

Development of *Augmented Reality-Based Flashcard Media* In Science Class Viii Junior High School

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Abstract.

This study aimed to develop an Augmented Reality (AR)-based flashcard learning media for the Human Digestive System topic for eighth-grade students at SMP Kartika 1-7 Padang and to evaluate its validity, practicality, and effectiveness. The research employed the Research and Development (R&D) method using the ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation stages. The participants included one material expert, two media experts, six students in the small-group trial, and 31 students in the field implementation. Data were collected through validation sheets, student response questionnaires, and learning achievement tests in the form of pretests and posttests. The results indicated that the media achieved a validity score of 93.33% from the material expert and an average of 92.86% from the media experts, both categorized as highly valid. The practicality score reached 97.56%, categorized as highly practical. The effectiveness was demonstrated by an increase in the average score from 65.16 to 88.58 and an N-Gain value of 0.71 (high category). Therefore, the AR-based flashcard media is valid, practical, and effective in improving students' conceptual understanding.

Keywords: *Augmented Reality, Flashcard and Conceptual Understanding.*

I. INTRODUCTION

National education based on Law Number 20 of 2003 has the goal of developing the potential of students, one of which is through the use of technology in learning. In today's digital era, technology no longer only plays a role as a tool, but has become an important part of the learning process. Educational technology can help teachers overcome various learning difficulties for students through more effective management of learning resources (Aridianti et al., 2024). Therefore, the use of technology in learning needs to be continuously developed, especially to help explain abstract material.

In line with the implementation of the Independent Curriculum, science learning is required to be more interactive and able to actively involve students. Ideally, learning not only focuses on delivering material, but also provides a more concrete learning experience. This is important because many science concepts are abstract and difficult to understand if only explained verbally or through books. Therefore, the use of learning media that is able to display visualizations more clearly is needed so that students can understand the material better (Maulida & Rahmatan, 2025).

However, in reality, science learning at the junior high school level still often uses conventional methods centered on textbooks. The media used tends to be limited and less varied. This condition causes students to be less interested in participating in learning and has an impact on low understanding of concepts. In fact, the selection of the right learning media has a great influence on the success of the teaching and learning process (Kosim et al., 2024). If the media used is not able to explain the material clearly, then students will have difficulty understanding the concepts being taught.

One of the science materials that is quite difficult for students to understand is the human digestive system in grade VIII. This material has a high level of complexity because it discusses organs in the body as well as processes that cannot be observed directly. As a result, many students have difficulty understanding how the digestive process takes place as a whole (Febriany & Bektiningsih, 2025). This is exacerbated by the use of learning media that are still static, such as two-dimensional images in books.

Without media that is able to display the process in real terms, students tend to only memorize the material without really understanding it. This condition can cause misconceptions and make the knowledge gained not last long (Simorangkir et al., 2024). In addition, student involvement in learning is also low due to the lack of interaction with learning objects.

Based on observations and interviews conducted by researchers on September 17, 2025 with grade VIII teachers of SMP Kartika I-7 Padang, it was found that the learning process carried out in the classroom has not been maximized. From the results of the daily review of digestive system material in science subjects, it is known that the average score of grade VIII students is 67.29. The average daily test score of students who have not met the Learning Goal Achievement Criteria (KKTP) in science subjects is 85. In more detail, the daily test results of digestive system materials for grade VIII students can be seen in the following table.

Table 1. Results of Daily Reviews of Human Digestive System Materials

No.	Categories	CD	Number of Students
1.	Conclusion	85	8
2.	Incomplete	85	23

(Source: Science Teacher Class VIII)

Based on the table above, it is possible to get an idea that the average daily test score of students has not reached the KKTP. The low learning outcomes above are an indication that learning has not been carried out effectively. There are several factors that cause the understanding of the material to be low. There are limited learning facilities in schools and only have one torso media that is used alternately by students. This makes teachers more often use the pictures in the book in explaining the material.

This is in line with the research that has been carried out by Zulfikar (2024), the results were obtained, namely by the use of inappropriate learning methods by teachers, for example, learning that is more inclined to teacher activities than student activities which can make students passive individuals in participating in learning activities.

Seeing this, one of the solutions that can be provided is to use simple learning media, one of which is flashcard learning media based on *Augmented Reality* (AR) technology. This technology is able to display virtual objects in the form of two-dimensional or three-dimensional into the real world directly (Rachim et al., 2024). By using AR, students can see the visualization of body organs more clearly and get closer to the actual condition.

The use of AR in the form of *flashcards* is the right choice because it is easy to use and can be accessed independently by students through smartphone devices. This media allows students to see models of digestive organs in the form of three dimensions so that learning becomes more interesting and not boring. Previous research has also shown that the use of AR-based media can improve students' understanding because it is able to present more concrete visualizations (Utomo et al., 2022).

Although research on AR has been done quite a lot, there are still differences in research focus. Some of the previous studies have dealt more with other materials such as computer systems and the solar system. Therefore, this research has a novelty by developing a special AR-based flashcard media on class VIII human digestive system material. The media developed is also adjusted to the needs of students at SMP Kartika 1-7 Padang.

Based on this description, it can be concluded that it is necessary to develop learning media that is able to help students understand the material in a more concrete and interesting way.

II. METHODS

This study uses the Research and Development (R&D) method with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model which aims to develop, validate, and test the effectiveness of *Augmented Reality* (AR)-based *flashcard learning media* on Human Digestive System materials for students in grades VIII of SMP Kartika 1-7 Padang. The Analysis stage is carried out through observation, interviews, and analysis of competencies, student characteristics, and learning materials as the basis for media development. The Design stage includes *designing flashcards*, preparing materials, creating designs using Canva, developing AR displays through Assemblr Edu, and preparing research instruments. The Development stage includes media creation, integration of 3D objects, addition of interactive features, validation by one subject matter expert and two media experts, and product revision based on validator input. The Implementation phase was carried out through a small group trial of six students and a field test on 31 students of class VIII.1 with a One-Group Pretest-Posttest design to measure the improvement of conceptual understanding before and after the use of media. The Evaluation stage is carried out in a formative and

summative manner to assess the quality of the product from the aspects of validity, practicality, and effectiveness. The research data consisted of qualitative data in the form of validator suggestions and comments as well as quantitative data obtained through validation sheets, student response questionnaires, learning implementation observation sheets, and learning outcome tests. Data analysis includes validity analysis using the percentage of Likert scale scores, practicality analysis based on the percentage of student responses, and effectiveness analysis using N-Gain scores to determine the improvement of learning outcomes after the use of media

III. RESULTS AND DISCUSSION

Media Validity

Media validity aims to determine the feasibility level of *Augmented Reality* (AR)-based *flashcard media* before it is implemented in learning. The assessment was carried out by one material expert and two media experts who assessed aspects of material suitability, presentation, visual appearance, ease of use, and technical quality of the media. The validation results are the basis for determining whether the media has met the standards for eligibility for use or still needs revision.

Table 2. Summary of Media Validation Results

Aspects	Validator	Percentage	Categories	Remarks
Material Validation	Material Expert	93,33%	Highly Valid	Worth using
Media Validation	Media Member I	98,10%	Highly Valid	Worth using
Media Validation	Media Member II	87,62%	Highly Valid	Worth using
Average Media Validation	2 Media Members	92,86%	Highly Valid	Worth using

Based on the validation results, the media obtained a very valid category both from the material and media aspects. The subject matter expert gave several suggestions for improvement, such as adding information about digestive enzymes and adjusting anatomical terms. After the revision is carried out, the media is declared suitable for use. Meanwhile, the two media experts stated that the media has met the aspects of design, appearance, interactivity, and ease of use so that it is ready to be implemented in learning.

Media Practicality

The practicality of media aims to determine the level of ease of use of AR-based *flashcard media* based on the experience of students during small group trials. The assessment was carried out through a response questionnaire which included aspects of ease of use, attractiveness, clarity of information, and the benefits of media in helping the learning process.

Table 3. Summary of Practical Test Results

Indicator	Results
Number of Respondents	6 students
Scores Obtained	439
Maximum Score	450
Percentage	97,56%
Categories	Very Practical

The results of the questionnaire showed that the media obtained a percentage of 97.56% with the category of very practical. Students assessed that the media is easy to use, attractive, has a clear appearance, and is able to help understand the material of the human digestive system. In addition, the three-dimensional object feature and interaction through AR provide a more enjoyable learning experience so that the media can be used without the need for further revisions.

Media Effectiveness

The effectiveness of media is measured based on the improvement of students' learning outcomes after using *AR-based flashcard media*. Measurement is carried out through the provision of pretests before learning and posttests after learning. In addition, effectiveness was also analyzed using the N-Gain value to determine the level of improvement in students' understanding of concepts.

Table 4. Summary of Student Learning Outcomes

Indicator	Pretest	Posttest
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Number of Students	31	31
Highest Score	85	100
Lowest Score	40	70
Average	65,16	88,58
Conclusion	3 (9,7%)	29 (93,5%)
Incomplete	28	2

Table 5. Media Effectiveness Summary

Indicator	Results	Categories
Increased Completeness	83,8%	Excellent
N-Gain Value	0,71	Height
Conclusion	Effective media improves understanding of concepts	Effective

Based on the results of the pretest and posttest, there was an increase in the average score of students from 65.16 to 88.58. The percentage of learning completeness also increased from 9.7% to 93.5%, indicating that almost all students have achieved learning completeness after using media. The result of the N-Gain analysis of 0.71 was in the high category, which shows that AR-based *flashcard* media is effective in improving the understanding of the concept of the human digestive system. These findings show that visualization of three-dimensional objects and interactive features in media can help students understand concepts more concretely than conventional learning.

IV. DISCUSSION

The learning media developed in this study is in the form of AR-based *flashcards* on human digestive system materials for grade VIII junior high school students. Media development is carried out using the ADDIE model which consists of five stages, namely analysis, design, development, implementation, and evaluation. The selection of the ADDIE model is based on its systematic characteristics and is oriented towards solving learning problems through interrelated stages. This model was chosen because it is suitable for the development of digital-based learning media and allows for evaluation and improvement at each stage of development (Simamora & Siregar, 2024). Each stage provides an opportunity to evaluate and improve the product so that the media produced is in accordance with the needs of students and learning goals. This is in line with the opinion of Branch (2009) who stated that the ADDIE model provides a flexible but structured framework for developing learning products.

The results of the analysis showed that science learning at SMP Kartika 1-7 Padang was still dominated by the use of textbooks and lecture methods, while the use of learning media was still limited. This condition causes students to have difficulty in understanding the material of the human digestive system because the concepts learned are abstract and cannot be observed directly. This finding is in line with the results of research by Suryani et al. (2023) which revealed that one of the main obstacles in learning science is the difficulty of visualizing abstract concepts, especially in biological materials involving organ structures in the body. Therefore, an AR-based *flashcard* media was developed that is able to visualize the digestive organs in the form of three-dimensional objects so that students get a more concrete and interactive learning experience.

The media developed combines *flashcards* with AR technology through the Assemblr Edu platform. Each card is equipped with a marker that can be scanned using a smartphone to display a three-dimensional object of the digestive organs. AR technology has the main advantage of seamlessly combining the interactivity of the digital world with the physical environment, creating a new ecosystem that makes a real impression on users. In addition to 3D visualization, the media is also equipped with 360° rotation features, zoom in, zoom out, and information pop-ups that contain explanations about organ function and the digestive process. The existence of these features allows students to observe the structure of organs in more detail than conventional learning media, thus helping the concept formation process. The combination of print media and AR technology is in line with the concept of multimodal learning put forward by Mayer (2009) in multimedia cognitive theory, which states that learning is more effective when information is presented through two channels (visual and verbal) simultaneously. *Flashcard* media as an instructional card that presents a combination of images, text, and certain symbols is effective in stimulating memory or directing

students' understanding of the material visualized (Husnaeni, 2025). The use of *flashcards* in the learning process offers various advantages that support the effectiveness of material delivery, one of the main aspects of this media's advantages lies in its portability that allows cards to be stored easily and used flexibly in various learning environments.

The feasibility of the media is reviewed through a validity test involving one subject matter expert and two media experts. The results of material validation obtained a percentage of 93.33% with the Very Valid category, while the media validation obtained an average percentage of 92.86% with the Very Valid category. These results show that the media has met the aspects of material suitability, presentation, language, display, and media functions so that they are suitable for use in the learning process. The high level of validity is inseparable from the development process that is carried out systematically and the revision based on validator input, such as the addition of information about digestive enzymes and the refinement of anatomical terms. This finding is in line with the research of Selang et al. (2025) which states that AR-based learning media has a high level of validity because it is able to integrate visual, interactive, and learning materials in a balanced manner. In addition, the research of Rahmawati and Kuswanto (2024) also found that AR media validation involving material experts and media experts simultaneously results in a more comprehensive and ready-to-use product. The validity of the media is also supported by Hasibuan's research (2025) which developed AR media assisted by Assemblr Edu and obtained an average validity score of 87.66% with a very valid category. Another study by researchers who developed AR media for building materials also showed an average validation result of 3.88 with a very valid category (Simamora & Siregar, 2024). Thus, the high consistency of validation results indicates that AR media developed through systematic procedures tends to obtain valid judgments from experts.

In addition to being valid, the developed media also shows a very high level of practicality. The results of the practicality test in the small group obtained a percentage of 97.56% with the category of Very Practical. This percentage shows that the media is easy for students to use, has an attractive appearance, and is able to help students understand the material more easily. The ease of scanning markers, accessing three-dimensional objects, and reading information available on media provides a more enjoyable learning experience and encourages students to learn independently. These results show that the media has a good level of usability so that it can be used as an alternative science learning media. This finding is strengthened by the research of Setyawan et al. (2024) which reveals that the practicality of AR media is greatly influenced by the ease of access and intuitiveness of the interface, where the media developed in this study has met both aspects. Hasibuan's research (2025) also showed the results of the practical test of Assemblr Edu-assisted AR media with an average score of 92% from educators and 88% from students, both of which were included in the very practical category. This indicates that the Assemblr Edu platform has characteristics that support the practicality of media due to its user-friendly interface and responsive scanning process.

The effectiveness of media is shown through improving students' learning outcomes after using AR-based *flashcard* media. The average score of students increased from 65.16 in the pretest to 88.58 in the posttest. The percentage of learning completeness also increased from 9.7% to 93.5%, while the results of the N-Gain calculation of 0.71 were in the high category.

The increase in learning completeness from 9.7% to 93.5% shows that AR-based *flashcard* media not only increases average grades, but also significantly increases the number of learners who achieve minimum competencies. Only 2 out of 31 learners (6.5%) remained incomplete after media use, indicating that these media were effective for a large portion of the learner population. The increase in completeness of 83.8% shows that this media has a wider impact than just an increase in average scores, because almost all students managed to achieve the standards of completeness set by the school. Research by Simorangkir et al. (2024) shows that the use of AR can improve learning outcomes because it is able to change abstract concepts into more real and easy to understand by students. Other research on the development of AR media in building materials also showed that 84% of students achieved complete grades after using AR media, which indicates consistent effectiveness (Olivia, 2025). Furthermore, research by Pramana and Suarni (2023) found that AR media not only improves cognitive learning outcomes, but also increases students' motivation and involvement in learning. This finding is also supported by the research of Mardia (2025) who developed

interactive multimedia-based media and obtained results of validity and practicality in the category of very valid and excellent. The effectiveness of AR media is also proven in research on three-dimensional materials which shows a classical completeness rate of 85.19% (Mulbar & Farhan, 2024). Thus, the consistency of findings from various studies shows that AR media has strong potential in improving student learning outcomes in various materials and levels of education.

These results show that the media developed is able to increase students' understanding of concepts on the human digestive system. The increase occurred because the visualization of three-dimensional objects helped students understand the relationship between organ structure, organ function, and the digestive process in a more concrete way than learning using only textbooks. Edgar Dale's Cone Theory of Experience (1969) reinforces this finding, where learning outcomes will be better if obtained through concrete experience. AR media in this study is included in the category of learning experience through visual representation (iconic), which occupies a more concrete level than abstract symbols such as text or spoken words. The use of AR in biology learning allows learners to observe organ structures directly through realistic 3D visualizations, thereby reducing the cognitive burden of imagining organ shapes and functions that cannot be observed directly. This is in line with the opinion of Ruqoyyah (2020) who states that concepts are seen as abstract ideas that function as an instrument of categorization, allowing students to organize objects, events, and phenomena into an organized cognitive scheme. A mature understanding of concepts is an absolute prerequisite for students to be able to communicate knowledge effectively, solve problems creatively, and make accurate data-driven decisions in various life contexts.

Based on all the results of the study, it can be seen that the AR-based *flashcard* learning media developed has met three main criteria in development research, namely valid, practical, and effective. Therefore, this media is suitable to be used as an alternative science learning media on the human digestive system material for grade VIII junior high school students and can help teachers in creating a more interactive, interesting, and meaningful learning process.

V. CONCLUSION

Based on the results of the research and development that has been carried out, it can be concluded that AR-based *flashcard learning media* on the human digestive system material for grade VIII junior high school students has been successfully developed using the ADDIE model which consists of the analysis, design, development, implementation, and evaluation stages. The product produced is in the form of an 8×12 cm flashcard combined with AR technology through the Assemblr Edu platform so that it is able to display three-dimensional objects of the digestive organs equipped with 360° rotation features, zoom in, zoom out, and information pop-ups as learning support.

The results of the study show that the media developed has met the criteria of valid, practical, and effective. This is evidenced by the results of the validation of material experts who obtained a percentage of 93.33% with the Very Valid category, as well as the results of the validation of media experts with an average percentage of 92.86% which is also included in the Very Valid category, so that the media is declared suitable for use in the learning process. Furthermore, the results of the practicality test obtained a percentage of 97.56% in the category of Very Practical, which shows that the media is easy to use, interesting, and helps students understand the material.

The effectiveness of media is shown by an increase in students' learning outcomes after using AR-based *flashcard* media. The average score increased from 65.16 in the pretest to 88.58 in the posttest, the percentage of learning completeness increased from 9.7% to 93.5%, and an N-Gain value of 0.71 was obtained in the high category. Thus, AR-based *flashcard learning media* on human digestive system materials is declared feasible to be used as an alternative to science learning media because it meets the aspects of validity, practicality, and effectiveness and is able to improve students' understanding of concepts.

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