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Augmented Reality Media Development for Human Digestive Material to Afford The Learn Motivation of High School Student on SMA Kartika I-2 Medan

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Abstract

Based on interviews was conducted at Kartika I-2 Medan High School the biology teacher at Kartika I-2 Medan High School confirmed that there are currently no technology-based learning resources available to help biology students learn about the human digestive system, Furthermore, known that acquisition of the average of the mid-semester term score was 53.35. So that certain students experience boredom when learning, unfocused and less active in the learning process, it is also found that students lack understanding of several biology learning materials, one of which is the digestive system. This research was carried out on Kartika I-2 Medan High School which consists of 3 science class. The respondent of product test consists of 70 students in science class of second grade (XI-MIPA Class). The research instrument is a validity instrument, namely media/material expert validation. This learning media was developed through 4-D stages (Definition, Design, Development, Dissemination). Results showed that the application of augmented reality media to evaluate student motivation at Kartika I-2 Medan High School especially on the human digestive system. Media experts' validation results were 100% with very feasible criteria, while material experts' results revealed 93.5% with extremely viable criteria. Thus, the learning process could take advantage of this augmented reality content.

Keywords: *Augmented reality, Motivation, Respiratory System*

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INTRODUCTION

In the current era of globalization, technological developments are increasingly advanced and more sophisticated so that they can be utilized in various areas of life, namely economic, political, social, cultural and educational (Nurmaulidina et al., 2022). The field of education is very important in facing the development of science and technology (Ariningtyas et al., 2017). The Partnership for 21st century learning explains the 21st century skills or abilities that students must possess, namely knowledge construction, real-world problem solving, communication skills, collaboration, self-regulation, and the use of information and communication technology for learning (Stehle & Burton, 2019). The capacity to use media, technology, information, and communication is one of the 21st century skills (Intana et al., 2018). Thus, education as a field that is influenced by developments in technology and information is expected to be used as a means of communication between teachers and students in learning, one of which is in creating learning media (Sejati & Koeswanti, 2020). Learning media is very important for educators to use, because it can be used as an intermediary in conveying material so that it can be easily understood by students, so that it can improve student learning outcomes (Wahyuningtyas & Sulasmono, 2020).

The usage of learning media can attract and encourage students by clarifying the presentation of messages and information, therefore facilitating and increasing the learning process and outcomes (Dewi et al., 2018). Then, Nasir et al., (2018) explained that learning media can help in the learning process so that learning concepts can be conveyed to students well. And learning media can also be used as a solution to answer students' learning difficulties (Muthy & Pujiastuti, 2020).

In order to build exceptional human resources with global competency in the field of education, educators must be able to use information technology to create learning media (Sembiring et al., 2022). The use of media can make the learning process not only easier and more effective, but also more interesting (Sanjaya, 2018). The learning process is a communication process that involves three main elements, namely the teacher as the sender of the learning message, the student as the recipient of the message, and the message itself in the form of learning material. So that learning messages can be conveyed more effectively, delivery tools are needed in the form of learning media. Media functions to create a good learning atmosphere, build students' will so that effective learning can be achieved. Good communication will have an impact on how an educator is able to identify, select and determine opinions, teaching methods and also learning media that suit the characteristics of students according to the times they are facing (Darmawan et al., 2019).

The application of learning media helps teachers in the learning process. The software and hardware facilities used by teachers in the learning process are able to foster new knowledge, new abilities and new changes for students (Fathurrohman & Suryana, 2019). Based on interviews conducted by researchers at Kartika I-2 Medan High School the average of mid-semester term score was 53.35. Therefore, the biology teacher at Kartika I-2 Medan High School confirmed that Unfortunately, there has been no technology-based learning media to support students

in biology disciplines about the human digestive system, so that during the learning process some students feel bored, unfocused and less active in the learning process, it is also found that students lack understanding of several biology learning materials, one of which is the digestive system. This is because the media used is less attractive to students, they only focus on textbooks as a learning resource, so create it feel harder for students to comprehend the subject, supported by the statement of Jundu et al., (2020) which states that less attractive learning media can be a factor in students' lack of enthusiasm in the classroom.

To overcome these problems, various technologies can be used to support learning. One example is Augmented Reality (AR). The AR is a technology that can combine real objects with the virtual world to produce real-time, interactive 3D animations (Haryanto et al., 2017). With AR, students can see cell objects more realistically and interactively (Usmaedi et al., 2020). Augmented Reality is a technology that has the aim of adding real-time information or content to the real world in its development. Augmented Reality in its use can enable users to see and interact with computer-generated 3-dimensional objects in the real world (Septiandi & Dirgantara, 2019).

Augmented Reality development requires a lot of software, including Unity Game Engine, Blender, Vuforia and design software (Coreldraw). This software complements each other to develop augmented reality. Unity Game Engine is a game development ecosystem, a rendering engine that is integrated with a set of intuitive tools for creating interactive content ranging from 2D and 3D content (Fadli & Ishaq, 2019). Blender is software for creating 3-dimensional (3D) animations that can be run on Macintosh, Linux and Windows. According to Fadli & Ishaq (2019), markers are defined as patterns made in the form of images consisting of boundary lines and pattern images. Markers can be made using design software, such as Coreldraw. Vuforia is an SDK (Augmented Reality Software Development Kit) that can help in creating applications that include Augmented Reality features. Vuforia is stable and effective in image recognition. Vuforia has the advantage of allowing applications to be used on mobile devices.

The use of Augmented Reality requires assistance from other devices, namely smartphones (Wahyudi, 2016). The way Augmented Reality works begins with detecting images/markers using a camera from a smartphone in real time and then from above the marker virtual information will appear (can be in the form of 2-dimensional or 3-dimensional objects, video and sound) (Ambarwulan & Muliyati, 2016).

Therefore, this research requires to produce Augmented Reality learning media, especially in biology learning for the human digestive system. By using Augmented Reality media, it is hoped that students will have enthusiasm in participating in teaching and learning activities and Augmented Reality can be useful for teachers in the learning process and provide new things for teachers in using technology as a learning media tool.

METHOD

The approach employed in this research is a research and development process with the four-dimensional (4D) model, which comprises of four steps. There are 4 stages of the Four-D model, namely: (1) Definition, (2) Design, (3) Development, (4) Dissemination.

Sample or Participant

This research was conducted on January 2025 at Second grade (XI-MIPA Class) of Kartika I-2 Medan High School which consists of 3 science group classes. The product test sample consists of 70 students who will be tested on 20 students in XI-MIPA 1, 25 students in XI-MIPA 2, 25 students in XI-MIPA 3.

Instrument

Validity instrument, the instrument used in this research to determine the validity of the Augmented Reality media product being developed is media/material expert validation. The validity of the questionnaire is assessed by media/material experts. Practicality instrument, the instrument used to determine the practicality of the Augmented Reality media being developed is a teacher and student response questionnaire. This instrument aims to determine the quality of practicality based on students' responses and responses to aspects of the usefulness and convenience of the Augmented Reality media that have been developed. The effectiveness instrument is the pretest/posttest assignment score and student motivation questionnaire based on student learning outcomes from a number of questions or statements

Data Analysis

Data collection instruments consist of: 1) Test instruments, tests given to Second grade of science students (XI class) before and after using Augmented Reality media, namely student motivation tests. 2) Expert validation, expert validation is carried out to determine the effectiveness and feasibility of the Augmented Reality media being developed. 3) Questionnaire, response questionnaire given to biology teachers and students (as respondent), regarding Augmented Reality media.

Procedure

This learning media was developed through 4 stages, namely: (1) Definition, (2) Design, (3) Development, (4) Dissemination. The definition stage includes activities to analyze or collect learning needs relevant to the product being developed. In this stage, initial observations or observations are usually made regarding conditions at the school. The compatibility of needs to the applicable curriculum, the stage of development of children, school settings, and challenges in the field must all be addressed when defining learning needs (Prayitno, 2017).

The design stage contains activities to design the product being developed. Design activities at this stage include: 1) Preparation of Tests (Constructing Criterion Referenced Test), instrument exams are created based on learning objectives, and they

serve as a benchmark for students' abilities in the form of products, processes, and psychomotors during and after learning activities. 2) Media Selection, Media selection is performed out to choose learning media that are related to the features of the topic and fit the needs of students. Media is chosen according to student assessment, conceptual analysis, and evaluation of tasks, target audience characteristics, as well as Dissemination strategies with various media features. This helps pupils attain the needed core and basic competencies. 3) Format Selection, The format selection is done in the initial stage (first stage).

Format selection is accomplished so that the selected format is appropriate for the learning material. The presentation format is customized to the learning media used. Choosing a design in development refers to creating educational materials, picking methods and resources, and planning and creating content for augmented reality, producing layouts, graphics, and text for augmented reality designs. 4) Making an Initial Design, The supervisor provided feedback after the researcher built the Augmented Reality media design. Prior to production, the supervisor's suggestions will be utilized to enhance the Augmented Reality content. Then make revisions after receiving suggestions for improvements to the supervisor's augmented reality media, and this concept will subsequently be implemented during the validation phase. This design is in the form of Draft I from Augmented Reality media.

This development stage aims to produce Augmented Reality media that has been revised based on expert input and trials with students. There are two steps in this stage, namely: 1) Expert validation (expert appraisal), this expert validation functions to validate the material content of the human digestive system in Augmented Reality media before testing is carried out and the validation results will be used to revise the initial product. The Augmented Reality media that has been prepared will then be assessed by material expert lecturers and media expert lecturers, so that it can be seen whether the Augmented Reality media is suitable for application or not. The outcomes of this validation are utilized as input to refine the augmented reality content that is being created. After draft I was validated and revised, a limited field trial phase was produced. 2) Product Trial (development testing), A small-scale experiment was conducted following expert validation to ascertain the outcomes of using Augmented Reality media in the classroom, including Assessing student motivation for studying and student learning results. This stage's output takes the shape of updated Augmented Reality content.

This distribution stage is to disseminate Augmented Reality media. In this research, only limited dissemination was carried out, namely by distributing and promoting the final Augmented Reality media product on a limited dissemination basis to biology teachers at Kartika I-2 Medan High School.

Data Analysis

Instrument Validation Test

Validation sheet data will be analyzed for validity by Riduwan (2011) formula :

$$percentage\ (\%) = \frac{score\ obtained}{maximum\ score} \times 100\ \% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

Table 1. Validity Criteria, Source: (Riduwan, 2011)

No.	Interval (%)	Criteria
1	0 - 20	Invalid
2	21 - 40	Less Valid
3	41 - 60	Fairly Valid
4	61 - 80	Valid
5	81 - 100	Very Valid

Table 2. Practicality Criteria, Source: (Riduwan, 2011)

No.	Intervals (%)	Criteria
1.	0 - 20	not practical
2.	21 - 40	Less Practical
3.	41 - 60	Fairly Practical
4.	61 - 80	Practical
5.	81 - 100	Very Practical

A media is said to be valid if it reaches 60 %. Practical analysis is carried out by analyzing data obtained from student response questionnaires. A learning media is said to be practical if it has reached a fairly practical level, namely above 61 %.

N-Gain Analysis

Independent Sample N-gain using formula by Sugiyono (2017).

$$\text{N Gain} = \frac{\text{Skor Posttest} - \text{Skor Pretest}}{\text{Skor Ideal} - \text{Skor Pretest}} \quad \text{..} \quad (2)$$

Table 3. Effectiveness Categories of Interpretation of N-Gain, Source: (Hake, 1999)

Percentage (%)	Interpretation
< 40	Ineffective
40-55	Less effective
56-75	Effective enough
> 76	Effective

Based on the pretest and posttest data, an effectiveness analysis was produced. N-gain calculations or normalized gain values are utilized to determine whether the media being created is beneficial in enhancing student learning results.

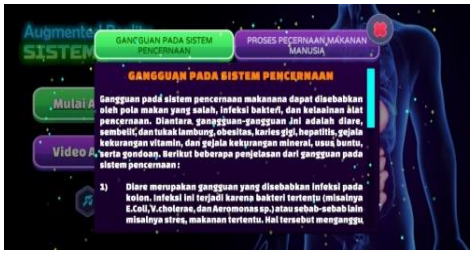
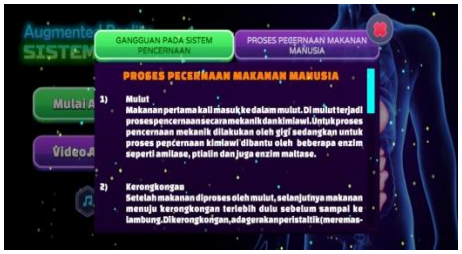
RESULT AND DISCUSSION

There are multiple steps involved in designing augmented reality content, and the first step is figuring out the stage. The first step in the defining stage is doing a variety of analyses to gather data about the requirements for creating augmented reality media (Sudarmayana et al., 2021). First, the biology teachers was interviewed by the researchers at the Kartika I-2 Medan High School schools about issues

concerning media, resources, and students' opinions about the media utilized in the educational process. Researchers created augmented reality content about the human digestive system after gathering data through interviews. The design of the augmented reality media can be seen in Figure 1.

The design stage or augmented reality design stage is filled with initial product design in making augmented reality material on the human digestive system for second grade (XI-MIPA Class) high school. Researchers created and gathered a number of books at this point to serve as references for information on the human digestive system. Preparation of augmented reality media designs and assessment instruments is also carried out so that the augmented reality media is in accordance with the content framework to be designed. In augmented reality media, several tasks are also implemented to see students' learning motivation, namely by having quizzes through pretests and posttests so that Students can comprehend and use them in their daily lives.

Figure 1. Augmented Reality Media Design for Human Digestive System Material

No	Before	After
1		
2		
3		

Validation Analysis

The augmented reality media design has been validated by 2 expert lecturers, namely a media expert and a material expert. The content in augmented reality media will be assessed starting from the balance of text and image composition, color

selection, physical criteria, practicality, long-term use which will be validated by media experts. The content of the material in augmented reality media will be assessed starting from the material, the topics discussed are in accordance with the indicators that will be validated by material experts. After the development was carried out with improvements, suggestions were given by validation lecturers, material experts and media experts. Then the augmented reality media will be tested on students according to the final results after revisions from the two validation lecturers. The results of the validation of material expert lecturers can be seen in table 6 and 7.

Table 6. Results of augmented reality material expert validation tests on the respiratory system

Statement	Average Score	Criteria
1-13	93.5 %	Very worthy
Average Score		**93.5 %**
Criteria		**Very worthy**

In the results of the material validation test, an average score of 93.5 % was obtained, including very feasible criteria. In this material expert validation test, the results obtained during the validation process were included in the appropriate category for testing in biology learning with revision. The notes or suggestions from the validator are to pay attention to the writing, such as spacing, choosing the same font, color, size and the size of the animation/graphics used in augmented reality media.

Table 7. Results of augmented reality media expert validation tests on the respiratory system

Statement	Average Score	Criteria
1-10	100 %	Very worthy
Average Score		**100 %**
Criteria		**Very worthy**

In the results of the material validation test, an average score of 100 % was obtained, including very feasible criteria. In this media expert validation test, the results obtained during the validation process were included in the appropriate category for testing in biology learning with revision. The notes or suggestions from the validator are that there needs to be instructions for using augmented reality in the application, in the augmented reality profile the name of the supervisor needs to be included, in the material there needs to be additional information, namely the process of the human respiratory system from the mouth to the anus and the function of each organ.

Teacher and student responses

Data on the practicality of using augmented reality media was obtained through a response questionnaire from biology teachers and second grade of science class

students (XI-MIPA Class) at Kartika I-2 Medan High School after the application was used in the learning process. Data on the practicality of teacher responses is presented in table 8.

Based on the biology teacher response questionnaire, It is well known that augmented reality content has a 100 % score percentage and is very useful for learning. In simple terms, augmented reality can provide interesting interactions, because it can display virtual objects that appear to be in our environment via a computer or smartphone screen. Lolowang et al., (2017) defines Augmented reality as a combination of real and virtual objects in a real environment, running interactively in real time, and there is integration between objects in three dimensions, namely virtual objects are integrated in the real world. Sejati & Koeswanti (2020) shows that the application of augmented reality in biology education can improve students' understanding of complex concepts. In the modern world marked by technological advances, augmented reality has emerged as a promising innovation to enrich digital experiences in various areas of life (Herlina, 2019). In an era of ever-developing technology, the use of learning media is not only important, but also a practical means of improving the learning experience. Data on the practicality of student responses can be seen in table 8.

Table 8. Data Results of Biology Teacher and Student Responses to Augmented Reality Media

Responden	Score	Category
Biology teacher for XI MIPA Class Kartika I-2 Medan High School	92.5 %	Very Practical
70 Students XI MIPA Class Kartika I 2 Medan High School	91.0 %	Very Practical

Considering the practicality questionnaire's findings, its known that the function of augmented reality media based on scientific literacy is categorized as practical because It obtained a score of 91.0 %, and studies have shown that children can use augmented reality media on their own because the usage guidelines align with the media's intended function. According to Nanditasari & Wibawa (2024) view, as technology advances, digital-based learning media, including augmented reality, can project and manage active learning activities into analytical skills. In this way, students gain access to advanced technical knowledge by absorbing complex energy information.

Effectiveness of Augmented Reality Media to Increase Student Motivation

Testing the effectiveness of augmented reality media was carried out by giving questions and questionnaires before and after using augmented reality media to 70 students. The purpose of this efficacy test was to determine whether using augmented reality media could boost student motivation. Table 9 displays the findings from the analysis of the efficacy of augmented reality media.

Table 9. Effectiveness Media Augmented Reality Media

Respondent	Persentase (%)	Category
70 Student	86.5%	Very Effective

Based on the results of the analysis of the effective test of augmented reality media, it was found that the value obtained was 86.5 %, which shows that the criteria are very effective. So the use of augmented reality media is very effective in biology learning, and can support the achievement of learning objectives well. The results of student motivation can be seen in table 9.

Motivation

Researchers first distributed questionnaires regarding student motivation. The aim is to test student motivation results without using augmented reality. After learning, motivation questionnaires were distributed again to find out students' motivation after learning using augmented reality. The data obtained was then analyzed using the normalized gain technique to determine student motivation criteria. The average results of the motivation questionnaire before and after learning are shown in Figure 2.

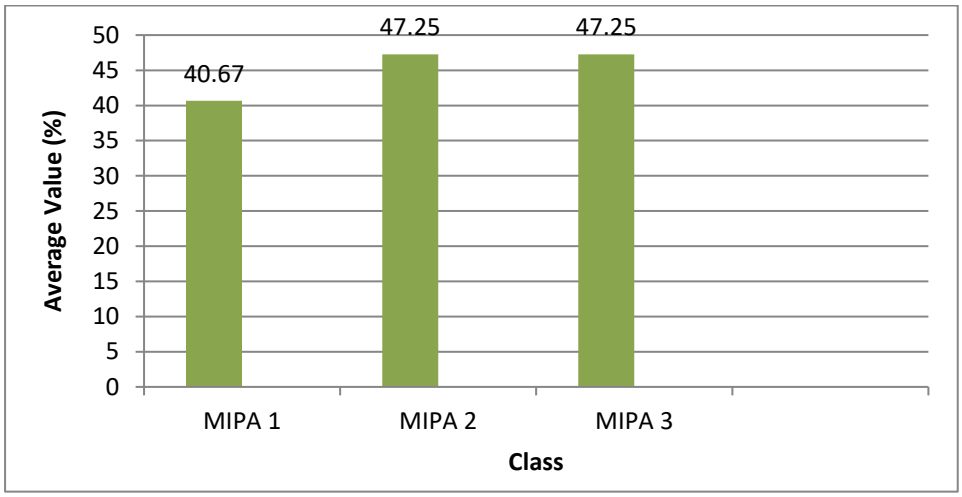


Figure 2. The average results of the motivation questionnaire

It is evident from Figure 2 that the motivation questionnaire ratings have increased in second grade student (XI-MIPA Class). This proves that students are more motivated in learning by using augmented reality. The N-gain test's computed result indicates that the experimental class's average value is 94.50 %. A category is considered valid if its N-gain value is 90 % or above. According to the N-gain score calculation, second grade class (XI-MIPA 1) has an average score of 40.67 %, falling into the median range. The minimum N-gain value is 6 % and the maximum N-gain value is 54 %. The use of augmented reality media is effective in increasing motivation for the digestive system in humans in biology subjects.

CONCLUSION

Based on the results of research and development data analysis carried out by researchers, it can be concluded that the product produced is augmented reality media on the human digestive system to measure student motivation at Kartika I-2 Medan High School. The validation results by material experts showed 93.5 % with very feasible criteria, while for media experts the results were 100 % with very feasible criteria. So this augmented reality media can be used in the learning process. The results of the augmented reality media research carried out by the teacher obtained a result of 92.50 % with very practical criteria. The results of the augmented reality media trial carried out on students obtained a score of 91.00 % with very practical criteria. The results of the augmented reality media effectiveness test obtained results of 86.50 % with effective criteria. For students' learning motivation results, they got a score of 94.50 %. So the augmented reality media developed is considered practical and effectively applied in the biology learning process.

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