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Development of Augmented Reality-Based Learning Media for Computer Hardware Materials at SMP Santa Monika

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Abstract: This study aims to develop augmented reality-based learning media for computer hardware materials for Grade VII students at SMP Santa Monika. The research method employed is Research and Development (R&D) using the ADDIE design model, which consists of Analysis, Design, Development, Implementation, and Evaluation. The product development subjects include expert validators in media and material: two lecturers in Information Technology Education, one lecturer in Information Technology Education, and an informatics subject teacher. The small-scale and large-scale product testing subjects consist of Grade VII students at SMP Santa Monika, with a total of 40 students. Data collection techniques used in the study include direct communication, indirect communication, and data collection tools such as unstructured interviews, questionnaires, and documentation. Based on the results obtained, the conclusion of this study is that the augmented reality-based learning media developed is feasible for use in the learning process. The validation results from media and material experts achieved an average percentage of 89.75%, categorized as highly feasible. Additionally, the student response questionnaire results in the small-scale trial showed a percentage of 80.33%, while the large-scale trial achieved 89.74%, both categorized as excellent.

INTRODUCTION

The rapid technological advancements in today's era of globalization have profoundly impacted all areas of life, including education. Education plays a pivotal role in enhancing skills, improving quality of life, and elevating human dignity in the effort to build a nation. Efforts to improve education can be undertaken through various institutions, including schools, as formal educational establishments. The integration of technology in education fosters high-quality learning processes. However, in education that utilizes technology as a learning medium, several factors must be considered, such as teaching methods, student characteristics, the learning environment, and the type of learning media used (Hasanah & Rodi'ah, 2021). Integrating technology into the learning process in schools can encourage students to engage actively in learning, aligning with contemporary learning styles that favor visual and technology-based formats.

According to Ibrahim (in Firnanda Y, 2020; Budiman et al, 2024), a school is an institution designed for educational activities, serving as a place for educators to teach and students to learn in their respective fields. Schools have undergone significant changes in

teaching and learning approaches due to technological integration. With the adoption of technology, schools have transitioned from traditional learning models to more varied and innovative ones, catering to students' needs. However, the rapid technological advancements also pose new challenges for teachers to create diverse and innovative learning experiences. Numerous technological innovations in learning media development can enhance the learning process in schools. Therefore, teachers today must be equipped to create digital learning media such as instructional videos, educational applications, simulations, educational games, e-books, 3D animations, and more.

Nasution (2018) efines learning media as teaching aids that support the teaching methods used by educators. Learning media can be categorized into two types: conventional media and technology-based media. Currently, the most commonly used media in schools include textbooks and PowerPoint presentations. However, these media often fail to maximize the delivery of material to students, particularly in subjects like computer hardware, which require models of components and tangible or virtual objects to help students understand and identify computer hardware. The monotony of textbook images tends to make students passive and reduces their engagement.

Observations and unstructured interviews conducted at SMP Santa Monika revealed several challenges in Grade VII Informatics lessons. Morning-session students lack access to the computer lab due to scheduling conflicts, as the lab is reserved for high school students. As a result, only afternoon-session students can utilize the computer lab, leaving the morning students with unequal access to learning facilities. Limited access to projectors prevents teachers from incorporating PowerPoint presentations or instructional videos into lessons. The reliance on student worksheets has led to boredom and a lack of enthusiasm among students, who also face difficulties in learning and understanding computer hardware materials.

These findings align with Suryadi (2023), who emphasizes the importance of inclusive education to ensure equal opportunities for all students in nurturing learning environments. Teachers must also enhance their digital skills to help students develop digital literacy, technological understanding, and proficiency in using digital tools wisely (Astini, 2019). Furthermore, Lase (2022) highlights the need for teachers to master technology and integrate it effectively into learning processes. However, in reality, many teachers lack the motivation to create diverse and innovative learning media utilizing technological advancements.

A needs analysis revealed that students require more varied and innovative learning media to support their learning process. This has led to the innovation of developing augmented reality (AR)-based learning media as an alternative and new tool in classroom learning. This approach ensures that morning-session students receive the same quality of education as their afternoon-session counterparts while making learning more engaging and stimulating. AR-based media allows students to understand the material better by transforming lessons into interactive, enjoyable experiences that motivate and excite them, fostering effective and efficient learning outcomes (Wangge, 2020; Prasetya et al., 2023; Arpan et al., 2018; Budiman et al., 2018).

AR-based learning media for computer hardware materials is designed to help students recognize and identify computer hardware components. By utilizing AR technology, teachers and students gain new experiences in the learning process. Augmented Reality enables users to view the real world with digital elements that interact with physical objects in their environment (Nadeem J et al., 2021; Arianto et al., 2023; Samala et al., 2024; Budiman, 2016). AR combines the real world with digital elements displayed on electronic devices such as smartphones, tablets, and AR glasses (Hasnain et al., 2021). These digital elements enhance the learning experience by complementing physical objects. The use of AR in education offers advanced, sophisticated media solutions. It provides an alternative for classroom learning when access to a computer lab is unavailable, allowing students to engage with realistic 3D models.

Based on the aforementioned discussion, this study aims to develop AR-based learning media to enrich the variety of media available for teaching Informatics. This media enables teachers to visualize computer hardware for students using 3D virtual objects, allowing for an interactive and accessible learning experience. Students can engage directly with the AR media using smartphones, enabling them to independently revisit lessons at home with their parents.

METHOD

The research method used in this study is a developmental research method, also known as Research and Development (R&D). According to Sugiyono (2019), Research and Development is a method employed to produce a specific product and to test its validity. The design adopted in this study refers to the ADDIE development model, which stands for Analysis, Design, Development, Implementation, and Evaluation (Sugiyono, 2019).

The ADDIE development model is commonly used due to its iterative evaluation process, which ensures that each stage is thoroughly reviewed and refined before progressing to the next. The results of these evaluations provide valuable insights to facilitate subsequent stages. The steps of the ADDIE model are illustrated in the following diagram:

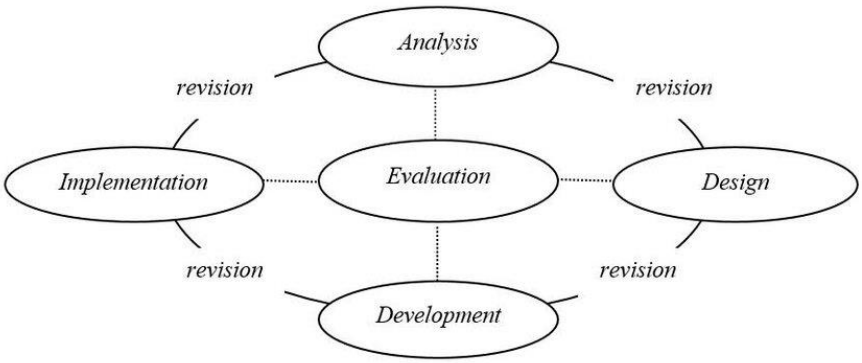

Figure 1. ADDIE Development Model (Sugiyono, 2019).

The ADDIE development model is a versatile framework that can be utilized to develop learning media, teaching materials, learning models, or instructional strategies.

This research employs a developmental approach aimed at designing and producing augmented reality (AR) learning media for computer hardware materials, evaluating the feasibility of the AR learning media, and analyzing user responses to the AR learning media at SMP Santa Monika. The data collected in this study comprises both qualitative and quantitative data. Qualitative data is used to interpret and analyze information obtained through interviews with Grade VII Informatics teachers at SMP Santa Monika. Quantitative data is analyzed statistically, using data collected from validation sheets completed by media experts, subject matter experts, and student responses. The formula used to determine the feasibility level and student responses is presented as follows (Sugiyono, 2019):

$$Percentage = \frac{Score\ Total}{Maximum\ Score}\ x\ 100\%$$

Based on the data analysis results, conclusions regarding the feasibility of the evaluation tool will be drawn using the following criteria:

Table 1. Scoring Criteria for Media Experts and Subject Matter Experts

Percentage	Criteria
0% - 20%	Very Infeasible
21% - 40%	Infeasible
41% - 60%	Fairly Feasible
61% - 80%	Feasible
81% - 100%	Highly Feasible

The percentage index is calculated using the formula:

$$Percentage\ Index = \frac{Score\ Obtained}{Maximum\ Score}\ x\ 100\%$$

(Sugiyono, 2019)

From the percentage index, the achievement score is then classified using the following qualifications:

Table 2. Scoring Criteria for Student Responses

Percentage Achievement	Category
0% < Score ≤ 20%	Very Poor
21% < Score ≤ 40%	Poor
41% < Score ≤ 60%	Fair
61% < Score ≤ 80%	Good
81% < Score ≤ 100%	Very Good

RESULT AND DISCUSSION

The type of research used in the development of augmented reality (AR)-based learning media for computer hardware materials for Grade VII at Santa Monika Middle School is Research and Development (R&D). This method aims to produce a learning media application product using the development model proposed by Sugiyono (2019), which includes the stages of **analysis, design, development, implementation, and evaluation.**

A. Analysis Phase

1. User Needs Analysis

   This phase involves analyzing the teaching methods, available learning resources, school facilities, required media, student expectations during classroom learning with the teacher, and target users. The analysis is conducted

to meet the needs of both teachers and students through unstructured interviews with Grade VII teachers and students.

2. System Requirements Analysis
   This phase determines the technology required for developing and implementing the planned learning media. It includes hardware and software specifications essential for the successful development and implementation of AR-based learning media.
3. Content Needs Analysis
   This phase identifies the learning content to be included in the learning media, how it will be presented, and its alignment with the teaching materials. The content consists of computer hardware material, 3D objects, exercises, and educational videos.

B. Design Phase

1. Flowchart Design
   This step involves creating a graphical representation of the system or process flow using symbols such as boxes, arrows, diamonds, and circles to depict steps and their logical order.
2. Storyboard Design
   This step develops sequential illustrations or images that plan the visualization and storyline of the project, such as animations or multimedia presentations, accompanied by brief descriptions of actions or dialogues.

C. Development Phase

1. Learning Media Development
   The design concepts are developed into AR-based learning media using Unity. The product includes:

Tabel 1. Results of Augmented Reality Learning Media Development

Section	Display	Description
Loading Screen		Progress bar and logo display.
Menu Page		Contains six navigation buttons: AR play, video, exercises, guide, profile, and exit.

Section	Display	Description
AR Scan Page		Displays 3D objects with descriptions when the camera detects markers.
Video Page		Features video playback with play, pause, and stop buttons.
Quiz Page		Includes 20 multiple-choice questions with pop-up images for correct/incorrect answers and score calculations.
Guide Page		Contains instructions for using the application.
Developer Profile		Displays brief information about the developer.

2. Expert Validation
   The developed application undergoes validation by media and subject matter experts.

Tabel 4. Media Validation Results

Validator	Total Score	Percentage
Validator 1	85	85%
Validator 2	94	94%
Overall	**179**	**89.5%**

Tabel 5. Subject Matter Validation Results

Validator	Total Score	Percentage
Validator 1	95	95%
Validator 2	85	85%
Overall	**180**	**90%**

Tabel 6. Average Feasibility Scores

Validator	Average Percentage	Criteria
Media Expert	89.5%	Highly Feasible
Subject Matter	90%	Highly Feasible
Overall	**89.75%**	**Highly Feasible**

3. Small-Scale Trial
   The application is tested with six randomly selected Grade VII students to identify errors.

Tabel 6. Small-Scale Trial Results

Total Score	Percentage
482	80.33%

D. Implementation Phase

Large-Scale Trial

The media is implemented in Grade VII classrooms during Informatics lessons with 34 students.

Tabel 7. Large-Scale Trial Results

Total Score	Percentage
3051	89.74%

E. Evaluation Phase

Evaluation is conducted throughout all phases to ensure continuous improvement and assess the quality of the developed media. Feedback from experts and trials helps determine whether the media is suitable for use in schools or independent learning at home.

CONCLUSION

The development of augmented reality (AR)-based learning media for Grade VII computer hardware materials at Santa Monika Middle School aimed to explore its development, determine its feasibility, and assess student responses to its use. The results showed that the media has a significant impact, with media and material experts rating it

as highly feasible at 89.75%, and student responses being very positive, achieving 80.33% in small-scale trials and 89.74% in large-scale trials. This AR-based media serves as an effective alternative to traditional classroom activities, addressing the lack of computer lab access by providing a 3D learning model that creates an experience akin to real-world situations. Compared to previous studies, this research includes 18 3D object models, which are more engaging than the 10 models used in prior studies by Dalimunthe, H.F., and Simanjuntak, P. (2023). Future research is encouraged to expand this media to other classes, teachers, and schools, as well as to develop it for other subjects using different models and approaches to meet field needs. Additionally, it is recommended to increase the number of 3D objects in alignment with the material requirements of the respective schools.

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