

**DEVELOPMENT OF AUGMENTED REALITY LEARNING MEDIA USING ASSEMBLR EDU
IN THE EXCRETORY SYSTEM MATERIAL FOR GRADE XI HIGH SCHOOL**

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ABSTRACT

The biology learning process often poses challenges for teachers and students, one of which is the excretory system material. This is because most of the organs studied cannot be observed directly, so the concepts studied tend to be abstract. The purpose of this study was to produce a quality Augmented Reality learning medium using Assemblr Edu on excretory system material. This research was conducted at the Biology Education Study Program - Faculty of Teacher Training and Education (FKIP) - University of Riau, SMA Negeri 1 Pekanbaru, and SMA Negeri 7 Pekanbaru from February to May 2025. This development research used the ADDIE model, which was carried out up to the development stage. The results showed that the validation of all aspects of the Augmented Reality media using Assemblr Edu obtained a very valid category with an average score of 3.82. The results of the limited trial phase I obtained a very good category with an average score of 3.93. The results of the limited trial phase II obtained a very good category with an average score of 3.94. The calculation of the average quality score of Augmented Reality media using Assemblr Edu obtained an average score of 3.89 with a very good category. Based on the research results obtained, it can be concluded that Augmented Reality learning media using Assemblr Edu in the excretory system material has very good quality.

Keywords: Learning Media; Augmented Reality; Assemblr Edu; Excretory System.

INTRODUCTION

The excretory system is a system that functions to remove metabolic waste and toxins from the body. According to Campbell and Reece (2020:985), the excretory system is the process of removing nitrogenous metabolites and other waste products from the body. This system plays an important role in maintaining fluid and electrolyte balance and supporting the body's health by removing toxins and waste products that are no longer needed. The human excretory system consists of four organs responsible for the cleansing process, namely the kidneys (ren), skin (integument), liver (hepar), and lungs (pulmo).

The material on the excretory system is biology material studied by students in phase F (grade XI high school). Based on the learning outcomes for phase F, students are expected to understand the relationship between the structure of organs in the organ system and their functions in responding to internal and external stimuli (Curriculum and Education Assessment Standards Agency Document, 2024:230). The topics covered in the excretory system include the structure of the organs that make up the human excretory system and their functions, disorders of the excretory system, and technologies that can address disorders of the excretory system.

The process of learning about the excretory system is often challenging for teachers and students. This is because most of the organs studied cannot be observed directly, so the concepts studied tend to be abstract, for example, the structure of the excretory organs (Simorangkir, 2020:7). This condition makes text-based and two-dimensional (2D) image-based learning less effective in helping students understand the structure and function of organs in depth. Therefore, there is a need for innovative learning media that can visualize the material in a more concrete and interactive way so that students' understanding can improve.

Based on interviews with biology teachers at SMA Negeri 1 Pekanbaru, SMA Negeri 2 Pekanbaru, SMA Negeri 7 Pekanbaru, and SMA Negeri 15 Pekanbaru in August 2024, it was found that the learning media often used for the excretory system material were PowerPoint and torsos. The use of two-dimensional (2D) images in PowerPoint has limitations because it cannot display the entire structure of organs. Meanwhile, torso media only displays organ structures in three dimensions without accompanying names of parts or explanations of organ functions. This condition shows that the media used is not yet fully capable of helping students understand the material completely. Therefore, teachers are expected to utilize learning media that can visualize the material more effectively in accordance with the learning outcomes. This effort is important, especially for material whose objects cannot be observed directly, so that the learning process becomes more meaningful and learning outcomes can be achieved optimally.

One learning medium that can overcome this problem is Augmented Reality. Augmented Reality can be defined as a technology that is capable of combining two-dimensional and three-dimensional virtual objects into reality and projecting them in real time (Fitriyah et al., 2023:122). The purpose of Augmented Reality is to simplify real objects by bringing virtual objects that appear to be real. This learning medium is very effective for observing abstract biology material visually.

The success of applying Augmented Reality in learning has been proven in several studies, such as the study by Murdhani et al. (2023), which used Augmented Reality-based learning media in introducing the human organ system to present abstract material as if it were real with a three-dimensional display through gadgets. Another study conducted by Lestari (2023) was entitled the development of Augmented Reality-based learning media with Islamic values in human excretory system material for grade XI SMA/MA. The difference lies in the results of the research, which is in the form of an application and there are no excretory system disorders, while the research that will be conducted produces a product in the form of a website that appears after scanning the AR marker and there are several excretory system disorders. Additionally, the applications and websites used to develop Augmented Reality media are also different. Previous research used Unity 3D, Soft Blender 3D, and Vuforia applications, while this research uses Assemblr Edu.

The development of Augmented Reality learning media can be done using the Assemblr Edu website. Assemblr Edu is a platform for creating three-dimensional (3D) content that is visualized in the form of Augmented Reality (AR) and can be accessed by everyone (Padang et al., 2022:40). Assemblr Edu provides three-dimensional objects that can be developed by users for free or for a fee. If the material objects are not yet available on Assemblr Edu, users can add them through the Augmented Reality editor feature on Assemblr Edu. Based on this explanation, the purpose of this study is to produce high-quality Augmented Reality learning media using Assemblr Edu for the 11th grade high school excretory system material.

RESEARCH METHODS

This study uses the ADDIE development model. The ADDIE model consists of five stages, namely Analyze, Design, Development, Implementation, and Evaluate. However, in this study, the researcher only carried out the development stage. The product developed was an Augmented Reality learning medium using Assemblr Edu on the excretory system material for grade XI high school students. This research was conducted at the Biology Education Study Program, FKIP, University of Riau, namely the design stage, revision, validation by media experts and subject matter experts, and limited testing stage I. Validation by biology teacher 1 was conducted at SMA Negeri 7 Pekanbaru. Validation by biology teacher 2 and limited testing stage II were conducted at SMA Negeri 1 Pekanbaru.

This research was conducted from February to May 2025. The subjects of the limited trial of the Augmented Reality learning media product were 10 sixth-semester students and 20 eleventh- grade students at SMA Negeri 1 Pekanbaru. The instruments used in this research were validation sheets, response questionnaires, and interview guidelines. This study used three data analysis techniques: validation data analysis by validators, limited trial results analysis, and analysis of the quality of the developed media. The validation results were calculated using the average score formula, namely:

$$M = \frac{\sum Fx}{N}$$

Explanation:

M = Average score

Fx = Score obtained

N= Number of validation components

Learning media can be used if the average validation score is categorized as valid or highly valid. The categories in the validation decision-making process can be seen in Table 1.

Table 1. Media Validity Categories

No	Average Score Interval	Category
1	3.25 ≤ x ≤ 4	Highly Valid
2	2.5 ≤ x < 3.25	Valid
3	1.75 ≤ x < 2.5	Invalid
4	1 ≤ x < 1.75	Not Valid

(Source : Sugiyono, 2016)

The quality of the learning media that has been developed will be determined based on the results of the average validity score and the average limited trial score in stages I and II. The quality score of the media can be determined using the average score formula, namely:

$$\bar{X} = \frac{\sum \bar{X1} + \sum \bar{X2} + \sum \bar{X3}}{3}$$

Explanation:

X = Average score (mean)

X1 = Average validation score

X2 = Average score of limited trial I

X3 = Average score of limited trial II

Learning media can be considered high quality if the average validity score and average limited trial score in stages I and II are categorized as good or very good. The average quality score of learning media can be determined based on the media quality categories shown in Table 2.

Table 2. Media Quality Categories

No	Average Score Interval	Category
1	3.25 ≤ x ≤ 4	Very Good
2	2.5 ≤ x < 3.25	Good
3	1.75 ≤ x < 2.5	Not Good
4	1 ≤ x < 1.75	Poor

(Source : Sugiyono, 2016:173)

RESULTS AND DISCUSSION

The development of Augmented Reality learning media using Assemblr Edu on the excretory system material used the ADDIE model, which was implemented up to the third stage, including Analyze, Design, and Development. The results and discussion of the three stages are described as follows.

Analyze

The analysis stage of this study consists of three stages, namely curriculum analysis, learning media analysis, and student analysis. The results of the curriculum analysis were obtained through a review of the learning outcomes (CP) in the biology subject on the excretory system for 11th grade high school students, published by the Head of BSKAP, Ministry of Education, Culture, Research, and Technology on June 11, 2024. In learning outcomes (CP) phase F, it is stated that students are expected to be able to understand the relationship between the structure of organs in the organ system and their functions in responding to internal and external stimuli. The learning media analysis stage found that the dominant media used by teachers were PowerPoint (PPT) and torso. The media analysis also found that teachers had never used Augmented Reality learning media using Assemblr Edu in the classroom. Based on the student analysis results, the dominant learning style among students in the classroom is visual. Students with a visual learning style generally prefer the delivery of material through various visual media, both two-dimensional and three-dimensional, rather than listening to lectures (Kusumardi, 2023:20). Thus, Augmented Reality media can be used in the learning process, especially for students with a visual learning style.

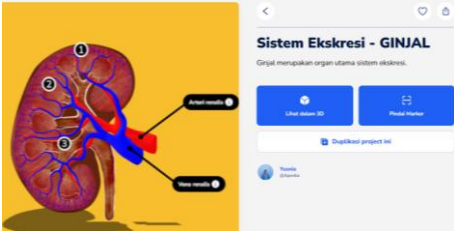
Design

The design stage aims to create a learning device design, Augmented Reality media design, and validation sheet and response questionnaire design. The design of learning tools includes the design of learning objectives and teaching modules. The design of Augmented Reality media begins with creating a storyboard for three meetings on the material of the excretory system. This storyboard can be used as a reference or initial sketch for the development of Augmented Reality media. The final design is the design of validation sheets and response questionnaires. Validation sheets are used to see the validity of the Augmented Reality media that has been developed. The validation sheet contains statements that support the validity of the media and material aspects. The response questionnaire is designed to determine the quality of the Augmented Reality media by the respondents, namely university and high school students. The validation sheet and response questionnaire are compiled using a Likert scale with ratings of very good (4); good (3); not so good (2); not good (1).

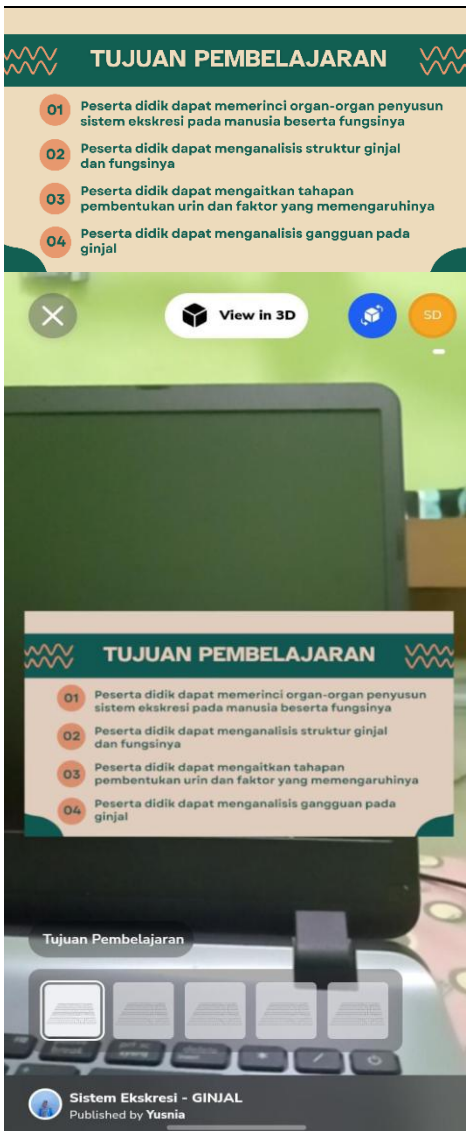
Development

The development stage aims to produce and validate the designed learning media for the " " (The Body's Excretory System). At this stage, the development of learning tools is carried out, including the learning objective flow (ATP) and teaching modules, as well as the development of Augmented Reality media. The learning objectives flow and teaching modules for the excretory system material were developed into three sessions, namely session 1 on the renal excretory system, session 2 on the skin excretory system, and session 3 on the liver and lung excretory systems. The development of the Augmented Reality media product used the Assemblr Edu website. This development was adjusted to the design that had been made in the design stage. The following are the results of the development of Augmented Reality media using Assemblr Edu.

Table 3. Results of Augmented Reality Media Development using Assemblr Edu

Media Display Augmented Reality	Description
	<p>The cover slide displays the title and image of the organ to be studied, a feature to display 3D images, and the editor's name.</p>
<p>Learning Objectives</p>	<p>The first slide displays the learning objectives tailored to the sub-topic to be studied. In addition to the 3D view, the content can be viewed</p>

through the user's camera, making it appear real.

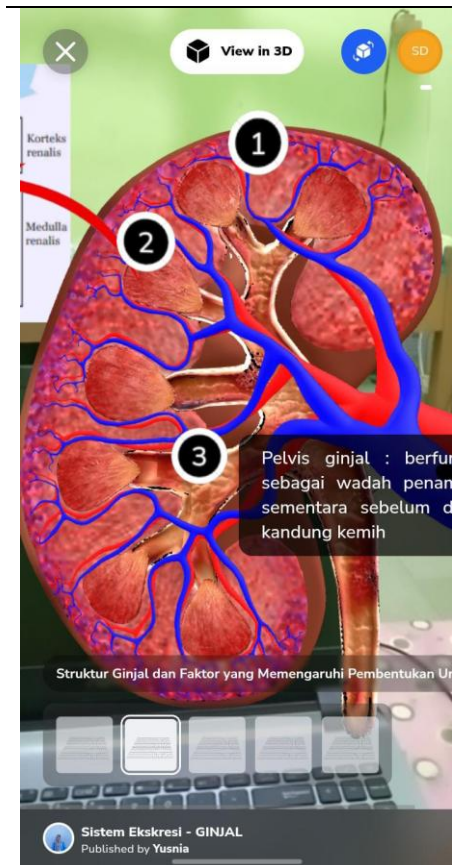


Kidney Structure



In this view, researchers present 3D images of the kidney structure and its functions, as well as videos of factors that influence urine formation.

If the numbers and names on the organ structure are pressed, the name and function of that structure will appear. The organ structures displayed can be enlarged or reduced according to the user's needs.



The developed Augmented Reality media will be validated by a team of four experts consisting of two validators, namely media experts and subject matter experts, who are lecturers in Biology Education at the Faculty of Teacher Training and Education, University of Riau, and two validators who are grade XI high school teachers. After validation, a limited trial phase I will be conducted for sixth-semester biology education students with a total of 10 respondents. Next, a second phase pilot test will be conducted with 20 eleventh-grade students from SMAN 1 Pekanbaru.

The validation results were obtained based on assessments using a validation sheet by the validator team, which contained five aspects, namely linguistic aspects, presentation aspects, aspects of media effects on learning strategies, aspects of overall display feasibility, and aspects of content feasibility. Based on the data obtained, the results of the validation of the development of Augmented Reality media in all aspects are as follows.

Table 4. Validation Results for All Aspects of Augmented Reality Media

No.	Evaluation Aspect	Average	
1.	Language	3.90	SV
2.	Presentation	3.85	SV
3.	The Effect of Media on Learning Strategies	3.94	SV
4.	Overall Display Feasibility	3.62	SV
5.	Content Suitability	3.81	SV
Average		3.82	SV

Note : SV = Very Valid

Based on the table above, it can be seen that the aspect with the highest average score is the effect of media on learning strategies, with a score of 3.94 in the highly valid category. This indicates that Augmented Reality media using Assemblr Edu is very easy to use in learning both inside and outside the classroom, and can be used to motivate students in learning about the excretory system. This is in line with the results of research by Primadona et al. (2024:912), which shows that Augmented Reality media using Assemblr Edu is easy to use in the daily learning process and can increase student motivation in learning biology because it makes it easier for students to see and study objects or images discussed in biology material.

The next highest scoring assessment aspect was language, which received an average score of 3.90 in the very valid category. This shows that the language used in Augmented Reality media using Assemblr Edu is easy to understand, clear, and appropriate for the thinking level of high school students, thereby supporting their understanding of the material presented. The delivery of information in concise, compact, and clear language will help students understand the learning material more easily and quickly. This is reinforced by Ningsih and Lestari (2021:76), who state that the use of appropriate language in learning media can improve student understanding because the information conveyed is concise and clear, making it easier to understand and appropriate for the cognitive development level of students.

Based on the average score obtained from the validation, it can be concluded that the Augmented Reality media product developed using Assemblr Edu is highly valid with an average score of 3.82, allowing it to proceed to the next stage, which is a limited trial to observe user responses. The assessment aspects in the response questionnaire consist of visual communication, content suitability, language, and usefulness. The results of limited trials I and II can be seen in the following graph.

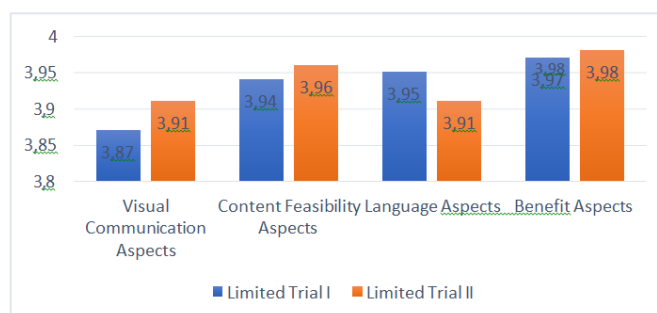


Figure 1. Results of Limited Trials I and II

Based on the image above, it can be seen that the aspect with the highest score in the limited trial results is the benefit aspect. This shows that Augmented Reality media is considered to make a real contribution to supporting learning, both in terms of improving students' understanding and interest in the material. This is in line with the general impression given by respondents regarding Augmented Reality media, namely, "In my opinion, this media can attract students' interest in learning because it has a contextual display and can clearly show the structure of organs." The response that Augmented Reality media can attract students' interest in learning is in line with previous research by Wilayanti et al. (2024:958) that Augmented Reality-based learning media can increase students' interest in learning.

The benefits aspect also shows that Augmented Reality (AR) can also help students understand material with objects that cannot be seen directly. This is in line with the impression of respondents who said, "The AR media created is creative and sophisticated because it can help students understand material that cannot be seen in real life. The AR display with its 3D images is clear, making it easy for students to understand the material by seeing objects that cannot be seen directly." This is supported by the results of Uno's (2024) research, which shows that AR-based learning media consistently improves conceptual understanding and attracts students' interest in learning, especially for material that is difficult to visualize. In addition, the results of research by Khairunisa et al. (2024) also show that students are more motivated to learn when using Augmented Reality media.

After conducting limited trials in stages I and II, the average scores were 3.93 and 3.94, which is categorized as very good. Therefore, the researcher can proceed to the product quality testing stage of the Augmented Reality media, which is obtained from the calculation of the validity test scores, limited trial stage I, and limited trial stage II. The results of the average quality score calculation for the Augmented Reality media can be seen in the following table.

Table 5. Results of the Average Quality Score Calculation for Media

No.	Subject	Average	Note
1.	Validity Test	3.82	SB
2.	Phase I Trial	3.93	SB
3.	Phase II Trial	3.94	SB
Average		3.89	SB

Note: SB = Very Good

Based on the table above, the quality of the Augmented Reality media that has been developed obtained an average score of 3.89, which is categorized as very good. This shows that the Augmented Reality media product using Assemblr Edu in the 11th grade high school excretory system material is of very good quality. Quality media can have a real impact on the learning process of students and increase learning outcomes. This is in line with the results of research by Padang et al. (2022:44), which states that Augmented Reality media using Assemblr Edu can improve student learning outcomes. This media can also provide new experiences for students. This is in accordance with the opinion of Sari et al. (2023:91) that Augmented Reality (AR) media can provide contextual and enjoyable learning experiences.

CONCLUSIONS

Based on the research results obtained, it can be concluded that the Augmented Reality learning media using Assemblr Edu for the 11th grade high school excretory system material is of very good quality with an average score of 3.89. The quality of the media is seen from the average validation results, limited trial phase I, and limited trial phase II. The validation results for all aspects obtained an average score of 3.82, categorized as highly valid, while the limited trials in stages I and II obtained average scores of 3.93 and 3.94, categorized as very good.

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