Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

DEVELOPMENT OF AUGMENTED REALITY (AR) LEARNING MEDIA ON DIGESTIVE SYSTEM MATERIALS IN IMPROVING THE UNDERSTANDING OF CONCEPTS FOR STUDENTS OF CLASS XI MAN 2 LANGKAT

Helpi Tiana[1a*], Rohani [2b]

[12] Universitas Islam Negeri Sumatera Utara, Indonesia

1a helpitiana@uinsu.ac.id
2b rihani@uinsu.ac.id

(*) Corresponding Author
helpitiana@uinsu.ac.id

ARTICLE HISTORY
Received : 31-07-2025
Revised : 08-08-2025
Accepted : 10-08-2025

KEYWORDS
Learning Media
Augmented Reality
Digestive System
4-D Development

ABSTRACT
This study is a type of research and Development (R&D) which aims to develop augmented Reality (AR) based learning media on the topic of the human digestive system for high school students. This study was initiated because of the increasing need for interactive learning media that are able to visualize abstract biological concepts and support * independent curriculum*, which emphasizes meaningful and technology-oriented learning. The development process follows the 4-D model (Define, Design, Develop, Disseminate) introduced by Thiagarajan, but this study was limited to the Develop stage due to time constraints. Research instruments include expert validation sheets, teacher and student practicalities questionnaires, and pretest and posttest assessments to measure media effectiveness. The validation results of 98% media experts and 88% material experts showed that the media is very feasible. The practical test received a score of 90% from teachers and 98% from students, both belonging to the "very practical"category. Furthermore, the effectiveness test showed an increase in students' conceptual understanding, with an average N-Gain score of 76.52%, which is high. These results indicate that AR-based learning media are effective in increasing students' engagement and conceptual understanding of the human digestive system.

INTRODUCTION

One of the main problems in the Indonesian education system is the low quality of learning, which is highly dependent on the optimization of the teaching and learning process. Indonesia update . The use of technology is an important bridge in achieving learning goals and supporting teaching and learning activities in schools. Entering the 21st century, efforts to improve the quality of education require reform through improvement. These challenges must be faced by students to be able to adapt to the dynamics of the present and the future. In this context, it is an important strategy to have an effective process of fun. (Kumalasari et al., 2023) (Azhar et al., 2023) (Maritsa et al., 2021) (Wisada et al., 2019) (Azaly & Fitrihidajati , 2021)

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

Learning media functions as a means of delivering information, allowing teachers to present material in a more interesting and easy-to-understand way for students. When aligned with the student's developmental stages, media can create an interactive learning environment and encourage active participation in the learning process. In the digital era, educational media needs to be developed to match the characteristics of Generation Z, which is a generation that grows up in a technology-rich environment. Therefore, teachers are required to be creative and innovative in designing learning media that is relevant to the needs of 21st-century students. (Cahyadi, 2019; Saputra et al., 2024) (Düsseldorf & Utami , 2024) (Khasanah et al., 2024; Mardin et al., 2025)

One form of educational technology that is in harmony with the original digital character of Generation Z is *Augmented Reality* (AR). AR is a technology that combines real and virtual environments in *real-time*, providing an interactive and immersive experience. The application of AR in education has been shown to improve conceptual understanding, especially in subjects that involve abstract or difficult-to-observe concepts, such as Biology.Interactive 3D visualization through AR helps reduce misconceptions, increase learning motivation, and increase student engagement. Therefore, AR is emerging as a promising alternative to creating effective, contextual, and enjoyable learning experiences for digital learners. (Ramadhan et al., 2021) (Aripin & SquirrelSquirt , 2019) (Thahir & Kamaruddin , 2021; Zulfahmi & Authority , 2020)

According to Marshall, the understanding of media is a human extension that allows it to influence others who do not have direct contact with it. Media is very helpful in the teaching and learning process and plays an important role in the world of education, where every teacher needs media to support the successful delivery of the information provided. Basically, the teaching and learning process is a communication process. In communication, there are often irregularities so that the communication does not run effectively and efficiently. Therefore, one of the efforts to overcome this is the use of media in the learning process. (Nurhasana, 2021)

Generation Z prefers to use *smartphones* and the internet in their daily lives, so the right learning media is needed so that students do not get bored quickly. Requires smartphones and direct learning media using the internet (Tamboo et al., 2024). By utilizing *smartphone* devices and existing internet access, the learning process will become more enjoyable. (Mardin et al., 2025) *Augumented Reality* is a technology that combines real-world elements with three-dimensional virtual objects in *real time*. Through *augumented reality*, users can see virtual objects that are integrated with the real environment in an interesting way. Effective learning is not only interactive and fun, but it is also capable of stimulating and providing more opportunities for students to develop their creativity and independence according to their interests and potential. *Augumented reality* technology plays a crucial role in creating a more dynamic and relevant learning experience by displaying realistic-looking three-dimensional images. Thus, *augemented reality not only increases students' interest in the subject matter but also prepares them to face the challenges of the modern world that is increasingly digital (Riskiono et al., 2020).*

Augmented Reality (AR) technology is one of the innovations that is currently widely used in learning media in the world of education. AR has become popular due to its ability to combine the real world with virtual elements simultaneously. This technology has three main characteristics, namely being interactive, providing an *immersive* experience or deep involvement, and being able to work in *real time*. These three aspects are very helpful in conveying learning information appropriately and accurately, so that students can more easily understand the material delivered by the teacher. In addition, the use of Augmented Reality-based learning media (Ramadhan et al., 2021) has been proven to be able to improve student learning outcomes. In the research conducted by , it was stated that this technology has a positive impact on the academic achievement of students. Not only that, AR is also considered effective in helping students to understand concepts more deeply, especially in materials that are usually presented in the form of two dimensions (2D). With the help of interactive three-dimensional visualization, AR can reduce the misconceptions that often arise when students are only looking at flat images or text explanations. Furthermore, the use of (Aripin & SquirrelSquirt , 2019) *Augumented Reality* in delivering educational materials also has a positive effect on students' learning motivation. Engaging visualizations, hands-on interaction, and fun material delivery make students feel more interested and excited in participating in the learning process.

This is reinforced by the results of research from those who stated that AR technology can be an effective means to foster students' interest in learning, so that they are more active, involved, and motivated in understanding the subject matter being taught. This media can also be relied on as the right alternative because it is able to present biology learning content that is often considered difficult for students to understand, in a more contextual way. The material taught is not only in the form of theory, but also accompanied by image observation with explanations of its parts, as well as interesting images, animations, videos, and so on displayed through (Zulfahmi & Authority

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

, 2020) *Augmented Reality* applications. This is expected to encourage students to be more creative, actively engaged, and improve their understanding of the subject matter, which in turn can improve student learning outcomes. (Thahir & Kamaruddin, 2021) *Augumented reality* as a system that has three characteristics, namely (1) combining the real and virtual worlds; (2) be interactive;and (3) using three-dimensional space. *Augumented reality* is interactive and can be applied in mobile-based learning, can provide a good understanding of a concept.

According to Mustaqim and Kurniawan (2017), *Augmented Reality* (AR) technology in a system has a number of advantages and disadvantages that need to be considered. The advantages of AR include: 1. It is interactive, allowing users to engage directly with virtual objects in *real-time*, thereby increasing the attractiveness and understanding of the material. 2. Its use is quite effective, because it is able to convey information visually and attractively in a short time. 3. Can be applied in various media, such as *smartphones*, tablets, to AR-specific devices, making it flexible in application. -4. Object design tends to be simple, as this technology is often used to display limited but quite informative visualizations of objects. 5. Development costs are relatively affordable, so they can be accessed by various groups, including educational institutions. 6. Easy to operate, both by developers and users, as its interface and usage mechanism are designed to be user-friendly. The disadvantages of AR include: 1. Sensitivity to changes in viewing angle, which can lead to visual instability or loss of object tracking when the camera position changes drastically. 2. The number of AR developers is still limited, so AR-based content and applications have not been widespread, especially for certain fields. 3. Requires large memory capacity, as AR applications typically contain complex graphic and data elements that require high-spec hardware. (São Paulo & Budiyono , 2020; Murdianti , 2024)

Understanding concepts is a very important skill in the learning process, especially in the fields of mathematics and science. This understanding includes a wide range of abilities, such as explaining, defining, describing, and interpreting a concept. More than just knowing the definition, conceptual understanding also involves the interconnectedness between existing concepts. emphasizing that understanding concepts is the basis for understanding principles and theories in a discipline. This shows that understanding concepts is an important foundation for understanding more complex material. The ability of students to restate concepts, provide examples and cons, and classify objects based on the concepts learned is an indicator of good concept understanding. Thus, understanding concepts is not only limited to understanding definitions, but also involves the ability to explain, give examples, classify, and relate the concepts learned. A deep understanding of concepts will help students in solving problems, developing skills, as well as applying knowledge in a wider range of contexts. (Rismawati & Al-Pansori, 2023) (Yurniwati & Stuttgart , 2019) (Djatmiko & Mahbubah , 2022) (Aeni et al., 2022)

Indicators of concept understanding according to Sumarmo include, restating a concept, classifying objects according to certain properties (according to the concept), providing examples and non-examples of concepts, presenting concepts in various forms of mathematical representation, developing necessary or sufficient conditions of a concept, using, utilizing, and choosing certain procedures or operations, applying concepts. One of the big challenges in the world of education is ensuring that every student gets a meaningful learning experience and is able to understand the concepts taught well. In science subjects such as Biology, understanding concepts becomes very important because Biology studies life and its interaction with the environment. (R & Pujiastuti , 2018) (Rahmawati et al., 2024)

The development of *Augmented reality* learning media on existing digestive system materials is Research by Aripin & Suryaningsih (2019) developing *an Augmented Reality (AR)-based Biology learning application* for nervous system materials using the Akker model. Media is declared very feasible by experts in terms of media, pedagogic, and content.The implementation in grade XI of SMAN 1 Kadipaten showed an increase in student learning completeness of up to 76% and a positive response of 80.61%. The advantage of AR lies in 3D visualization and animations that help students understand abstract concepts more easily. This study provides a framework for the development and evidence of the effectiveness of AR in Biology learning.

Research by Haka et al. (2025) developed an Android-based AR learning media for circulatory system materials using the Borg & Gall model. The media was declared very feasible with media, material, and language feasibility scores of 82%, 84%, and 79%, respectively. The student response was positive (83%), and the N-Gain test showed a significant improvement in conceptual understanding in the experimental class (0.47) compared to the control (0.23). This research confirms that AR is effective in helping students understand complex biological processes and is well accepted by learners. (Haka et al., 2025)

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

Indriani & Abidin (2022) through a qualitative literature study concluded that AR technology in Biology learning is effective in increasing students' motivation and concept understanding. They identified three types of tracking in AR, with *Marker Based Tracking* being most commonly used in education due to its convenience. Analysis of various studies shows that AR has a positive impact on learning outcomes, especially for abstract materials such as the nervous system and biotechnology, and has the potential to be a solution to students' difficulties in understanding complex Biology concepts. (Indriani & Abidin , 2022)

In Biology learning, students face various problems in learning. In facing this challenge of learning Biology, teachers can use more interesting teaching media, which can reduce problems that usually occur during the learning process. One of the obstacles in learning Biology is the low ability of students to remember and understand the material. Meanwhile, material about the digestive system is difficult to observe directly because most of it occurs in the body (Faidah et al., 2022). (Saputra et al., 2024)

The use of media in the learning process can make it easier for teachers to convey information. The learning media used in the learning process is expected to help students follow learning optimally and with fun, according to the stage of their learning needs. Learning media can be interpreted as tools and means that connect and convey messages and ideas. The presence of media in learning greatly supports teachers in presenting learning optimally, because media is part of the learning resource that can facilitate the learning process to improve students' understanding of the material taught (Hayati, 2022), In addition, the use of media in learning activities can encourage students to actively participate in solving problems, making decisions, asking questions, and summarizing information (Murti, 2019). Learning media must be adapted to the characteristics of the current generation, namely generation Z. Gen Z is growing and thriving in the digital age where the internet has come a long way. They have been familiar with advanced technology and devices such as smartphones since childhood. To face the challenges of teaching Gen Z, teachers need to be more creative in developing appropriate and interesting learning media. (Saputra et al., 2024) (Düsseldorf & Utami , 2024) (Cahyadi, 2019) (Khasanah et al., 2024; Mardin et al., 2025)

Juliati br zega (2022) Media Development Using Android-Based *Augmented Reality* on Atomic Structure Materials at SMA Negeri 1 Simpang Kiri, Subulussalam City This research focuses on the development of *Augmented Reality* (AR)-based learning media for atomic structure materials at SMA Negeri 1 Simpang Kiri, Subulussalam City. The background of this research is the lack of use of interesting learning media, which leads to a lack of interest and motivation of students. The AR media developed uses *marker-based tracking methods* and includes features such as quizzes, profiles, materials, and 3D objects with animations. The purpose of this study is to test the validity of AR media, as well as the response of teachers and students to the media. The validation results showed that this media was very valid (96.35%), teachers were very interested (100%), and students responded positively (88.61%), concluding that this AR learning media was effective and feasible to be developed. (Zega, 2022)

Nurul Asih (2024) This research has succeeded in developing and validating Android-based Augmented Reality (AR) learning media to improve the understanding of the concept of high school grade XI students on circulatory system material. The media, which was developed through the 9 stages of Borg and Gall's R&D, proved to be very feasible based on the assessment of media experts (82%), subject matter experts (83%), linguists (79%), as well as positive responses from students (83%), and was significantly able to improve students' understanding of concepts, as shown by the test results and higher N-Gain increase in the experimental class (0.47) compared to the control class (0.23). (Asih, 2024)

Based on the previous study above, it can be concluded that in previous research, *augumented reality* media has been developed for neural matter, circulatory system material in biology learning. However, there has been no research that specifically develops *augumented reality-based* media to improve students' understanding of concepts in digestive system materials. In the above study, it still uses augumented reality in the form of non-physical videos, but in Nurul Asih's thesis has used *augumented reality* in the form of works, but the card design is not specific, only the title and explanation of the material and code. Then Nurul Asih's study used the Borg and Gall model. Therefore, this opens up an opportunity for researchers to conduct research related to the development of *augmented reality media* at the high school level with a location in MAN 2 Langkat . (Setiawan, 2021)

Based on the results of interviews with biology teachers conducted at MAN 2 Langkat that currently teaching media such as *augumented reality* are not available in the school. Teachers still use *PowerPoint* and books as teaching resources. However, because the material is only delivered briefly through *slides* and relies more on verbal explanations, many students have difficulty understanding concepts, especially the digestive system. Therefore the development of *augumented reality* media that can connect the concepts of the digestive system. With this approach,

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

it is hoped that students will more easily understand the material being taught. Then due to inadequate media, students find it difficult to understand many concepts. One of them is material on the human digestive system, which is considered complicated because it involves digestive organs that function in the body, making it difficult to explain clearly to students. Therefore, the development of *augmented reality* media with a science literacy approach is expected to be a solution to this problem. This approach allows students to see models of digestive organs in three-dimensional (3D) form, understand the relationships between organs, and deepen their understanding of concepts through direct interaction with digital media. (Aditia, 2024)

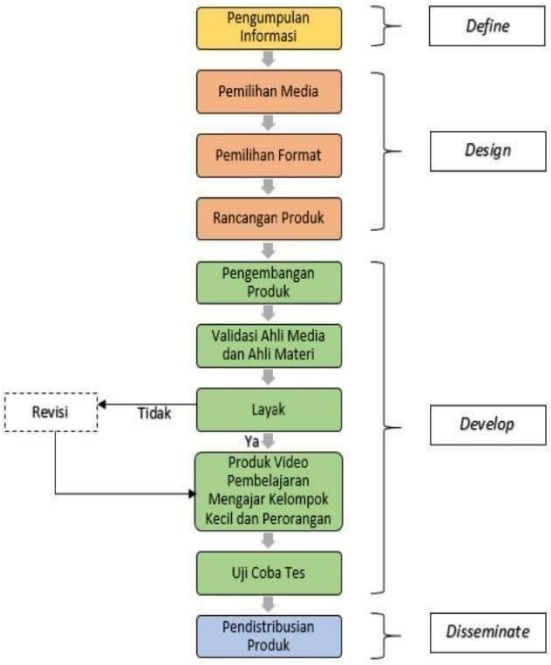
From the above problems, the researcher is interested in developing *augmented reality* media that can provide learning experiences to students to visualize in real terms how the digestive system and digestive organs function in the body. The purpose of this experiment is to increase students' understanding of the concept of the digestive system. Through *augumented reality learning media*, it is hoped that students can more easily understand the concept of the human digestive system through more real and interactive visualization of lessons.

METHOD

Research Design

This research is a type of Research and Development (R&D) that aims to produce a certain educational product while testing its effectiveness. R&D (*Research and Development*) is a systematic method used to produce new products, improve the quality of existing products, or create innovations based on the results of planned research. In the field of education, R&D serves as an approach to develop learning tools, media, methods, or strategies that can be used to improve the effectiveness of the teaching and learning process. This process not only focuses on product creation, but also involves an ongoing evaluation and revision process so that the resulting product is truly in accordance with the needs of users, in this case learners and educators. (Haka et al., 2025)

The development model used in this study is the 4-D model developed by Thiagarajan (1974), which consists of four main stages: Definite, *Design*, *Develop*, and *Disseminate*. The *Define stage* involves the analysis of learning needs, including student characteristics and the applicable curriculum.The Design stage focuses on selecting the right media, determining the content format, and preparing the initial design of the product. During the *Develop* phase , the product is tested and revised based on feedback from experts (validators) and limited test results. The final stage, *Disseminate*, aims to expand the use of media in broader learning contexts, such as hands-on implementation in the classroom. However, in this study, the development process was limited to the *Develop* stage due to limited time and available resources. The above steps or procedures can be depicted on the chart as follows:



Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

Figure 1. 4D Model Development Procedure
Source: (Mesra, 2023)

RESULTS AND DISCUSSION

Result

This research aims to develop a learning media based on *Augmented Reality* (AR) on the material of the human digestive system and test its validity, practicality, and effectiveness in improving students' understanding of concepts. Development is carried out using 4-D model (*Define*, *Design*, *Develop*and *Disseminate*).

a. Define stage

At the definition stage, the researcher conducts an initial analysis to identify needs and problems in the learning process. The steps taken include interviews with teachers of Biology subjects, the distribution of needs analysis questionnaires to teachers and students, as well as curriculum studies and student characteristics analysis.Based on the results of the interview, it was revealed that the learning process still relies on conventional media such as textbooks and PowerPoint presentations, which are considered less interesting and less interactive. The material of the digestive system is also considered difficult to understand by students because of its abstract nature, microscopic scale, and cannot be observed directly in daily life. The needs analysis questionnaire also showed that most students found it difficult to understand the digestive process as a whole and needed visual, interactive, and contextual learning media. Teachers also expressed the need for learning media that can connect the material with real-life contexts and encourage active student engagement. These findings reinforce the need for the development of innovative media that can bridge the limitations of conventional tools and improve students' conceptual understanding.

b. Design Stage

1. Text preparation: studied based on the context of the content in the learning media material that has been adapted to the biology package book for class XI based on the independent curriculum
2. Media selection: adjusted to the needs of students to overcome problems that exist in students
3. Format selection: This *augumented reality* media was designed using *the Canva* application and using *the assembly application with* a size of 17.6 x 25cm using 150 gsm thick construction paper. This *augumented reality* media uses combined *fonts* consisting of *types of fonts*, namely fredoka, *hit and run* and with a combination of black, brown, black and white font colors and Some materials are equipped with *QR scans* containing the organs of the digestive system with 3D and learning videos

c. Develop Stage

At this stage, the researcher prioritizes the content quality and functionality of the Augmented Reality (AR) media that has been developed to ensure that the media not only meets the feasibility of the content aspect, but also has a high level of usability in the context of Biology learning in the classroom. Validation is carried out prior to implementation, as emphasized by , which states that feasibility testing is a crucial stage to ensure the media meets quality standards, both from a pedagogical and technical perspective. The validation process involves two experts with competencies that are in accordance with the focus of media development, namely: (Kahfi & Ulefah , 2024)

1. Validity Test
   a) Media Expert Validation Results

Media Expert Validation Results Table

Aspects Assessed	Assessment Score	Maximum Score	Percentage
a. Graphic Aspects	32	32	100%
b. AspectPresentation	12	12	100%
c. Layout Aspects	15	16	93,75%
Total Score	**59**	**60**	98,3%
Sum			
Average Percentage		**98,3%**	
Category		**Highly Valid**	

From the media aspect, validation includes three main indicators: graphic design, material presentation, and layout. The highest score (100%) was achieved on the graphic design and presentation of the material, which showed that the 3D visualization of the digestive organs was attractive, sharp, and able to accurately represent biological structures. The layout aspect also obtained a high score, at 93.75%,

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

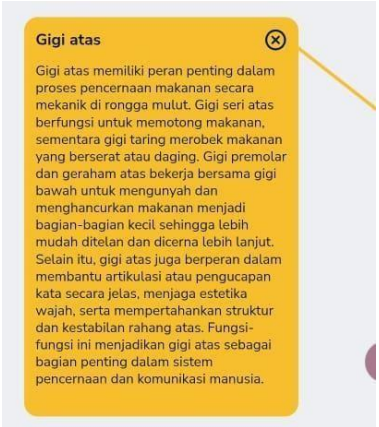
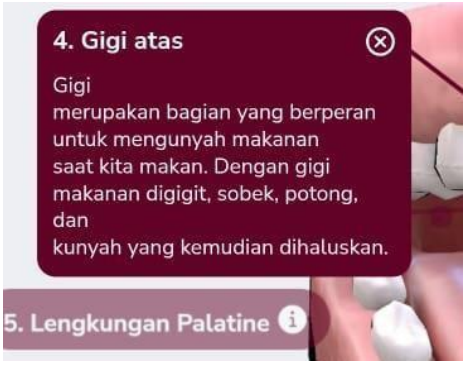
which indicates that navigation, interactive button placement, and visual comfort have been well optimized. This finding is in line with Murdianti (2024) who emphasizes the importance of visual appearance and accessibility in the effectiveness of digital learning media.

b) Media Expert Revision

Based on the observations of media experts on the learning media developed by the validator gave several suggestions, namely:

- Every material in this media must have a reference reference
- For each component of the organ alangah, it is good to be given a sign or number or number
- Fix the bibliography
- The material on the organ should be written not too long
- Media Prompts

Table 6. Media Expert Revision

Before Revision	After Revision
• Every material in this media must have a reference reference 	• Each material already has a reference reference. The following picture is an example: 
• The material on the organ would be better written not too long 	• The material on the organs has been repaired 

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

• Instructions for the use of media are made because they are not in the media	• Media usage instructions 

c) Material Expert Validation Results

Validation by media experts aims to assess the quality of learning media in terms of design, appearance, interactivity, and ease of use. The data obtained were analyzed using quantitative descriptive techniques with a Likert scale consisting of four levels of assessment. The material expert validation instrument consists of 2 aspects, namely the aspect of the content of the material in the media there are 4 questions and the presentation aspect there are 4 questions, with a total of 8 questions on the material expert validation questionnaire. The following is a table of the results of the assessment of material experts.

Table 7. Material Expert Validation Results

Aspects Assessed	**Assessment Score**	**Maximum Score**	**Percentage**
a. Material Aspects	13	16	81,2
b. Presentation aspect	15	16	94
Total Score	**28**	**32**	88
Average Percentage		**88**	
Category		**Highly Valid**	

Meanwhile, from the material aspect, validated indicators include the accuracy of the content and presentation of the material. The highest validation score was found in the presentation of the material (88%), which showed that the conceptual explanations in AR media were systematic and in harmony with the students' cognitive flow. The accuracy of the content obtained a score of 88%, which indicates that the material is in line with the Independent Curriculum, although there are some suggestions for improvement from experts, such as the addition of a brief explanation of the chemical digestion process. According to Rahmawati et al. (2021), the accuracy of content is one of the keys to the success of science-based educational media, because it requires the accuracy of terminology and scientific processes.

d) Subject Matter Expert Revision

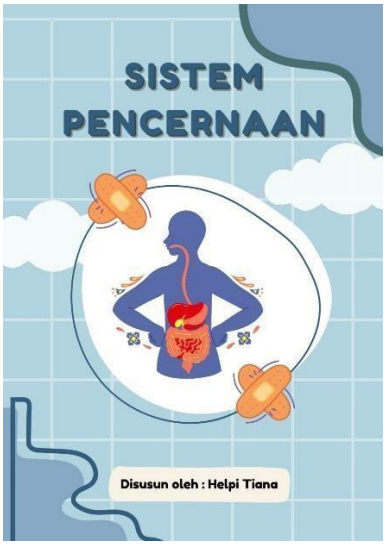
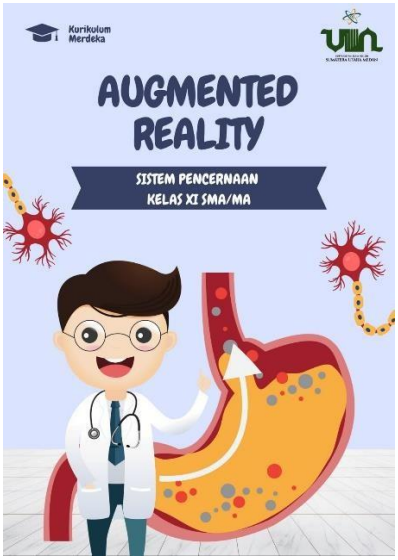
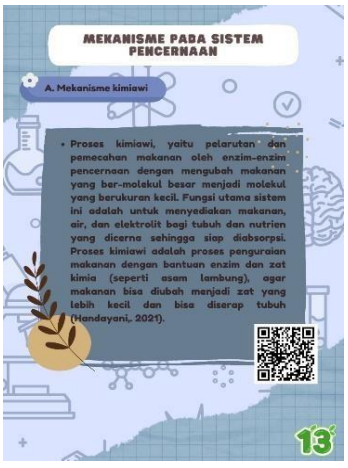
Based on the observations of material experts on the learning media developed by the validator gave several suggestions, namely:

- Create *an augumented reality cover*
- Additional pages so as not to confuse students
- Additional introductory material

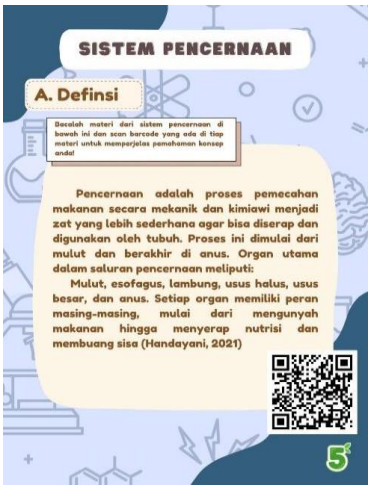
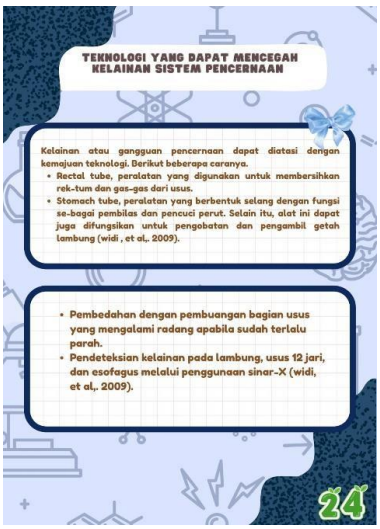
Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

- Additional learning video of the mechanism of the human digestive system through barcodes
- Add the latest technology to the digestive system material

Table 8. Results of Revision of Material Validation

Before Revision	After Revision
• Add a cover 	• Cover added 
• Add pages so as not to confuse students so that the concepts are organized and additional learning videos and digestive system mechanisms	• Pages have been added and learning videos and mechanisms of the digestive system 

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

• Add an introduction to the material	• Introduction to the material 
• Add new technologies to the digestive system material	• New technologies in the material digestive system 

2. Product Practicality

a) Biology teacher's response

The product practicality response test was used by the biology teacher's response. The response of the biology teacher was used to evaluate the practicality of the learning media developed.If deficiencies are found, the media will be revised to improve the learning media developed. However, if no shortcomings are found, then the learning tool is declared feasible and ready to be implemented. Here below is the educator response table.

Table 9. Results of the Biology Teacher Response Questionnaire

Aspects Assessed	Assessment Score	Maximum Score	Percentage

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

a. Learning design aspects	6	8	75
b. Aspects of the content of the material	8	8	100
c. Aspects of Debate	11	12	91,6
d. Graphic aspects	29	32	90,6
Total Score	**54**	**60**	90
Average Percentage		**90**	
Category		**Highly Valid**	

The results of the practicality assessment seen from the response questionnaire by educators obtained an average percentage of 90% with the category of very practical.

b) Student Response

The practicality of the learning tools was also tested through responses from students. By providing a questionnaire in the form of student responses with a total of 31 students. The questionnaire contains a statement describing students' assessment of *augumented reality learning media* on digestive system materials.

Total score	**1631**	**3042**	Very Practical
Average		**98%**	

The results of the practicality assessment seen from the response questionnaire by students in grade XI obtained an average percentage of 98% with the category of very practical.

3. Product Effectiveness

The effectiveness of the product in learning was obtained through the comparison of students' learning outcomes before and after the implementation of the product. The product was implemented in 32 students of class XI MAN 2 langkat. The effectiveness of the product can be assessed from the results *of the pre-test* and *post-test* given to students at the time of implementation. The provision of *pre-tests* and *post-tests* aims to determine the acquisition of scores between before and after learning using learning media, namely *augumented reality media* on the digestive system material.

The implementation was given to 31 students of class XI MAN 2 langkat. Before learning activities begin using *augumented reality* media on the digestive system material, *a pre-test* will be given. After giving *the pre-test* to students, learning activities were carried out using augumented reality media on the digestive system material. Then students are then given *a post-test*. *Pre-test* and *post-test* scores were seen to increase the average score of students.

Table 11. Effectiveness Test Results Analyzed Using the N-Gain Formula with SPSS

	N	**minute**	**Maximum**	**Mean**	**Standard Deviation**
NGain_Score	31	.25	.96	.7652	.17080
Persen_Penghasilan_N	31	25.00	96.49	76.5238	17.07964

Regarding effectiveness, the results of *pretests* and *postes* analyzed using the N-Gain formula showed an average score of 76.52%. This score falls into the "High" category (g > 0.7), which indicates a significant improvement in conceptual understanding after students use AR media. These media help students develop their conceptual understanding through realistic, interactive, and contextual visual representations. With an attractive design and content that aligns with conceptual understanding indicators such as repeating, classifying, and providing examples and non-examples, this media successfully facilitates students in achieving deeper conceptual mastery.

Discussion

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

This research aims to develop *Augmented Reality* (AR)-based learning media on human digestive system materials and test its validity, practicality, and effectiveness in improving students' understanding of concepts. Media development is carried out through a 4-D model consisting of *Define, Design, Develop, and Disseminate* stages.Based on the results of validation by media experts, a score of 98.3% was obtained which is included in the very valid category. This shows that in terms of visuals, presentation, and layout, the media developed meets the feasibility standards. As for the material experts, a validation score of 88% was obtained, which is included in the category of quite valid. Several inputs from material expert validators have been followed up by researchers, such as the addition of *covers*, page arrangements to be more structured, the inclusion of learning videos, and the addition of new technologies in the digestive system material. This revision was carried out to ensure that the media was not only visually appealing, but also had a systematic content structure and relevant to the basic competencies of biology learning.

Furthermore, the practicality of the media was tested through questionnaires distributed to teachers and students. The results of the analysis showed that both teachers and students gave an assessment of 90% of teachers and 98% of students who were classified as very practical. This shows that the media developed is easy to use, visually appealing, and in accordance with the needs of 21st century learning. This AR-based media is able to present three-dimensional visualization of the organs of the digestive system so that students can interact directly with the learning object. This interaction makes it easier for students to understand concepts that have been considered abstract because they cannot be observed directly.

In terms of effectiveness, the results of *the pretest* and *posttest* tests analyzed using the N-Gain formula showed an average score of 76.52%. This value falls into the high category ($g > 0.7$), which indicates that there is a significant improvement in conceptual understanding after students learn to use AR media. This medium helps students develop the ability to understand concepts through real, interactive, and contextual visual representations.With an attractive display and content that matches indicators of concept understanding such as restatement, classifying, and providing examples and non-examples, this media is able to bridge students to achieve better conceptual understanding.

These results reinforce the findings from previous research by , as well as stating that the use of AR media in biology learning can significantly improve conceptual understanding. In addition, this media is also relevant for use in Generation Z who are used to the use of digital technology such as (Aripin & SquirrelSquirt , 2019) (Haka et al., 2025) *smartphones* and the internet. Therefore, the use of AR in learning not only meets the visual needs of students, but also stimulates their interest, motivation, and active participation in the learning process. Thus, it can be concluded that the Augmented Reality-based learning media developed in this study is very valid, very practical, and very effective in improving students' understanding of the concept of the human digestive system in class XI MAN 2 Langkat.

CONCLUSION

Based on the research and development that has been carried out, it can be concluded that *Augmented Reality* (AR)-based learning media developed for the topic of the human digestive system has proven to be very valid, very practical, and very effective. Validation by experts shows the feasibility of media in terms of content and presentation, with an average percentage of 98.3% and material 88%.Practicality tests involving students and teachers resulted in scores of 90% and 98%, respectively, indicating that the media is user-friendly and aligned with learning needs.The effectiveness of the media is also demonstrated through increased conceptual understanding among students, with an average N-Gain of 76.52%, which falls into the high category. Thus, this AR-based medium successfully bridges the abstract nature of the topic of the digestive system through interactive visualization and significantly improves students' engagement and conceptual understanding.

REFERENCES

Aditia, R. (2024). Peran dan Tantangan Teknologi Augmented Reality dalam Meningkatkan Pengalaman Pengguna Media. *Amerta: Jurnal Ilmu Sosial Dan Humaniora*, *4*(1). https://ejournal.amertamedia.co.id/index.php/amerta/article/view/197

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

Aeni, N., Sulaiman, R., & Rahman, T. (2022). Pengaruh Pendekatan Kontekstual terhadap Pemahaman Konsep dan Keterampilan Berpikir Kritis pada Pembelajaran IPA. *Jurnal Pendidikan Sains Indonesia*, *10*(2).

Aripin, I., & Suryaningsih, Y. (2019). Pengembangan Media Pembelajaran Biologi Menggunakan Teknologi Augmented Reality (AR) Berbasis Android pada Konsep Sistem Saraf. *Sainsmat : Jurnal Ilmiah Ilmu Pengetahuan Alam*, *8*(2), 47–57. https://doi.org/10.35580/SAINSMAT82107192019

Asih, N. (2024). *Pengembangan Media Pembelajaran Augemented Reality Berbasis Android Untuk Meningkatkan Pemahaman Konsep Peserta Didik Kelas XI di SMA* [Skripsi]. UIN Raden intan Lampung.

Azaly, Q. R., & Fitrihidajati, H. (2021). Pengembangan Media Pembelajaran Berbasis Microsoft Office Sway pada Materi Perubahan Lingkungan untuk Melatihkan Kemampuan Literasi Sains Siswa Kelas X SMA. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *11*(1), 218–227. https://doi.org/10.26740/bioedu.v11n1.p218-227

Azhar, A., Nuraida, I., Sugilar, H., & Haryadi, N. R. S. (2023). Permasalahan Siswa dalam Memecahkan Masalah Matematika dalam Mengerjakan Soal PISA. *Gunung Djati Conference Series*, *32*(2), 45–51. https://doi.org/10.31980/MOSHARAFA.V10I2.825

Cahyadi, A. (2019). *Pengembangan Media dan Sumber Belajar: Teori dan Prosedur*. Laksita Indonesia.

Djatmiko, R., & Mahbubah, K. (2022). Identifikasi Keterampilan Literasi Sains Siswa Pada Materi Asam Basa. *SCIENING : Science Learning Journal*, *3*(1), 59–63. https://doi.org/10.53682/slj.v3i1.4190

Haka, N. B., Asih, N., Oktafiani, R., & Masya, H. (2025). Pengembangan Media Pembelajaran Augmented Reality Berbasis Android Untuk Meningkatkan Pemahaman Konsep Siswa SMA. *Didaktika Biologi: Jurnal Penelitian Pendidikan Biologi*, *9*(1), 63–74. https://doi.org/10.32502/didaktikabiologi.v9i1.241

Indriani, R., & Abidin, Z. (2022). Literature Review : Pengembangan Media Pembelajaran Augmented Reality Pada Mata Pelajaran Biologi. *Jurnal Wahana Pendidikan*, *9*(2), 139. https://doi.org/10.25157/wa.v9i2.8138

Indriyani, Ahied, M., & Rosidi, I. (2020). Penerapan Model Pembelajaran Double Loop Problem Solving (DLPS) Terhadap Kemampuan Pemecahan Masalah Siswa Pada Materi Bencana Alam. *Jurnal Luminous: Riset Ilmiah Pendidikan Fisika*, *1*(1), 8. https://doi.org/10.31851/luminous.v1i1.3442

Kahfi, M., & Ulfah, M. (2024). Perencanaan Media Pembelajaran di SMK Sandikta Bekasi. *Journal Education and Government Wiyata*, *2*(1), 78–92. https://doi.org/10.71128/e-gov.v2i1.73

Khasanah, U., Anggraeni, A. D., Mardin, H., Khoiriyah, K., Husnah, D. H., Pentury, H. J., Mamu, H., Nababan, K., Rusdi, W. K., Wahyuni, M. S., Amir, J., & Syahfitri, D. (2024). Pengembangan Media Pembelajaran Berbasis Information and Comunication Technology (ICT)TECHNOLOGY (ICT). In S. I. Ika Trisnawati (Ed.), *Penerbit Tahta Media*. Tahta Media Group. https://tahtamedia.co.id/index.php/issj/article/view/945

Kinanty, P., Kartono, K., & Salimi, A. (2024). Pengembangan Media Pembelajaran Interaktif Berbasis Power Point Pada Tema 1 Subtema 3 Pertumbuhan Hewan Kelas III SDN 36 Pontianak Selatan. *As-Sabiqun*, *6*(1), 157–177. https://doi.org/10.36088/assabiqun.v6i1.4376

Kumalasari, S., Jamili, J., & Yanti, N. A. (2023). Pengaruh Model Guided Inquiry Learning Berbantuan Media Flash Card Terhadap Keterampilan Observasi Dan Pemahaman Konseptual Peserta Didik Pada Materi Animalia. *Jurnal Biofiskim: Pendidikan Dan Pembelajaran IPA*, *5*(1). https://doi.org/10.33772/biofiskim.v5i1.462

Mardin, H., D. Mamu, H., Husain, I., & Arafat, M. Y. (2025). Validitas Media Pembelajaran Flashcard Berbasis Augmented Reality Pada Materi Sel Kelas XI SMA. *Jurnal Biogenerasi*, *10*(1), 796–802. https://doi.org/10.30605/biogenerasi.v10i1.5378

Maritsa, A., Salsabila, U. H., & Wafiq. (2021). Pengaruh Teknologi Dalam Dunia Pendidikan. *Al- Mutharahah: Jurnal Penelitian Dan Kajian Sosial Keagamaan*, *18*(2).

Masuri, D. K., & Budiyono. (2020). Pengembangan Media Pembelajaran Video Animasi Materi Volume Bangun Ruang Untuk SD Kelas V. *Jurnal Penelitian Pendidikan Guru Sekolah Dasar*, *8*(5). https://ejournal.unesa.ac.id/index.php/jurnal-penelitian-pgsd/article/view/35876

Mesra, R. (2023). *Research & Development Dalam Pendidikan*. https://doi.org/10.31219/osf.io/d6wck

Murdianti, W. (2024). Inovasi Media Pembelajaran Digital untuk Meningkatkan Minat Belajar di Era Digital. *Innovative: Journal of Social Science Research*, *4*(1).

Mustaqim, I. (2017). Pengembangan Media Pembelajaran Berbasis Augmented Reality. *Jurnal Edukasi Elektro*, *1*(1). https://doi.org/10.21831/jee.v1i1.13267

Nurhasana, I. (2021). Penggunaan Media Audio-Visual Pada Mata Pelajaran Bahasa Arab. *Al-Fikru : Jurnal Pendidikan Dan Sains*, *2*(2), 217–229. https://doi.org/10.55210/al-fikru.v2i2.573

Sosioedukasi
JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL
ISSN: 2086-6135 E-ISSN: 2541-612x
Volume 14 No. 3. September 2025 https://ejournal.unibabwi.ac.id/index.php/sosioedukasi/index

Puspita, W. P. R., Helendra, Yogica, R., & Olvia Rahmi, F. (2024). Pengaruh Model Pembelajaran Berbasis Proyek Terhadap Pemahaman Konsep Peserta Didik Fase E Pada Materi Ekosistem di SMA Negeri 1 Kubung. *Jurnal Biogenerasi*, *10*(1), 390–395. https://doi.org/10.30605/biogenerasi.v10i1.4787

Rahayu, Y., & Pujiastuti, H. (2018). Analisis Kemampuan Pemahaman Matematis Siswa SMP Pada Materi Himpunan: Studi Kasus di SMP Negeri 1 Cibadak. *Symmetry: Pasundan Journal of Research in Mathematics Learning and Education*. https://doi.org/10.23969/symmetry.v3i2.1284

Rahmawati, Y. P., Handayani, A., & Rakhmawati, D. (2024). Efektivitas Penggunaan Media Virtual Reality Dalam Pembelajaran Sains. *PAUDIA: Jurnal Penelitian Dalam Bidang Pendidikan Anak Usia Dini*, 325–333. https://doi.org/10.26877/paudia.v13i2.766

Ramadhan, A. F., Putra, A. D., & Surahman, A. (2021). Aplikasi Pengenalan Perangkat Keras Komputer Berbasis Android Menggunakan Augmented Reality (AR). *Jurnal Teknologi Dan Sistem Informasi*, *2*(2).

Rismawati, L., & Al-Pansori, Muh. J. (2023). Implementasi Model Project Based Learning (PJBL) Terhadap Pemecahan Masalah Ipa Siswa Kelas IV SDN 3 Loyok. *Innovative: Journal Of Social Science Research*, *3*(6), 9360–9371. http://j-innovative.org/index.php/Innovative/article/view/7035

Safitry, A., Rahmi, Y. L., Yogica, R., & Anggriyani, R. (2023). Analisis Kebutuhan Pengembangan Lembar Kerja Peserta Didik Elektronik Berbasis Literasi Sains pada Materi Metabolisme. *Jurnal Pendidikan Tambusai*, *7*(3), 20722–20727. https://doi.org/10.31004/JPTAM.V7I3.9556

Saputra, I. D., Khodijah, S. N., Rohayat, A., Mulyaningsih, S., & Amalia, L. (2024). Pengaruh Media Pembelajaran Flashcard terhadap Hasil Belajar Siswa pada Materi Bioteknologi di Kelas X SMAN 16 Garut. *Jurnal Life Science: Jurnal Pendidikan Dan Ilmu Pengetahuan Alam*, *6*(2), 63–68. https://doi.org/10.31980/lsciences.v6i2.1613

Setiawan, A. H. (2021). Studi Terhadap Media Augmented Reality (AR) dalam Meningkatkan Hasil Belajar Peserta Didik Pada KD Memahami Jenis-Jenis Alat Berat. *Jurnal Kajian Pendidikan Teknik Bangunan*, *7*(1). https://ejournal.unesa.ac.id/index.php/jurnal-kajian-ptb/article/view/37593

Syarisma, N. F. (2020). *Pengembangan Media Pembelajaran Berbasis Android Berbantu Aplikasi Appypie Pembelajaran Fluida* [Skirpsi]. Universitas Islam Negeri Alauddin Makassar.

Thahir, R., & Kamaruddin, R. (2021). Pengaruh Media Pembelajaran Berbasis Augmented Reality (Ar) Terhadap Hasil Belajar Biologi Siswa SMA. *Jurnal Riset Dan Inovasi Pembelajaran*, *1*(2), 24–35. https://doi.org/10.51574/jrip.v1i2.26

Widahyanti, W., & Utami, A. D. (2024). Pengembangan Media Pembelajaran Flashcard Guna Menunjang Proses Pembelajaran Model Make a Match Untuk Mendukung Kemampuan Pemecahan Masalah Peserta Didik. *Jurnal Pembelajaran, Bimbingan, Dan Pengelolaan Pendidikan*, *4*(8), 13. https://doi.org/10.17977/um065.v4.i8.2024.13

Widarti, E., Efitra, E., Juansa, A., Adhy, D. R., Anwar, N., Prasetya, L. A., & Rianty, E. . (2025). *Smart Life With Internet of Things (IoT): Optimalisasi & Pemanfaatan IoT untuk Kehidupan Modern*. PT. Star Digital Publishing.

Wisada, P. D., Sudarma, I. K., & Yuda S, Adr. I. W. I. (2019). Pengembangan Media Video Pembelajaran Berorientasi Pendidikan Karakter. *Journal of Education Technology*, *3*(3), 140. https://doi.org/10.23887/jet.v3i3.21735

Yurniwati, & Handayani, R. (2019). Pengaruh Metode Realistic Mathematics Education terhadap Kemampuan Matematis Ditinjau dari Konsep Diri pada Siswa SD. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *3*(1), 27. https://doi.org/10.33603/jnpm.v3i1.1020

Zega, J. B. (2022). *Pengembangan Media Menggunakan Augmented Reality Berbasis Android Pada Materi Struktur Atom Di Sma Negeri 1 Simpang Kiri Kota Subulussalam* [Skripsi]. UIN Ar-Raniry Darussalam.

Zulfahmi, M., & Wibawa, S. C. (2020). Potensi Pemanfaatan Augmented Reality sebagai Media Pembelajaran Terhadap Motivasi Belajar dan Respons Siswa. *IT-Edu : Jurnal Information Technology and Education*, *5*(1), 334–343. https://doi.org/10.26740/IT-EDU.V5I1.37491