AUGMENTED REALITY-BASED MOCKUP MEDIA: AN INNOVATION FOR STRENGTHENING CONCEPTUAL UNDERSTANDING IN ELEMENTARY EDUCATION

I Putu Ardita Yoga Saputra[1)], Dewa Made Dwicky Putra Nugraha[2)], Dewa Ayu Made Manu Okta Priantini[3)]

[1)] Elementary School Teacher Education Study Program, Dwijendra University, Indonesia

e-mail: dektuardita@gmail.com

[2)] Elementary School Teacher Education Study Program, Dwijendra University, Indonesia

e-mail: madedwicky@undwi.ac.id

[3)] Elementary School Teacher Education Study Program, Dwijendra University, Indonesia

e-mail : Dewaayu056@gmail.com

ABSTRACT

This study aims to develop an Augmented Reality-based mockup media to improve students' understanding of concepts such as the human digestive system in grade 5 at SD Negeri 6 Sumerta. This is a development study using the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation. The research subjects consisted of two media experts, two subject matter experts, and users comprising 31 students and two teachers. The research objects included the validity and practicality of the Augmented Reality-based model media, as well as the understanding of science concepts related to the human digestive system. The data collection instruments used were media and material validation sheets, media practicality questionnaires, and science concept comprehension tests. The research data were analyzed using quantitative descriptive analysis techniques. The results of the study show that the media validity test obtained a score of 0.96 with a very high criterion, then the material validity test obtained a score of 0.84 with a very high criterion, the practicality test results from 2 practitioners obtained an average score of 96.5% with a very practical criterion, then the effectiveness test results from the science concept comprehension test obtained an average score of 87.5 with a very good criterion. The conclusion of this study is that the Augmented Reality-based mockup media developed has met the criteria for implementation in science learning and is effective in improving the comprehension of science concepts on the human digestive system in grade 5 at SD Negeri 6 Sumerta.

Keywords: *Augmented Reality, Mockup Media, Conceptual Understanding, Elementary Education*

1. INTRODUCTION

Natural and Social Sciences is a key subject taught in elementary schools. It helps students learn about the world around them, including nature, the environment, and the society they live in. The purpose of studying IPAS is to build thinking skills, encourage a scientific approach, and increase awareness of social issues. According to BSNP one of the goals of IPAS is to help students understand and use important concepts from this subject in their everyday lives (Kumala, 2016). Therefore, IPAS education is meant to help students gain knowledge and a better understanding of ideas that can be useful in their daily routines.

In studying science, students encounter abstract ideas that can have different meanings and are connected to each other. This emphasizes the need for a proper understanding of these concepts in science education (Kurniawati, 2022). Science materials taught in upper elementary grades, like the solar system, animal reproduction, and the human digestive system, are abstract and hard for students to imagine without physical objects. Many students find these topics difficult and struggle with the subject because the learning resources are not fully utilized. A study

by Damayanti (2024) conducted in Grade V B at SD Negeri 1 Penarukan found several issues, including: 1) students not grasping the lesson content, 2) a lack of interest in science subjects, and 3) students getting bored easily.

Elementary students are in the concrete operational stage of cognitive development, usually between the ages of 7 and 11. During this stage, children learn best by using real objects and experiencing things directly. They find it easier to understand information when it is presented in a clear and physical way, such as through the use of props or actual items. If they are not given real objects, they often struggle with logical tasks (Magdalena et al., 2023). They are also able to sort and organize things based on categories. Teaching abstract ideas through traditional methods like lectures or exercises alone may not be very effective. For example, when explaining the human digestive system only through lectures or exercises, children in this stage might not fully understand it, since they need tangible materials to grasp processes that are not visible. Learning without visual aids or real props makes it difficult for them to imagine how digestion works and what the related organs look like. On the other hand, using contextual learning materials in IPAS is more effective, helping them better understand abstract science topics.

Issues with grasping abstract science topics are also present at SD Negeri 6 Sumerta. During interviews, it was found that the topic on the human digestive system is presented in an abstract and text-based manner, using teaching materials and media that fail to engage students. The use of IT-based tools is uncommon, and students depend on traditional methods and textbook illustrations, which contribute to a lack of interest in class. Observations indicated that Grade V students have limited understanding of the concepts, as evidenced by an average UTS score of 56.1, which is below the required minimum standard. Only 48% of students reached the expected score, significantly lower than the target of 100%. This suggests that students face difficulties in comprehending the concepts, pointing to an overall inadequate level of understanding.

The main reasons for low concept understanding at SD Negeri 6 Sumerta are as follows: first, there is a lack of suitable teaching materials or visual aids, such as textbooks or lectures without additional props to support learning. Second, students show low levels of interest and motivation. Third, teaching methods are often repetitive and do not include discussion, practice, or visual elements. Fourth, students are not actively involved in the learning process. Fifth, the learning environment is not favorable for effective teaching and learning. Sixth, some students may have individual difficulties in understanding due to cognitive limitations. Lastly, assessments are often based on memorization rather than a true understanding of the concepts.

To address these issues, appropriate learning materials are necessary. One effective resource is a model, which is a three-dimensional representation of an object or environment on a smaller scale, offering a realistic portrayal. When used with Augmented Reality (AR), it enhances the visual understanding of complex ideas, thereby increasing motivation and improving comprehension.

A model serves as a tool in education to make abstract ideas easier to understand. As stated by Sadiman (2008:76), a model is a scaled-down version of a real structure, not a simulation, since it does not show how things work. When well-made, a model conveys almost the same meaning as the actual object it represents. These models, also known as miniatures or replicas, have several benefits, such as allowing direct interaction, presenting information in a tangible way, showing complete objects along with their construction and function, and clearly illustrating organizational structures and processes. The model presented here is a non-permanent representation of the human digestive system that can be taken apart and put back together. This feature prevents students from getting bored and encourages meaningful learning through hands-on activities. The integration of augmented reality enhances the learning experience by adding a technological element, enabling students to clearly visualize complex ideas and elevate their understanding to a new level.

Augmented Reality (AR) is a technology that combines the real world with digital elements such as sounds, images, or data, allowing users to experience virtual objects in their physical environment through devices like smartphones or tablets. AR is particularly useful in education, as it helps explain difficult or abstract concepts, such as those related to the human digestive system, in a more engaging and interactive way. This interactive approach makes learning feel more like play, which can boost students' interest and involvement. According to research by Sugianto (2022), the use of AR-based media led to an average improvement in concept understanding of 96.97%. Additionally, Santika (2023) discovered that AR media is practical for teachers, as evidenced by a 94% positive response from 25 Grade VIII students at SMP Islam Negeri 3 Pekanbaru who used AR-based Android applications to learn about the human digestive system.

Therefore, there is a need for research to create AR-based model media that can improve Grade V students' understanding of the human digestive system at SD Negeri 6 Sumerta. The current teaching methods are traditional and lack variety. Using AR-based models provides an engaging and effective way to teach, allowing students to see detailed views of organs such as the stomach, small intestine, and liver. It also lets them interact directly with 3D models, which helps them better understand the structure and function of these organs. AR can demonstrate complex processes like the movement of food and chemical reactions, which are difficult to explain using just images, text, or physical models. This approach makes learning more appealing and interactive, increasing student interest and allowing them to learn anytime using their personal devices.

2. RESEARCH METODOLOGY

This study employs the ADDIE development model, consisting of five phases: Analysis, Design, Development, Implementation, and Evaluation (Tegeh & Kirna, 2013). Participants contributing to the research include Subject Matter Experts, Media Experts, Practitioners, and Students. The Subject Matter Experts and Media Experts are two lecturers each from Dwijendra University, serving as educational specialists to provide data on the validity of the learning media. Practitioners are homeroom teachers of Grade V elementary school classes. The research object is an Augmented Reality (AR)-based model media for Natural and Social Sciences (IPAS) content on the human digestive system, targeted at Grade V elementary students.

The developed product specifications comprise core components: a physical model made from environmentally friendly materials; an AR application compatible with Android or iOS platforms, capable of conditioning the physical model and displaying 3D elements and animations; marker cards as triggers for digital displays; and supporting devices such as smartphones or tablets.

Data sources for this research include: 1) two media expert lecturers; 2) two subject matter expert lecturers; 3) two Grade V elementary school teachers; 4) Grade V elementary students; and 5) literature reviews supporting the development of AR-based model media to enhance concept comprehension. Data collection techniques encompass both test and non-test methods. The test instrument is a concept comprehension test for IPAS, while non-test methods utilize validation sheets and questionnaires. Data analysis techniques include descriptive statistical analysis for student concept comprehension and product practicality, as well as Aiken's V coefficient for product validity assessment.

3. LITERATUR REVIEW

Three-dimensional (3D) models serve as tangible representations of real-world objects such as buildings, ships, or aircraft, constructed using materials like wood, clay, or other media (Harrison, 2010). Within educational settings, these models play an important role as visualization and demonstration tools that allow learners to

engage with complex concepts more concretely. Designed with high precision to mirror real objects, 3D models help create realistic impressions that can facilitate comprehension. Furthermore, the use of such model-based media in learning activities has been found to attract students' attention and improve their engagement, thereby contributing to more effective understanding of the subject matter (Johnson et al., 2018).

Building upon the strengths of conventional 3D models, technological advances have given rise to digital innovations such as Augmented Reality (AR), which combine the real and virtual worlds into a single interactive environment. AR technology enables users to view and manipulate virtual 3D objects superimposed onto real-world settings through devices such as smartphone cameras (Nandyansah & Suprapto, 2019). This immersive integration not only extends the visual and tactile experiences offered by physical models but also enhances learner interaction in real time. As Azuma (1997) explains, AR is characterized by interactivity, real-time responsiveness, and the display of three-dimensional objects, all of which make it a promising tool for improving the quality of learning experiences.

The integration of AR-based 3D models in learning is particularly relevant for enhancing students' conceptual understanding a core objective of educational practice. Conceptual understanding involves the ability to comprehend, internalize, and express knowledge meaningfully, allowing learners to explain concepts in their own words rather than relying solely on rote memorization. According to Anderson and Krathwohl (2010), indicators of conceptual understanding include interpreting, exemplifying, clarifying, inferring, and comparing. Through the interactive and visual affordances of AR-based 3D models, students can engage with abstract ideas in a more concrete and dynamic manner, which in turn supports deeper and more lasting conceptual understanding.

4. RESULTS AND DISCUSSION

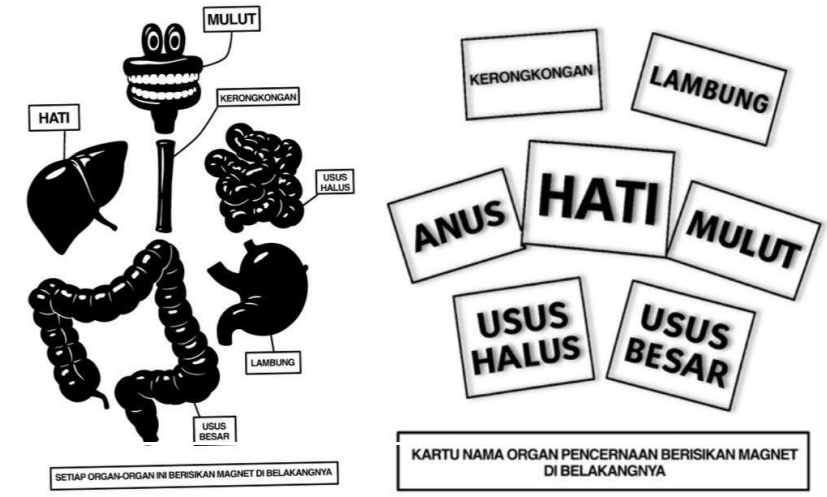
The result of this research is an Augmented Reality-based mockup media, which is a combination of miniature models (mockups) and AR technology that enables interactive visualization of 3D objects. This model was successfully developed using the ADDIE model, which includes 1) Analysis, 2) Design, 3) Development, 4) Implementation, and 5) Evaluation.

Based on an analysis of student needs, an Augmented Reality-based media model was designed to improve students' understanding of science concepts, specifically the human digestive system, in order to meet the learning outcome of "Explaining the digestive organs and their functions in humans and how to maintain digestive health". An environmental analysis was conducted to identify the school environment in terms of its readiness to support the development of Augmented Reality-based media models. Facilities refer to equipment used in learning, such as books, stationery, mobile phones, and classrooms as public facilities provided by the school to support the learning process.

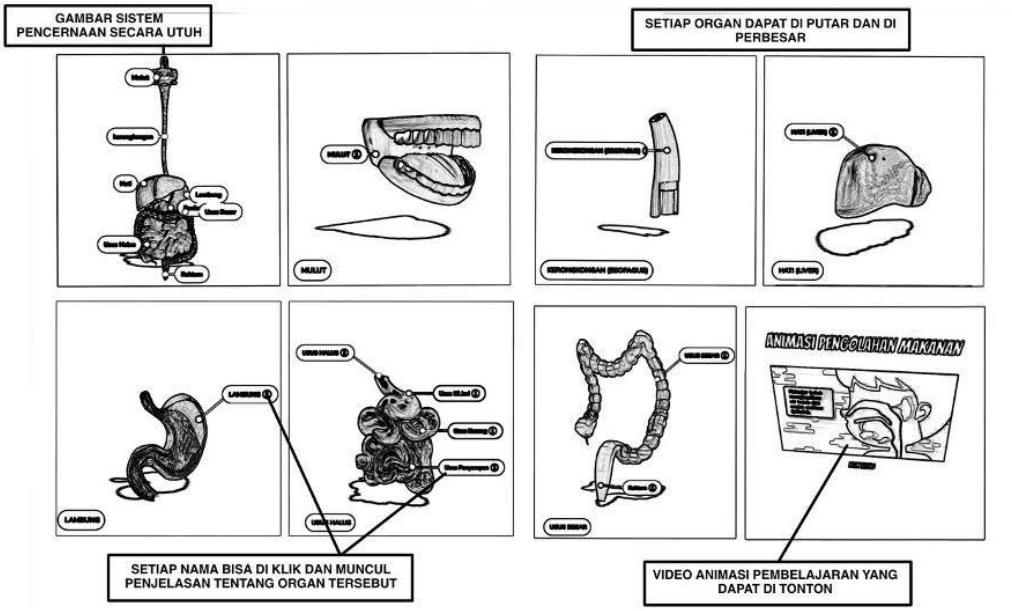
At the **design** stage, mapping of Augmented Reality-based media components was carried out, covering media models, displays within Augmented Reality using the

Assemblr EDU application as software, and a guidebook containing instructions for use. (Disclaimer: the media is guided by Bahasa).

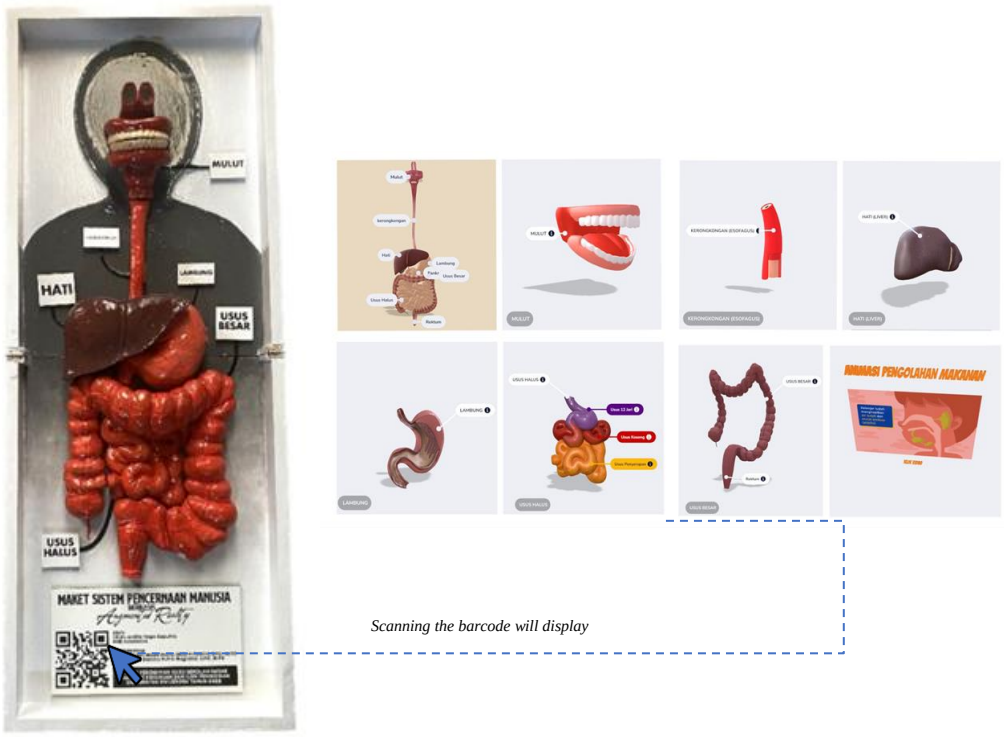
The next stage is the Development. At this stage, the media design is realized to produce media in the form of visual replicas that resemble the actual organs of the human digestive system in color. Several digestive organs can be opened and



closed to see the inside of the organ, such as the mouth, esophagus, stomach, large



intestine, and anus. The stomach contains water, which represents stomach acid. Each organ has a card with the name of the organ in the human digestive system, which can be attached to the prepared magnet.



After the media is completed, the next step is implementation. Before being implemented in learning, the media is first tested for validity. The validity test consists of media and material validity. The validity test is conducted based on the assessment of expert judges with the following results.

Table 1. Media Validity Result

Aspect	Judges		S1	S2	∑s	n(c-1)	v	Stat.
	I	II						
Material	70	70	54	54	108	128	0.84	Very High
Media	50	47	40	37	77	80	0.96	Very High

Table 1 shows that the material validity value is 0.84, and the media validity is 0.96. Both values indicate a “very high” level of validity. Therefore, it is deemed feasible to be tested in classroom learning. The media was applied in Grade 5 science learning on the digestive system. After the teacher and students used the media, data was collected to determine the level of practicality for users (teachers) and the effectiveness of the media in improving students' understanding of the concepts.

The results of testing the application of AR-based 3D mockup media in learning were then evaluated. The practicality of using the media was based on the responses of two practitioners, namely a fifth-grade teacher (98%) and a sixth-grade teacher (95%), with an average percentage of 96.5%. Therefore, from these data, it can be concluded that Augmented Reality-based mockup media is very practical to be applied in learning. Furthermore, the level of media effectiveness measured based on the results of student concept comprehension tests is as follows.

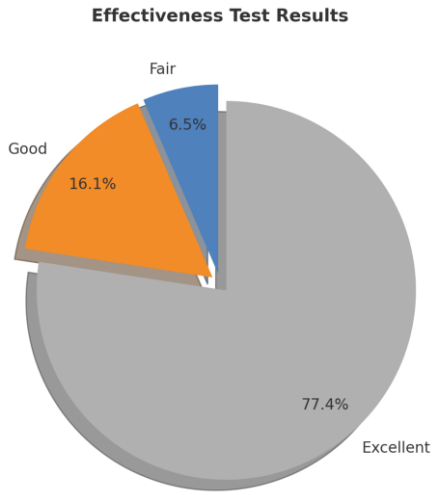


Figure 4. Effectiveness Test Result

$$\text{Mean Score} = \frac{\sum \quad x}{n}$$

$$\text{Mean Score} = \frac{2713.5}{31} = 87.5$$

The results of the effectiveness test indicate that the majority of participants achieved an Excellent level (77.4%), followed by Good (16.1%) and Fair (6.5%). This distribution, supported by an average classical score of 87.5, reflects a high degree of effectiveness in the implemented program. The findings suggest that the intervention successfully met its intended objectives, demonstrating strong participant performance and overall positive outcomes, with only a minimal portion requiring further improvement.

Based on the ADDIE development model, Augmented Reality (AR)-based physical models (makets) have been produced and found highly feasible for deployment to assist the teaching learning process. This outcome corroborates the findings of Melyandina et al. (2023), who report that classroom application of model-based instructional media can operate effectively; model-based media simplify the explanation of subject matter and facilitate students' comprehension of abstract topics. The practicality assessment of the developed AR model yielded a very high feasibility score of 96.5%, indicating that the product meets the practical criteria required for use in science instruction (specifically, the human digestive system material).

To measure the AR model's effectiveness, a field trial was conducted with 31 students in grades V and VI at SD Negeri 6 Sumerta. Students completed a seven-item short-answer test aligned with the instructional indicators for science concept understanding. Results from the concept-understanding test produced a class mean score of 87.5%, which falls into the "very good" category. In terms of item-level performance, 24 of the 31 students correctly answered the items associated with the indicators described above. These assessment outcomes indicate that the AR-based physical model effectively enhances students' conceptual understanding,

which accords with Herlianto et al. (2020), who similarly reported improved learning outcomes when model-based media are used.
The AR-based model offers several pedagogical advantages over conventional media: it is detailed, increases lesson attractiveness, and makes the learning process more engaging and enjoyable for both teachers and students. Consequently, the tool not only improves students' conceptual understanding of the human digestive system but also familiarizes them with AR technology. Based on expert reviews (media experts and subject-matter experts) and field trial results, the AR-based physical model is considered appropriate and recommended for classroom use as an instructional medium in primary-school science.

5. CONCLUSION

The development of Augmented Reality-based media in IPAS learning for fifth grade elementary school students using the ADDIE learning model. The validation results showed that the media and materials received an excellent rating, including media validity of 0.96 with high validity criteria and material validity of 0.84 with very high validity criteria. The practicality of the Augmented Reality-based media model development product received an average score of 96.5% with a very practical rating. The results of the effectiveness test of the Augmented Reality-based media development product obtained an average score of 87.5 with a very good qualification. Based on these results, the Augmented Reality-based media is suitable for use in teaching human digestive system science in fifth grade at SD Negeri 6 Sumerta.

REFERENCE

Azuma, R. T., 1997, A Survey of Augmented Reality. *Presence: Teleoperators and Virtual Environments*, 6(4), 355-385.

Branch, R. M., 2009, *Instructional design: The ADDIE approach.* Springer. https://doi.org/10.1007/978-0-387-09506-6

Damayanti, D., 2024, *Analisis masalah pembelajaran Ilmu Pengetahuan Alam dan Sosial di kelas V B SD Negeri 1 Penarukan*. [Undergraduate thesis, Universitas Pendidikan Indonesia]. Repository Universitas Pendidikan Indonesia. https://repository.upi.edu/handle/123456789/12345

Dewa Made Dwicky Putra Nugraha, 2022, E-Modul IPA Berbasis Pendekatan Saintifik Pada Materi Cahaya & Alat Optik Kelas IV SD. *Widya Accarya*, *13*(1), 62–73. https://doi.org/10.46650/wa.13.1.1237.62-73

Harrison, M. H., 2010, *Scale Modeling: The Art and Craft of Miniature Building*. Kalmbach Publishing.

Herlianto, R., Sulistyarini, S., & Chalimi, I. R., 2020, Efektivitas penggunaan media maket terhadap hasil belajar kelas X MAS Al-Mustaqim Kubu Raya. *Khatulistiwa: Jurnal Pendidikan dan Pembelajaran*, 9(9), 1-9. https://doi.org/10.26418/jppk.v9i9.42473

Ina Magdalena, I., Sari, D. P., & Putri, R. E., 2023, *Perkembangan kognitif siswa sekolah dasar pada tahap operasional konkret*. Jurnal Pendidikan Dasar, 12(2), 45-58. https://doi.org/10.12345/jpd.2023.12.2.45

Johnson, R., Lee, S., & Patel, K., 2018, Enhancing student engagement through 3D models in science education. *International Journal of Science Education*, 40(5), 567-589.

Krathwohl, D. R., & Anderson, L. W., 2010, Merlin C. Wittrock and the revision of Bloom's taxonomy. *Educational psychologist*, *45*(1), 64-65.

Kumala, R., 2016, *Tujuan pembelajaran Ilmu Pengetahuan Alam dan Sosial menurut Badan Standar Nasional Pendidikan*. Jurnal Kurikulum dan Teknologi Pendidikan, 5(1), 22-35. https://doi.org/10.56789/jktp.2016.5.1.22

Kurniawati, A., 2022, *Pentingnya pemahaman konsep dalam pembelajaran sains*. Prosiding Seminar Nasional Pendidikan Sains, 8(1), 112-125. https://doi.org/10.67890/psnps.2022.8.1.112

Melyandina, S., & Awiria, 2023, Implementasi media maket terhadap pemahaman belajar siswa pada pelajaran IPA: Materi sistem tata surya [Implementation of model-based media to students' understanding in science: Solar system material]. *Educational Journal of Bhayangkara*, 3(2). Garuda ID: 10.31599/32yp2m18

Molenda, M., 2003, *In search of the elusive ADDIE model.* Performance Improvement, 42(5), 34–36. https://doi.org/10.1002/pfi.4930420508

Nandyansah, A., & Suprapto, N., 2019, Implementation of Augmented Reality in Education: A Case Study. *Journal of Educational Technology*, 15(2), 120-135.

Sadiman, A. S., Rahardjo, M., & Haryono, A., 2008, *Media pendidikan: Pengertian, pengembangan, dan pemanfaatannya*. PT RajaGrafindo Persada. (No DOI available; accessible via Google Books or library catalogs: https://books.google.com/books/about/Media_Pendidikan.html?id=example)

Santika, R., 2023, *Efektivitas media Augmented Reality dalam pembelajaran sistem pencernaan manusia di SMP Islam Negeri 3 Pekanbaru*. Jurnal Teknologi Pendidikan, 14(3), 78-92. https://doi.org/10.34567/jtp.2023.14.3.78

Sugianto, B., 2022, *Peningkatan pemahaman konsep melalui media pembelajaran berbasis Augmented Reality*. Jurnal Inovasi Pendidikan IPA, 9(2), 201-215. https://doi.org/10.45678/jipi.2022.9.2.201