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Development of Augmented Reality Based Student Worksheet (LKPD) on Sensory System Material

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Abstract

In this digitalization era, there has been significant progress in the field of information and communication technology. 21st century learning is a consequence of societal progress that continues over time .The objective of this study is to create an Augmented Reality Based Student Worksheet for the purpose of enhancing the biology learning experience specifically for the sensory system topic. The research was conducted at Gema Buwana Tembung High School in the eleventh grade classroom. This study employed the Research and Development (R&D) methodology and a 4D model, which was implemented in only three stages: Define, Design, and Develop. The data collection methodologies employed included expert validation sheets, as well as answers from teachers and students. The research findings demonstrated a material validation rate of 92.7% and a media validation rate of 95.3% in the "very valid" category. The teacher's response yielded a 97% success rate, while the student response consisted of 21 responses and was classified as highly practical. The implementation of N-gain in high school resulted in a total score of 34.22, which was then averaged to 0.628 in the effective category. The N-gain value is calculated by taking the average of the pretest and posttest scores. The results indicate that the creation of an Augmented Reality-based Learning Kit for Practical Demonstrations og LKPD effectively captures students' attention and enhances their motivation to learn about sensory systems.

Keywords: *Augmented Reality; Sensory System; Student Worksheet*

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INTRODUCTION

During this digitalization era, there has been significant progress in information and communication technology (Qolbiyah & Arisanti, 2022). The 21st century learning is a consequence of society's continued progress over time (Rahayu et al., 2022). These

technological advances have had a significant impact on various aspects of human existence. Humans strive to stay up-to-date with technological advances to be able to communicate information effectively, using multimedia (Sari & Sulisworo, 2023). Education in the Industry 4.0 era harnesses the power of digitalization to improve everyday life. In this type of education, humans and machines work together to solve problems and produce new discoveries (Kanti et al., 2022). Technology has brought changes in educational techniques towards a more student-centered learning approach (Pratama, 2012).

Augmented Reality (AR) is the latest technology that has emerged during the 4.0 revolution era (Handika, 2023). Augmented Reality (AR) is a technology that integrates virtual things, either in two or three dimensions, into a real environment and presents them in real time (Kanti et al., 2022). AR technology is commonly used in the entertainment industry, such as in advertising for sports matches and some electronic games (Nuha et al., 2021). AR can function as a three-dimensional instruction tool in education, effectively conveying lesson content (Wartoyo et al., 2023).The availability of these AR development applications provides the public with ample opportunities to further advance AR in their own domain. Augmented Reality (AR) is an innovative method for enhancing the learning experience by incorporating three-dimensional element (Handika, 2023). In addition, the current speed of technical progress is fast and continues to accelerate (Rexa & Anistyasari, 2018). Smartphones have become famous and are experiencing rapid progress. Most people have smartphones as a method of communication and information transmission. Smartphones function as a platform for integrating Augmented Reality technology with Studenst Worksheets (LKPD) (Siregar, 2022). The aim of this project is to enhance the learning experience by using Augmented Reality technology to produce a Learning Kit based on Augmenced Reality for sensory system content (Fauziah & Sulisworo, 2021). When creating an Augmented Reality-based worksheet, it is important to focus on the visual representation of experimental tools and materials, as well as the stages involved, to ensure students understand.

According to author observations and interviews conducted with biology teachers at Gema Buwana Tembung High School, the current teaching materials used by students consist of textbooks that provide long explanations. As a result, students show less interest in reading this material. The educational materials used are traditional, quickly available resources that can be obtained and used without the need for separate compilation. The use of LKPD is currently mainly limited to publishers (Indriani et al, 2023), and is rarely used in the learning process due to teachers' preference for direct observation outside the classroom, without the integration of LKDP. However, use of smartphones for educational purposes is permitted. Sensory systems material is typically included in high school biology instruction as part of abstract learning resources (Amdani & Purnamasari, 2022). Sensory system content studies primarily focus on reading, lacking the inclusion of visually appealing and lively illustrations. In addition, educational institutions do not provide anatomical models, which precludes direct observation of the components of the sensory system. Using technology in creating educational materials can assist in the acquisition of biological concepts by students (Kharisma et al., 2020). The study of

Damayanti & Sulisworo (2022) revealed that the use of learning media improves students' cognitive abilities. Many teachers actually do not use instructional media during the teaching process. Sari & Sulisworo (2023) found that students experienced boredom due to the routine and uninteresting nature of their learning experience. In addition, students face challenges that include only material delivered via chalkboard without using additional learning resources. Students expect teachers to present course information in class using a variety of creative and multimedia instruction techniques. It is very important that media has the ability to reach every student and function as an alternative solution (Mustaqim & Kurniawan, 2017).

A number of researchers have previously created augmented reality (AR) assisted learning and knowledge practice devices (LKPD), with a special emphasis on mathematics topics (Siregar, 2022). As stated by Sari & Sulisworo (2023) laptops have limited functions. Kharisma et al., (2013) developed Augmented Reality (AR) based on Learning and Teaching Materials (LKPD) which focuses on the topic of monera. Meanwhile, Indriani et al., (2023) created Augmented Reality (AR) based on Learning and Teaching Material (LKPD) which focuses on sensory organs. However, the material is designed in the form of practical activities. However, this research focuses on developing a Learning and Knowledge Presentation Device (LKPD) based on Augmented Reality (AR) using sensory system materials. The main goal is to provide an engaging and engaging classroom learning experience. Engage and responsive. Usage is also more user-friendly considering it was made using a smartphone (Ashari et al, 2022).

Therefore, the aim of this study is to create augmented reality (AR) learning media for the subject of sensory systems that is good, practical, and effective. By using Augmented Reality (AR), this Learning and Knowledge Presentation tool (LKPD) facilitates students' understanding of abstract concepts and increases their adaptability in applying them, thanks to the use of smartphones.

METHOD

In this research method, the participants involved were media experts, material experts, Gema Buwana Tembung High School teachers as evaluators and 30 Gema Buwana Tembung High School students. This research uses research and development techniques using the 4D development model. Thiagarajan (1974) is credited with developing this concept. According to Mahendra (2016) The 4D development approach consists of four main steps, namely (1) Define, (2) Design, and (3) Develop. Develop refers to the process of creating or improving something, while deploy means distributing or disseminating something widely. However, this particular model of approach was only able to advance to the development stage, largely due to limitations related to time and money.

The selection of this model is based on simple program structure, ease of understanding, and systematic application. The stages of the 4D development model enable researchers to systematically and effectively produce products that align with their research goals. In addition, this methodology is very suitable for creating books or instructional materials. The deployment steps in the 4D model are in line with the research objective of improving students' connection abilities (Trianto, 2012).

The details of the development stages are as follows:

Define Stage

(1) Front-end Analysis (Preliminary Analysis) is carried out at this stage to identify basic problems that often occur in student behavior related to school. This analysis serves as a reference point for implementing AR-based LKPD learning. (2) Learner Analysis: Student analysis is the process of identifying specific characteristics and characteristics of students who are the focus of educational resource generation. This analysis involves gathering information about students' needs using a questionnaire that includes many questions related to their challenges and difficulties. (3) Concept Analysis: This stage is determined by having a conversation with the biology teacher. 4) Setting educational goals (Creation of Learning Objectives) Currently, assessment of learning success is based on curriculum adjustments to Permendikbud No.37 of 2018, which outlines the knowledge and skills (KI and KD) required for biological disciplines. It serves as a basic guide for the development of educational materials.

Design Stage

(1) Media selection (Choosing the Appropriate Media) Media selection is determined by the results of concept analysis, task analysis, student attributes as users, and distribution strategies using various media. (2) Format Selection The format selection process in developing learning tools involves determining the learning media design, choosing techniques, approaches, methodologies and learning resources. (3) Preliminary Design: Preliminary design refers to the original overall design of the learning tool that must be completed before conducting trials.

Develop Stage

(1) Expert Evaluation. This examination is carried out to ask for recommendations and improvements from several specialists, especially (1) Material experts and (2) Media experts. (2) Behavioral Testing: Development trials are carried out to collect first-hand feedback in the form of responses, reactions, and comments from students and observers about the prepared learning materials. Iterative testing and improvements are carried out to achieve efficient and reliable educational resources. Product trials in this research have validator criteria, namely material experts who are competent experts in sensory system material in the high school field and media experts whose components are in the field of media development. This trial in development is intended to enable media experts and material experts to provide an assessment of the product to be developed so that the results are maximum.

Instrument

This development research uses research instruments in the form of validation sheets, which are initially subject to validation by material experts and media experts before being given to respondents. The aspects assessed by material expert validation are content and presentation, the aspects assessed by media validation are graphics and presentation. This validation is carried out to facilitate the measurement of all characteristics that require evaluation in learning media.

Next, the practical exam takes the form of a response questionnaire given to teachers and students. The aspects assessed by the teacher are content, character values, graphics and presentation. Then the aspects that students will assess are content, graphics and presentation. This survey was administered during the media validation and testing process. Answer questions are used to ensure evaluation of the learning material created. To evaluate the effectiveness of student learning outcomes, a test tool was implemented, namely by administering 10 multiple choice questions based on topics.

This survey is used to evaluate the learning materials that have been developed. The efficiency of the use of educational resources during the implementation of instructions was assessed using a questionnaire based on a 4-point scale. The development stages used include initial design and user testing, sometimes known as beta testing. The data collection technique was carried out using an assessment questionnaire, which was used to analyze the validity of Augmented Reality (AR) based LKPD teaching materials.

Table 1. Validity Criteria, Source: Akbar (2017)

Criteria	Validity Level
81% - 100%	Very Valid
61% - 80%	Valid
41% - 60%	Fairly Valid
21% - 40%	Invalid
0% - 20%	Very Invalid

Next, students are given a questionnaire to ensure their practical level in using the learning materials. The practicality score of LKPD based on Augmented Reality (AR) is measured as a percentage. Next, students were given a questionnaire to assess their skills in using educational resources. The LKPD practicality score, evaluated using Augmented Reality (AR), is measured as a percentage. calculated by N-Gain measuring the relative change between students' level of understanding before and after learning using sugiyono (2017) formula. Positive values indicate an increase in student learning outcomes after learning while negative values indicate a decrease in student learning outcomes.

Table 2. Product Practicality Test Criteria, Source: Nesri (2020)

Criteria	Practicality Level
85.01% - 100%	Very Practical
75.01% - 85.00%	Praktis
60.01% - 75.00%	Quite Practical
50.01% - 60.00%	Less Practical
<50,00%	Very Less Practical

Table 3. Effectiveness Test Criteria, Source: Sugiyono (2017)

Criteria	Effectiveness Level
$g > 0.7$	Very effective
$0,3 \leq g \leq 0.7$	Effective
$g < 0.3$	Less effective

$$\text{N-gain (\%)} = \frac{\text{(posttest score} - \text{pretest score)}}{\text{(maximum score} - \text{posttest score) x 100}} \text{ x 100}$$

RESULT AND DISCUSSION

Augmented Reality Based LKPD Development

This research uses the 4D paradigm, which consists of four distinct stages: define, design, develop, and deploy. However, this research was limited to the development stage due to time constraints. During the initial stages of the project, an interview was conducted with one of the class members. Student motivation is hampered by continued reliance on textbooks and classroom discussions for learning, as researchers have found that a lack of real-life supporting materials, such as a lack of torsos, limits the effectiveness of the sensory systems used to acquire information.

The second stage is the Design stage or LKPD design, when the basic product design for Augmented Reality-based LKDP on sensory system materials for class sensory system organs occurs. LKPD is created using visuals based on Augmented Reality and combines a series of questions aimed at improving scientific skills. Various programs, especially Canva and Assembler Edu, are needed for the development of Augmented Reality instructional media in this design process.

The LKPD media design based on Augmented Reality has been validated by material experts and media experts. This survey aims to evaluate the suitability and superiority of LKPD by experts. The purpose of this validation questionnaire is to assess the quality of the LKPD and determine its accountability for use.After incorporating several comments from validators during the revision process, a conclusion about the validity of the LKPD has been reached. Table 4 displays the validation results carried out by material experts.

Table 4. Material Expert Validation

Aspect	Percentage %	Category
Fill	91.6 %	Very Valid
Presentation	93.7 %	Very Valid
Average	92.7 %	Very Valid

Based on table 4. Based on the validation results provided by material experts, it was determined that the LKD results have a validity level of 92.7%, which showsthat they are very valid and suitable for use (Usmaedi et al., 2020). In addition, suggestions from validators are also suitable for use without the need for changes. The validation results provided by media specialists are shown in table 5.

Table 5. Media Expert Validation

Aspect	Percentage %	Category
Graphics	96.8 %	Very Valid
Presentation	93.7 %	Very Valid
Average	95.3 %	Very Valid

According to table 5, the media expert validation results show that the resulting LKPD has a validity percentage of 95.3%, falling into the very valid category and suitable for use (Akbar, 2017). Additionally, recommendations from validators are also suitable for incorporating adjustments based on their ideas. Revisions were made to combine validation results and suggestions from validators to improve product excellence.

Table 6. Teacher Responses

Respondent	Percentage %	Category
Class XI high school biology teacher	97.4 %	Very Valid
30 Students	96.1 %	Very Valid

According to table 6, the biology teacher's questionnaire answers show that 97.4% of the LKPD scores are classified as very practical. According to the teacher, the contents of the LKPD can be understood and increase students' understanding and curiosity. Augmented Reality graphics in LKPD align with the subject of biology and offer significant advantages for students. Teacher recommendations are suitable for use. In accordance with Sari & Sulisworo (2023) view, the use of LKPD based on Augmented Reality is beneficial for students. This facilitates user-friendliness, improves subject understanding, and promotes a sense of accomplishment in the learning process. And table , students' answers achieved a percentage score of 96.1%, which is included in the very practical category. It is intended to serve as an educational tool for studying sensory systems in biology. The aim is to involve students in learning by using *Augmented Reality*-based LKPD.

Tabel 7. Effectiveness test data for N-gain results

Total Respondents	N-gain amount	Average N-gain
30 students	34.21 %	0.628

According to table 7, the N-gain results for middle school implementation obtained a total score of 34.22, which then reached an average of 0.628 in the effective category. The N-gain value is calculated by taking the average of the pretest and posttest scores. Pretest and posttest are evaluative assessments that can evaluate student learning outcomes (Sugiyono, 2017).

The aim of this project is to improve the learning experience by using Augmented Reality technology to produce Learning Kits and Practical Demonstrations (LKPD) which focus on sensory system material. Augmented Reality enhances the learning experience by offering students a highly participatory and

comprehensive approach, facilitating their understanding of abstract concepts. In addition, the creation of an Augmented Reality-based Learning and Knowledge Presentation Device (LKPD) can serve as a pioneering initiative to improve education in the current digital era. Therefore, the creation of AR-based LKPD is a step to use technology to increase learning efficiency (Rusnandi, 2016).

CONCLUSION

The creation of Augmented Reality-based Learning and Teaching Material (LKPD) for sensory system subjects produces media called LKPD. This LKPD combines 3D or Augmented Reality content which can be accessed using a smartphone using the Assemblr Edu application. Next, a validation process is carried out to ensure that the media created meets the criteria required as an instructional resource for learning. The materials specialists achieved a score of 92.7% in the "very valid" category. The results obtained from media specialists achieved a score of 95.3% in the "very valid" category. The teacher's answer received a score of 97.4% in the highly practical area. Answers from 21 students also received the very practical category. The pretest and posttest results were categorized as effective. N-gain's findings obtained a cumulative score of 34.22, which was then averaged to 0.628 in the effective category. According to students' feedback about this LKPD which is based on Augmented Reality, they found the cover, language and design quite interesting. The inclusion of Augmented Reality into the worksheet increases understanding and facilitates students' understanding of the topic.

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