a smartphone device for the learning process, which enhances the acquisition of information due to its user-friendly features. Hutami et al., (2023) state that cellphones have the advantage of unrestricted usage in various locations, enabling the development of engaging learning methodologies. Smartphone devices offer not only convenient communication, but also a wide range of beneficial applications for scientific research. Rohmani, et al., (2021) assert that smartphones, when utilized correctly, facilitate convenient access to educational resources. One effective approach is to create technology-based learning materials that can be seamlessly integrated with smartphones. Students have the ability to utilize smartphones as a tool for engaging in educational activities. Utilizing learning media is strongly advised for educational endeavors as it has the potential to impact students' learning processes and outcomes, while also fostering more student engagement in the learning process (Indryani et al., 2022).

A smartphone is a device that can enhance learning interest by offering capabilities that facilitate the display of educational content accompanied by engaging graphics, animations, and videos. The use of smartphone features enhances the appeal and engagement of students with learning needs that are best supported by smartphone-assisted learning (Maknuni, 2020). Smartphones can be used to create learning media that cater to diverse learning abilities. These abilities are particularly relevant for comprehending abstract material, complex concepts, and circuits, as smartphones allow for practical visualization of such content (Ikbal et al., 2021). Thus, in order to enhance students' learning capacity, it is important to

possess a smartphone device that can effectively activate cognitive processes, emotions, and learning engagement (Rafael & Enstein, 2022).

The students' learning abilities vary, with some grasping concepts quickly with minimal explanation, while others require further explanations. Additionally, there are pupils who benefit from supplementary resources to aid in comprehension. Differences in abilities among students can be attributed to the rate at which they comprehend learning materials. This rate can be categorized as either high or low levels of understanding (Gumilar & Aulia, 2021). Variations in students' aptitudes will result in variations in their understanding of the subject matter. Therefore, it is imperative to augment sensory stimulation by offering learning resources that can boost the efficacy of learning (Turhusna & Solatun, 2020). Students may encounter conceptual errors as a result of variations in their understanding of the content, as well as the teaching methods employed by teachers, which heavily rely on media or traditional learning tools like printed books with two-dimensional visuals and tablets. According to Bakhruddin et al., (2021), the utilization of learning media can enhance students' comprehension and mastery of fundamental ideas pertaining to truth, reality, and accuracy. Consequently, students' comprehension of the subject matter will be enhanced when they can mentally perceive three-dimensional representations, such as visualizing organs and physiological processes occurring within the human body (Indrawan et al., 2021). Augmented reality technology can enhance the depiction of three-dimensional objects by boosting the user's perception and creativity when interacting with the created media (Dewi et al., 2017).

Augmented reality (AR) technology can be utilized as an innovative tool for creating educational material. It can be seamlessly linked with smartphone users to enhance the user experience of AR goods. Putri and Arifitama (2020) stated that the rapid advancement of technology has made it increasingly convenient for smartphone users to utilize it as a medium for learning. Ismayani (2020) suggested that AR technology has significant potential for integration into learning, enhancing the appeal and clarity of learning activities. This pertains to the convenience of accessing AR technology media solely through an Android smartphone by students, resulting in a heightened level of memory retention related to the studied information. AR technology offers a distinct learning experience by providing students with a different perspective. This technology allows students to engage with media in real-time while learning (Nawir & Hamdat, 2021).

AR technology can be accessed using a smartphone to display a dead object that seems to be real with the help of a camera. AR technology is a technique that involves a system in combining the real world with the virtual world, the object that appears from the virtual will be displayed to the reality world in real time (Hawari & Putra, 2022). AR technology is heavily focused on the visualization of an object, learning content that enables stimulating in-depth processing of the content presented through visualisation (Buchner & Hofmann, 2022).

Based on observations and interviews, grade 11th students of MIPA 7 SMAN 1 Kota Jambi showed the importance of understanding the concept of respiratory system

material by visualizing illustrations on 2D (dimensional) images in textbooks as the primary resource in school learning. The research was conducted in order to produce innovative learning media, as inspiration for teachers and to make learning activities on respiratory material more effective and effective.

The topic in the biology subjects about the human respiratory system belongs to abstract matter, where students do not directly see the organs and processes of the respiratory mechanisms that occur in the human body. According to Raida (2018), the students' difficulties in studying biological material are due to the abstract nature of the material, the difficult concepts to understand, the compact material. Based on the data obtained, students have difficulty studying respiratory material using only package books as the primary source in learning. With the characteristics of the package book that are less illustrative and too compact in material explanations resulting in students often not carrying books while studying in class.

Based on the information obtained from interviews with teachers in the field of study, the minimum completion criteria for biology subjects was 67. While students who only reach minimum completion criteria were about 60-70%. It can be concluded that there are still students who have not reached the level of completion. So it was necessary to make efforts so that the learning objectives can be achieved to the maximum by increasing the learning outcomes of students through a more effective and effective teaching process.

The media development in question utilizes AR technology, employing markers as a means of identification. When designing apps using Unity, the Blender program is utilized for the creation of 3D objects, which are subsequently exported to the Unity application system. Subsequently, it will be merged with a two-dimensional image that corresponds to the created three-dimensional objects. The 3D Objects will be stored in the Unity database. When utilizing the program, it will exclusively present 3D objects on the smartphone screen that are kept in the system database and correspond to their markers as detected by the device's cameras (Perwitasari, 2018).

The study elucidates the advantages of augmented reality (AR) in creating an Android-based pocket book for teaching breathing techniques to eleventh-grade high school students. It also examines the qualifications and evaluations of teachers involved in the project, as well as the responses of students to the outcomes of the developed media. Through the utilization of augmented reality technology, we create pocket books as physical print media and Android applications as digital ICT media. This technology allows for the virtual presentation of 3D objects and videos. This effort aims to enhance the understanding of grade 11th students at SMAN 1 Jambi regarding the respiratory system by providing visual depictions. It is anticipated that this approach will positively impact the students' learning outcomes.

METHODS

The research conducted was focused on Research and Development (R&D) with the aim of creating a product in the form of a printed pocket book and an android platform application. The content of the product specifically targeted the respiratory system and was meant for eleventh-grade high school students. The research employed the methodology of Research and Development (R&D). This strategy greatly facilitated researchers in the production, development, and evaluation of a product's effectiveness (Sohilait, 2020).

The device was built as a pocket book and an Android application with augmented reality technology, specifically focusing on the respiratory system. The study and creation of the respiratory system pocket book involves utilizing augmented reality technologies on the Android platform. The primary applications utilized for this project include Unity, Blender, Canva, and Microsoft Word. The research and development model employed is a 4D model, comprising of four stages: (1) stage define, (2) design, (3) develop, and (4) disseminate (Panggabean & Andis, 2020) as shown in Figure 1.

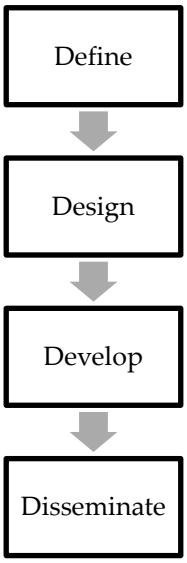

Figure 1. Phases of 4D model

The defining phase was conducted to ascertain the primary issues by comprehensive study from start to finish, material analysis, and analysis of learning objectives. The planning phase has been completed to ascertain the design specifications of the product to be developed, including tailoring the product to meet the requirements of the student during the defining stage. The development phase followed the design phase, during which the already designed product underwent validation by a panel of media and material specialists. Following the validation process, the product undergoes testing on a test group comprising teachers and students. The last stage of the 4D model involved dissemination, which in this study was accomplished through the utilization of the YouTube

platform. The product was released through video tutorials that primarily provided an introduction to the generated medium.

Data collection on this research and development was as follows: 1) qualification tests by material experts and media experts; 2) field tests to know the evaluation of teachers field of study; 3) field tests on student response as a small group with 6 students in grade 11th MIPA 7, SMAN 1 Kota Jambi; 4) field trials on student responses as a large group with 15 students in grade 11th MIPA 7, SMAN 1 Kota Jambi; 5) widespread dissemination using the YouTube platform with the channel name Rini Rahma Dina.

The instruments used for testing the media's validation of expert validators (media and material experts), the evaluation of teachers in the field of biology studies, and the student's response to the indicators are structured according to the needs in the assessment as well as the advice available in the instruments. The racket provided contains some written statements to the expert validator and test subject. The type of lift used is closed with the options as the answer has been specified to make it easier for respondents to fill in the lift (Sugeng, 2022). As for the discount guidelines for each sheet of expert validation and teacher assessment as well as student response using the likert scale by Sugiyono (2013) as shown in the Table 1.

Table 1. Criteria for validator, teacher assessments and student responses

Score Criteria	Category
4	Very Good
3	Good
2	Bad
1	Very Bad

The process of data analysis consists of two distinct stages: descriptive qualitative analysis and quantitative analysis (Ulfa et al., 2022). The acquired data is subsequently evaluated utilizing approaches that involve describing the data in terms of percentages. This methodology employs the process of converting quantitative data (scores) into percentages. The subsequent percentage outcome is interpreted into qualitative categories. Regarding the formulation employed in data processing, it is based on the range of values provided by Riyanto and Hatmawan (2020) as follows (1).

$$\text{Score range} = \frac{\textit{Highest Score} - \text{Lowest Score}}{\text{Scoring Category}} \quad (1)$$

Then the range of values obtained is presented with the formula submitted by Wahyuningtyas and Yahya (2021) as follows (2):

$$PS = \frac{n}{N} X\ 100\% \quad (2)$$

Description:
PS = Percentage
n = Number of scores obtained
N = Number of maximum scores

The result of the data analysis obtained is known the validity of the product developed in this study. Product eligibility category refers to Sugiyono (2013) as in Table 2.

Table 2. Media qualification level categories

Score Criteria	Percentage (%)	Category
4	81,25-100	Very Worthy
3	62,5-81,15	Worthy
2	43,75-62,4	Worthless
1	25-43,65	Very Worthless

In addition to quantitative data, there are quality data such as notes of suggestions or comments from both validators, teachers and students. It is meant to create products that are tailored according to the needs of students in learning.

RESULT AND DISCUSSION

Define

The research commenced with the defining step, which involved doing preliminary analysis, material analysis, and analysis of learning objectives. Regarding the initial analysis, it was discovered that students said that relying on the package book as the main resource for learning did not assist them in comprehending the content related to the human respiratory system. Specifically, 52.4% strongly agreed, 42.9% agreed, and 4.8% disagreed with this statement. 52.4% of the respondent strongly agreed that the textbook used in school did not effectively convey visual illustrations, while 47.6% agreed. During the interview, the teacher mentioned that many students did not carry textbooks to school due to the ineffectiveness of bulky textbooks. A majority of students, 52.4%, strongly agree with this sentiment, while 38.1% agree and 9.5% disagree. All of the respondents, totaling 100%, had not utilized augmented reality technology as a medium for learning.

An analysis was conducted on the activities and backgrounds of students, based on interviews with the biology teacher. It was found that students struggled with understanding illustrations of respiratory devices in the print book, as well as the processes and abnormalities of the respiratory system. This difficulty arose from the inability to observe these processes firsthand. The students' responses were consistent, with 76.2% finding it challenging to visualize the anatomy of human respiratory organs, whereas only 23.8% did not find it difficult. Dutta, et al., (2022) the use of augmented reality technology can improve the learning experience, critical thinking, and various skills and knowledge acquisition of students with learning difficulties based on their characteristics. It can also enhance their learning agility, motivation, and cognition.

The analysis focused on identifying the specific conceptual needs of students in relation to the respiratory system. This analysis was based on their competence in accessing and understanding learning materials. The lesson plan was designed for a biology class in grade 11th MIPA 7 at SMAN 1 Kota Jambi. The main topic of the

lesson is the human respiratory system, covering both theory and concepts. Table 3 displays the Fundamental Proficiency for the subject of the respiratory system.

Table 3. Basic competence and it's indicators

Basic Competence	Indicators
3.8 Analyses the relationship between the structures of the organ-building tissue of the respiratory system in relation to the bioprocesses and dysfunctions that may occur in the human respiratory systems.	3.8.1 Identifying the structure of the human respiratory system 3.8.2 Explaining the structure and function of the respiratory organ in humans 3.8.3 Explaining the process of exchange of O_2, CO_2 from the alveoli to the capillaries, the content of substances in cigarettes that can interfere with the human breathing system 3.8.4 Analysis of respiratory mechanisms in human beings 3.8.5 Analysis on respiratory disorders 3.8.6 Explains the influence of smoking on breathing health 3.8.7 Explanation of the relationship between unclean environmental air conditions 3.8.8 Explains the association of smoking behavior with the structure of human respiratory organs

The analysis of learning objectives was conducted in accorandce with the Basic Competence of the curriculum, which aligns with the materials being taught. The lesson plan aimed to enhance students' cognitive understanding of the respiratory system in humans. It enabled students to articulate the function of the respiratory system, identify the specific organs comprising it, visually represent the components of the breathing system, analyze the factors influencing respiratory frequency, elucidate the process of oxygen and carbon dioxide exchange in the alveoli and body tissues, and explain the binding reaction of oxygen and carbon dioxide in the blood. Hence, this development was specifically developed and organized to align with the intended objectives outlined in the lesson plan.

Design

The outcomes of analysis served as the foundation for media design. Planning was the process of finding learning media products that were designed to enhance the effectiveness and efficiency of learning activities. The outcome of this research project is a pocket-sized book that combines printed media with an Android-based application utilizing augmented reality technology. Optimizing the utilization of ICT can enhance the caliber of education by facilitating convenient access to diverse learning resources (Anggereini et al., 2018). With the help of AR technology, it provides the interactivity of displaying 3D objects or images like holograms (Liao, 2019).

The android operating system was selected by the pupils of grade 11th MIPA 7 SMAN 1 Kota Jambi as it is the most commonly used platform on smartphones. Smartphones using the Android operating system have gained more popularity among fans due to its classification in the entry-level category (Daeng et al., 2017). Augmented reality technology has the ability to enhance students' comprehension of abstract items, making the learning experience more pleasurable and beneficial (Shakeel et al., 2019).

The design and development of pocketbooks involved the utilization of Microsoft Word, Canva, and Photoshop software, whereas applications were developed using Unity and Blender software. Pocketbooks developed as a novel approach to utilizing packaged books or textbooks as the main tool for learning. The typical pocket book is appealing due to its user-friendly nature, vibrant colors, and captivating illustrations (Wati et al., 2019). The Unity application is a program that can create media using innovative augmented reality technology and can visualize abstract objects on materials taught in schools. This is because in building media with augmented reality technology can be created with Unity 3D software based on desktop and multi-platform (Famukhit, 2018). The steps involved in the process were as follows: first, a pocket book was designed using software such as Microsoft Word and Photoshop. The design was then printed in A6 size. Next, a 3D object that matched the illustration on the pocket book was created using Blender Software. After that, an Android-based application was programmed by incorporating the 3D objects using Unity Software and coding scripting in the C# language. Finally, the already designed application was rendered into an Android application.

The augmented reality (AR) technology employed in creating these media utilizes markers as reference points. When designing applications using Unity, the Blender application is utilized for 3D object design, which is then exported to the Unity Software system. Subsequently, it will be merged with a two-dimensional image that corresponds to the created three-dimensional objects. The 3D objects will be stored in the Unity database. Hence, while utilizing the program, it will exclusively present 3D objects as tangible entities on the smartphone screen. These objects must already be saved in the system's database and correspond to their markers through the relevant cameras (Perwitasari, 2018).

Develop

The outcome of this research is a portable book and an Android application that utilizes augmented reality (AR) technology. The developer's media combines printed media with ICT media, utilizing AR technology to increase communication by including advanced digital data imaging through an interface (Zaki et al., 2019). The "Human Respiratory System Pocketbook" is a printed pocket book that features a 2D image marker. This marker can be scanned using the "human respiratory system AR" Android application, allowing users to access augmented reality content related to the book (Figure 2).

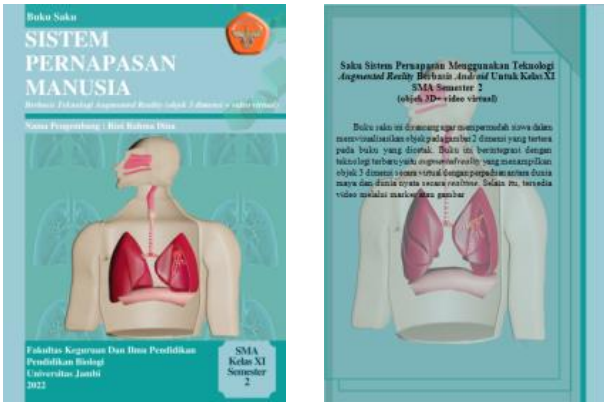

Figure 2. Book cover of human respiratory system based on augmented reality technology (AR)

This application was designed specifically for Android smartphones and can only be installed on devices that support the Android platform. Users can monitor their usage by referring to the pocket book and utilizing the developer-provided applications. After installation, users can utilize the application to scan 2D illustrations in a pocket book and then view 3D objects, text, sound, and video in real-time through the camera (Tumini & Romadhon, 2022). The display of the application can be seen in Figure 3.

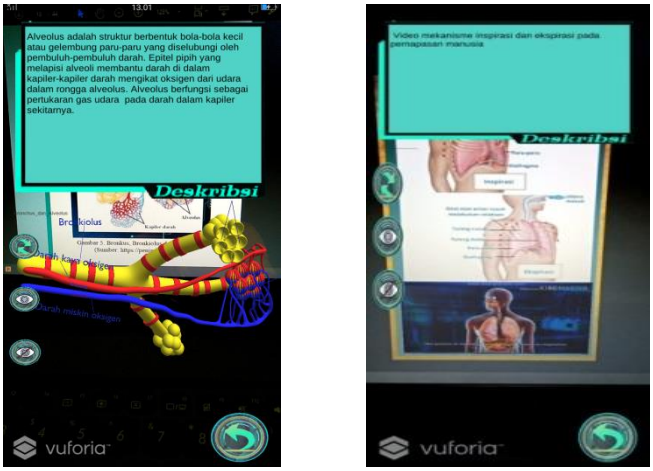

Figure 3. Display of 2D images when were scanned using an application that displays 3D objects and videos in real time

The objective of media creation was to create pocket books and apps utilizing Android-based augmented reality technology in order to enhance the value of this material. The development step involved conducting an eligibility test with a validator. The media will be amended according to the suggestions and comments provided by the validator. Upon being deemed eligible, the media commenced testing on certain users, including biology teachers and grade 11th students from SMAN 1 Kota Jambi.

The efficiency of the validation conducted on the respiratory system pocket book employing augmented reality (AR) technology, specifically built for android, may be determined by evaluating the opinions of subject matter experts and media

experts. The validation of this material was conducted by two groups of experts: (1) learning media experts who possess expertise in the field of media learning in print and ICT, and (2) material experts who possess expertise in the subject matter of the respiratory systems in the biology curriculum for grade 11th in high school. The correspondence of the media to the needs of students in learning activities refered to the results of the qualification assessment. According to Indrayani et al., (2021), validating the authenticity of a development product necessitates the use of a meticulously designed instrument that meets the criteria for validity and can be verified by an expert who possesses the necessary expertise in the instrument's components. The purpose of the trial was to ascertain the authenticity of a product, specifically a pocket book and an Android software called "Human Respiratory System AR" that utilizes augmented reality technology. Proficient evaluation of the material considering multiple factors, specifically the reliability of the substance or information, the manner in which it is presented, and the language used (Indriyani et al., 2016). While the materialists do some aspects of cover, content, and physical as well as appearance, and programming (Arif & Rukmi, 2020; Mawaddah et al., 2019).

The material expert's final stage validation results revealed an average score of 84.68%, meeting the highly eligible requirements. The material expert evaluates many characteristics such as content or material validity, presentation, and language. The educational media developed for eleventh-grade high school students focuses on the human respiratory system. When presenting information, it is important to consider the validation results of the material. These results indicated the worthiness of the medium in conveying information. A high validation value suggested that the material presented in the media is reliable and can be effectively used by teachers and students for learning purposes (Mashuri & Budiyono, 2020). Based on research by Pauziah & Laksanawati, (2023), validation of material against media using augmented reality technology with an average of 83% classified as highly suitable for use in the field, then for a score of 84.68% based on the assessment by expert validators of material developed by researchers can be represented can be used on the field. By performing 3 validations showed an increase in the number of scores and the percentage of each aspect like Table 4.

Table 4. Result of expert validation

Aspect	Validation steps (%)		
	1	2	3
Content qualification	65	75	85
Display	57,14	71,42	85,71
Language	50	66,67	83,33
Average (%)	57,38%	71,03%	84,68%
Criteria	Worthless	Worthy	Very Worthy

The final stage validation results by media experts showed an average score of 93.17% with highly eligible criteria. The aspects assessed by the media experts include the pocket book aspects (sample, content and physical), and the

Application (display and programming). According to a study conducted by (Sari et al., 2023) the media validation of augmented reality technology in terms of programming achieved a score of 90.5%, which is considered highly qualified and does not need any revisions. Additionally, the programming aspect of the technology received a validation score of 91.25% from a media expert, indicating its suitability for practical use. Arif and Rukmi, (2020) did a study on pocket book validation, which assessed the cover, content, and physical features of previous research. The study found that the pocket book received a score of 85%, indicating its validity as a learning medium and its suitability for usage in the field. This research have achieved a validation rate of 94.44% for pocket books, which falls into the highly commendable category. This result is based on the examination of indicators and enhancements made by the validator, making the pocket books suitable for practical usage. The media validation process resulted in an overall improvement, with a final score of 93.17%. This improvement was observed through three rounds of validation, which showed an increase in scores and percentages for each facet, as shown in Table 5.

Table 5. Media validation by expert

Scoring Aspect	Validation step (%)		
	1	2	3
Pocketbook			
Cover	50	66,66	83,33
Content	50	75	100
Physical	75	75	100
Android-based Augmented Reality (AR) Application			
Display	55	65	95
Programming	56,25	75	87,5
Average (%)	57,25%	71,33%	93,17%
Criteria	Worthless	Worthy	Very Worthy

The media and materials that have undergone validation within this category demonstrate exceptional performance in the exam. Subsequently, an evaluation was conducted with the respondents, namely biology teachers, focusing on various aspects of the subject of study. The media expert's final stage validation results revealed an average score of 93.17%, indicating a highly qualifying outcome based on the criteria. The media specialists assessed many factors such as relevance, language, substance, evaluation, and display. These aspects received a score of 85.36%. The material was then presented to both large and small groups of students for further evaluation. According to Faisal et al., (2019), this aspect has been tested and shown to be very suitable for evaluating technology-based learning media that contain informational knowledge. Therefore, the ratings given by respondents can accurately represent the appropriate learning product. The values provided by the respondents can be observed in Table 6.

Table 6. Evaluation results of subject teachers

No	Evaluation Aspect	Teacher Response (%)
1.	Relevance	100
2.	Language	75
3.	Content	87,5
4.	Evaluation	75
5.	Display	89,29
	Average (%)	85,36
	Criteria	Very Worthy

The students' responses were analyzed to assess the feasibility of the product utilizing Android-based augmented reality technology. The evaluated factors encompass visual aesthetics, composition, and educational value. The students, serving as respondents, rated several aspects in two groups: a small group of 6 people and a big group of 15 people. The scores obtained by the respondents were 86 and 83.65, respectively, when converted into highly qualified categories. According to these findings, all components of the assessed educational product warrant utilization in the classroom learning process. The survey assessed the worth of a learning product based on the credibility of its reviews. It aimed to enhance the quality of learning by providing students with an engaging and visually appealing learning experience (Faisal et al., 2019). Given the scores and % scores for each aspect, as shown in table 7.

Table 7. Result of student responses

No	Evaluation Aspect	Small group Test (%)	Large group Test (%)
1.	Display	83,86	82,92
2.	Content	84,72	83,87
3.	Learning scenario	89,59	84,17
	Average (%)	86	83,65
	Criteria	Very Worthy	Very Worthy

Disseminate

The objective of media distribution is to disseminate pocket book products and applications through the use of widely available Android-based augmented reality technologies. The release has been conducted on May 7th, 2022, using the YouTube platform under the developer account named Rini Rahma Dina. Regarding the method of its dissemination: 1) A product presentation video presented as a pocket book and an android app utilizing augmented reality technology, accessible to YouTube users. 2) The uploaded video is accompanied by a description box that provides comprehensive information about the product development process. It also includes a link to a Google Drive folder where the generated product can be accessed. 3) Both the video and the complete information were submitted to the research channel. According to Suryadi & Sofya, (2023), YouTube offers a vast platform for sharing knowledge by showcasing items as a means of introducing them to the public. This allows YouTube users to independently access the

products made by researchers, along with detailed information. The YouTube app was chosen as a platform to offer convenient introductions and tutorials on expanding the product's accessibility to a wide audience, without any constraints of time or location (Ihsan et al., 2023). The product distribution has been furnished with comprehensive details regarding augmented reality technology and instructions on how to utilize the product. Over the span of one month, this stage has garnered 115 views, along with 74 likes and 44 comments as shown in Table 8.

Table 8. Result of media distribution

Viewed	Liked	Commented
115	72	44

CONCLUSION

The discussion led to the conclusion that the end result of this developmental research is a pocket book-shaped learning tool in the form of a printed medium and an android application. This tool focuses on the sub-material biology sub-subjects of the human respiratory system and utilizes augmented reality (AR) technology. By utilizing this media, students acquire distinctive expertise and cutting-edge technology through the virtual observation of 3D objects and video-based learning. Furthermore, they are provided with workouts and evaluation games within the program. The evaluation of the material and media experts' validator indicates that the category is highly suitable for testing by instructors and students, as well as for conducting a user practicality test. Afterwards, the product was extensively disseminated through the utilization of the YouTube platform in order to reach a diverse array of internet visitors. Given that study restrictions solely pertain to practicality testing, it is advisable to continue developing media until the point of implementing student learning outcomes. Due to the study constraints, the current medium solely focuses on the sub-material of the respiratory system. However, future research may aims to create AR-based learning media that encompasses a broader variety of materials.

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