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VALIDITY AND PRACTICALITY OF STUDENT WORKSHEET BASED ON AUGMENTED REALITY APPLICATIONS OF MANGROVE ROOTS TO IMPROVE THE LEVEL OF SPATIAL THINKING

VALIDITAS DAN KEPRAKTISAN LKPD BERBASIS APLIKASI AUGMENTED REALITY AKAR MANGROVE UNTUK MENINGKATKAN TINGKAT BERPIKIR SPASIAL

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Abstrak

Augmented Reality (AR) telah menjadi bidang penelitian penting dalam beberapa tahun terakhir. AR adalah gabungan benda-benda di dunia maya (virtual) ke dalam dunia nyata dalam bentuk dua dimensi dan tiga dimensi yang dapat diproyeksikan dan dioperasikan. Tujuan penelitian ini yaitu menghasilkan media aplikasi *Augmented Reality* Akar Mangrove sebagai media pembelajaran yang inovatif dan praktis untuk meningkatkan kemampuan berpikir spasial peserta didik ditinjau dari aspek validitas, kepraktisan, dan keefektifan yang diberi nama media aplikasi MANGROVIA. Jenis penelitian ini menggunakan model pengembangan ADDIE (*Analysis*, *Design*, *Development*, *Implementation*, *and Evaluation*) dengan desain penelitian *pretest* dan *posttest* yang dilakukan 30 peserta didik kelas XI SMA. Rincian hasil penelitian yang telah dilakukan di antaranya validitas LKPD berbasis aplikasi *Augmented Reality* Akar Mangrove mendapatkan persentase rata-rata 100%, Kepraktisan aplikasi *Augmented Reality* Akar Mangrove ditinjau dari angket respon peserta didik sebesar 98,74. Berdasarkan hasil penelitian tersebut dapat disimpulkan bahwa aplikasi *Augmented Reality* Akar Mangrove guna meningkatkan kemampuan berpikir spasial dikatakan layak berdasarkan validitas dan kepraktisan.
Kata Kunci: akar mangrove, *augmented reality*, layak, mangrovia, spasial,

Abstract

Augmented Reality (AR) has become an important field of research in recent years. AR is a combination of objects in the virtual world (virtual) into the real world in two-dimensional and three-dimensional forms that can be projected and operated.. The purpose of this study is to produce Mangrove Root Augmented Reality application media as an innovative and practical learning media to improve students' spatial thinking skills in terms of validity, practicality, and effectiveness, which are named MANGROVIA application media. This type of research uses the ADDIE development model (analysis, Design, Development, Implementation, and Evaluation) with a pretest and posttest research design conducted by 30 students of class XI Senior High School. The details of the research results that have been carried out include the validity of the Augmented Reality application of Mangrove Roots getting an average percentage of 100%, the practicality of the Augmented Reality application of Mangrove Roots in terms of student response questionnaires of 98,74. Based on the results of this study it can be concluded that the application of Augmented Reality Mangrove Roots to improve spatial thinking skills is said to be feasible based on validity and practicality.
Keywords: *augmented reality, feasibility, mangrove root, mangrovia, spatial*

INTRODUCTION

Augmented Reality (AR) has become an important field of research in recent years. AR is a combination of objects in the virtual world (virtual) into the real world in two-dimensional and three-dimensional forms that can be projected and operated. AR provides great opportunities in science and engineering because these disciplines emphasize practical training in real time (Saputra & Fajriani, 2021). With AR techniques, a person can get the sensation of exploring and learning in a different and unique way because he is directly involved in it. By integrating virtual information into the user's environment, augmented reality attempts to make things easier for users (Usada, 2014). User perception and interaction with the real environment are improved with AR. The technique of how augmented reality functions using a webcam and a computer is described in the sections that follow the media.

The use of AR itself has entertaining elements that can increase students' interest in learning and playing, as well as real-world projections that involve the interaction

of all five senses of students with technology. Learning media with AR is very helpful in enhancing the learning process and students' interest in learning such AR. This is due to the fact that AR possesses traits and capabilities that are essentially identical to those of learning media, including functioning to convey knowledge exchanged between senders and recipients, or between teachers and students, clarify how knowledge is delivered during the learning process and can stimulate interest and motivation learning.

Spatial thinking is a cognitive set, including elements of space, tools, and thought processes or considerations (National Research Council, 2006). Spatial abilities form mental abilities in forming and manipulating visualized objects in analyzing objects or objects related to a three-dimensional perspective (Putra, 2015). Spatial thinking is the main characteristic in the process of practice and theory associated with biology learning activities (Huynh et al, 2009).

Especially for material on the structure and function of plant tissue, there are still very few media that present material in an interesting way, especially regarding the structure and function of mangrove plant tissue. Based on the observations that have been made, the younger generation (students) still do not understand mangroves. This is also due to the absence of media that explains the material structure and function of mangrove plant tissues, especially the mangrove roots. From a physiological point of view, mangrove plants that stand out are plants that can grow and are resistant to salt-containing soil and stagnant sea water, so they are known as halophytes. Based on the results of observations of the ability of mangrove plants to adapt, namely the morphology of the varied mangrove root systems, they can function as breathing apparatus. The types of mangrove roots are hanging roots, respiratory roots, knee roots, plank roots, and buttress roots. The strong roots of mangroves have the ability to withstand the effects of waves, retain mud, and protect the coast from erosion, tidal waves, and hurricanes. 2D structure of plant tissue, and depict plant tissue structure from various perspectives. The test results on the ability to think spatially showed that students had difficulty abstracting the 3D structure of plant tissue.

Spatial Thinking is higher-order thinking that involves various cognitive processes in solving spatial problems, such as managing, changing, creating new points of view or perspectives, and analyzing data, especially for large and complex data sets. Spatial thinking instruments are developed based on cognitive processes in spatial thinking, namely: (1) producing representations; (2) maintaining and managing representations in working memory; (3) scanning representations in working memory; and (4) performing representational transformation (Kosslyn, 1978). Research conducted by (Lazarowitz & Naim, 2013; Suprapto, 2012; Guillot et al., 2006; Hoyek et al., 2009; and Hoyek et al., 2014) shows that research is not only focused on how to frame (framing) cognitive processes in spatial thinking, but more on spatial abilities, and the role of spatial visualization in increasing the understanding of the concept of an object.

The application of the spatial thinking ability test is used at the high school level through a spatial thinking ability test (Oktavianto, 2017). Measuring students' spatial thinking abilities requires instruments in the form of tests that are able to measure in detail the abilities possessed at the high school level (Aliman et al, 2020). Spatial thinking tests that focus on images do not yet exist. Although many tests are about spatial thinking, most are just spatial visualization tests. (Lee, et al., 2009). A spatial thinking test based on plant morphology needs to be developed. This test is needed to measure the relationship between knowledge and skills in spatial thinking in biology. Multiple representation skills through students' knowledge and skills are the key to successful problem solving (Hwang, et al., 2007). Biology lessons are expected to focus on spatial thinking which is closely related to the morphology of mangrove roots to analyze spatial aspects. The creativity of students in using various options for their skills will be trained in a spatial thinking ability test.

Based on this information, the author tries to link the relationship between the development of Student Worksheet based on Mangrove Augmented Reality (AR) applications to improve spatial thinking for high school students which is analyzed regarding the validity and practicality of the learning media developed.

METHOD

Research design

The product produced in this study is an Augmented Reality Application "Development of Mangrove Root Augmented Reality (AR) Applications to Increase the Level of Spatial Thinking for High School Students". Many development models can be used, one of which is the ADDIE development model developed by Dick and Carey (1996) to design learning systems (Endang, 2013).

Figure 1. The stages of the ADDIE model

1. *Analysis*, namely conducting a needs analysis. Identifying problems, identifying products that are in line with the goals, thinking about the products to be developed.
2. *Design*, the design stage is the stage of designing the product concept to be developed.
3. *Development* is the process of making the design a reality.
4. *Implementation*, implementation is product testing as a concrete step to implement the product we are making.
5. *Evaluation*, namely the process to see whether the product made is successful, in accordance with initial expectations or not.

Research Subject

The target of this research is the Augmented Reality Application of Mangrove Roots. The test subjects were conducted on class XI Mathematic and Natural Sciences students at Ma'arif Bangkalan Senior High School and Indonesia School of Jeddah at the high school level.

Data Collection Technique

To obtain information and data in this study, data collection techniques were used as follows: interviews, observations, and questionnaires to respondents. Observations and interviews aim to obtain the information needed for needs analysis on the media being developed. The distribution of questionnaires is useful for knowing the assessments of media experts, the media and students on the products made.

Validation Method

Validation was carried out by providing validation sheets for the Mangrove Root Augmented Reality Application to three validators namely, material expert lecturers, education expert lecturers, and biology teachers. Application validation is carried out before being tested on students. The results of the review are used as a reference for revising and evaluating the applications developed. This method is used to determine the feasibility of applications that have been developed.

Questionnaire Method

The questionnaire method was carried out to assess empirical feasibility in the form of the practicality of the Mangrove Root Augmented Reality Application based on the responses of teachers and students. This method is carried out by distributing questionnaires containing questions about the feasibility of the application. Response questionnaires were given to 20 students at Ma'arif Bangkalan Senior High School and 10 students at the Indonesian School of Jeddah at the Senior High School level.

Data analysis technique

Analysis of the Validity of Mangrove Root Augmented Reality Applications

The measuring tool used in this study is a questionnaire with a scale of measurement used is the Likert scale. According to Sudaryono (2013), the Likert Scale is used to measure attitudes, opinions and perceptions of a person or group about events or social phenomena.

Table 1. Rules for Score Instruments of Media Experts and Material Experts

Percentage Range (%)	Category
0-25	Impractical
26-50	Less practical
51-70	Quite Practical
71-85	Practical
86-100	Very practical

The description of product eligibility by looking at the weight of each response and calculating the average

$$(\%)\ X = \frac{\Sigma X}{N} \times 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

score is by using the following formula:

Information:

X = Average score validity
ΣX = Total Score Respectively
N = Number of Validator

Assessment of each aspect of the product developed uses a Likert Scale, where the product can be said to be feasible if the average of each assessment at least gets

$$(\%)\ P = \frac{F}{N} \times 100\% \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

good criteria using calculations according to Sudjana (2001: 51) as follows:

Information:
P = Percentage
F = Score obtained
N = Maximum score

Additionally, percentage numbers are used to explain the outcomes of data processing using the percentage formula. There are 5 sections with extremely small differences in the percentage distribution on the category criteria feasible.

categories (> 80% -100%), appropriate (> 60% -80%), less feasible (> 40 %-80%), not feasible (> 20%-40%) and not very feasible (0%-20%) with the distribution of each percentage of 20%. The division of eligibility categories is in Table 2.

Table 2. Categorization of Data Processing Results

Assessment	information	Score
A	Agree	4
QA	Quite Agree	3
DS	Disagree	2
DA	Don't agree	1

Analysis of Student Response Questionnaires and the Practicality of Application Use

The results of students' responses to the Mangrove Root Augmented Reality Application were stated with the answers "yes" or "no". The questionnaire compiled by the researcher refers to the Guttman scale which is stated in the form of a question. The response data is calculated based on Table 3

Answer	Score
Yes	1
No	0

$$\text{Percentage of each aspect} = \frac{\Sigma\text{Answered "Yes"}}{\Sigma\text{Student}} \text{ x } 100\% \ldots (3)$$

Table 3. *Guttman* Scale Criteria

Analysis of student response data is presented in percentages for each aspect of the assessment which is calculated by the formula:

After knowing the percentage of each aspect, it is interpreted according to the table of students' response interpretation criteria to determine the level of practicality of the Student Worksheet Augmented Reality Application of Mangrove Roots Table 4.

Table 4. Student Response Interpretation Criteria

Percentage	Category
>80% - 100%	Very Good
>60% - 80%	Good
>40% - 60%	Less Good
>20% - 40%	Poor
0% - 20%	Very Poor

RESULT AND DISCUSSION

The research that has been carried out by researchers in development research to create Augmented Reality applications by combining spatial thinking indicators and material structures and plant tissues with the topic of mangrove roots in class XI Senior High School which is named MANGROVIA in terms of product practicality and effectiveness. The details of this research data are presented in the results below:

Profile of Mangrove Root Augmented Reality Application

The Mangrove Root Augmented Reality application produced in this study has been adapted to indicators to improve spatial thinking skills according to the results of Wahyuni and Amalia's research (2020), namely indicators of spatial ability, spatial visualization, and framing. The description of the resulting Mangrove Root Augmented Reality application device will be explained in detail as follows.

Figure 2. AR Camera

AR Camera is an Augmented Reality device that functions as a tool to scan markers to present the 3D shape of the marker. AR Camera is included in the application and can be installed on an Android Smartphone.

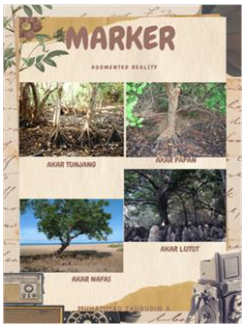

Figure 3. Mangrove Root Augmented Reality Marker

The marker is a device for Augmented Reality Mangrove Roots which functions as a planar which contains an image where the planar will be scanned or scanned by the AR Camera and from the planar it will bring up a 3D Object the planar image in the form of a Mangrove Root 3D Object.

Figure 4. Mangrove Root Augmented Reality Guide

The guide is a Mangrove Root Augmented Reality tool which consists of a cover, an application installs guide and markers from Augmented Reality Mangrove Roots.

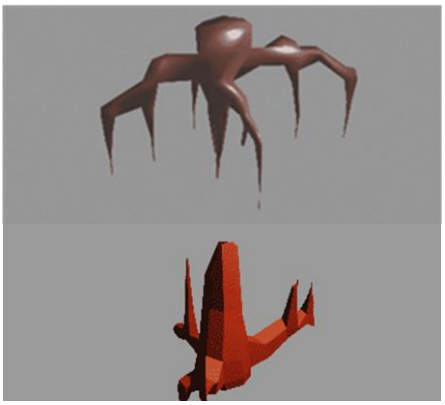

Figure 5. Mangrove Roots Augmented Reality 3D Object

3D Object is a tool for Augmented Reality Mangrove Roots which is visualized in the form of a 3D model of mangrove roots. This 3D object consists of 4 3D models, namely the 3D model of the abutment root, 3D models of the breath root, 3D model of the root of the board and 3D model of the root of the knee.

Figure 6. Mangrove Root Augmented Reality Application

The application is a device for Mangrove Root Augmented Reality which contains features for accessing the AR Camera along with the appearance of a description of each scanned 3D model complete with a description and root name.

Student Worksheet Based Application Validation Results of Mangrove Roots Augmented Reality

The Student Worksheet Based on Mangrove Root Augmented Reality application that has been developed is validated by lecturers of media experts and material experts, as well as biology teachers. The results of the validation of all validators regarding the application of Mangrove Root Augmented Reality obtained an average percentage of components that were assessed as very good categories. The details of the assessment are in the following table.

Based on the validation results by the validator in Table 5. The Student Worksheet Based on Mangrove Root Augmented Reality application that was developed obtained a percentage value from validating all criteria of 100% with a very good category. The assessment consists of seven aspects including material relevance, material organization, use of terms, use of language, spatial thinking skills, student worksheet display quality, layout quality, quality of presentation support. The media eligibility criteria (Hutagaol, 2019) explain that if the validity value interval based on several assessment criteria for a media gets an interval value of 80 ≤ 100, then the media is classified as very good media (Sumarni et al., 2022).

Table 5. Data from the validation results of the Student Worksheet Based on Mangrove Root Augmented Reality Application

No.	Criteria	Average %	Category
1.	Material Relevance	100	Very good
2.	Material Organizing	100	Very good
3.	Use of Terms	100	Very good
4.	Language Use	100	Very good
5.	Spatial Thinking Skills	100	Very good
6.	Student Worksheet Display Quality	100	Very good
7.	Layout Quality	100	Very good
8.	Quality of Presentation Support	100	Very good
Percentage%		100	Very good

Media that is presented well will attract the attention of students, make the learning atmosphere in the classroom feel fun, and create a new atmosphere so that students' motivation in learning increases. This increase will have an impact on the enthusiasm of students in participating in a series of activities in the classroom that make learning material more memorable. Memorable learning will make it easier for students to understand the material being taught (Baharuddin, 2020).

Learning media that contains questions adapted to indicators of spatial ability, spatial visualization, and framing can train students' spatial thinking skills (Intan et al., 2020). Media content that uses language and sentences that are well structured according to the level of thinking of students will be more easily understood by students (Rahmawati et al., 2021).

Practical results of Student Worksheet Based on Augmented Reality Application of Mangrove Roots

Student response questionnaire data were obtained using questionnaires filled out by students regarding responses to the Student Worksheet Based on Mangrove Root Augmented Reality application developed by researchers. This sheet lists the components reviewed by students after using the Student Worksheet based on Mangrove Root Augmented Reality application media. In detail, the responses of students will be presented in the table below.

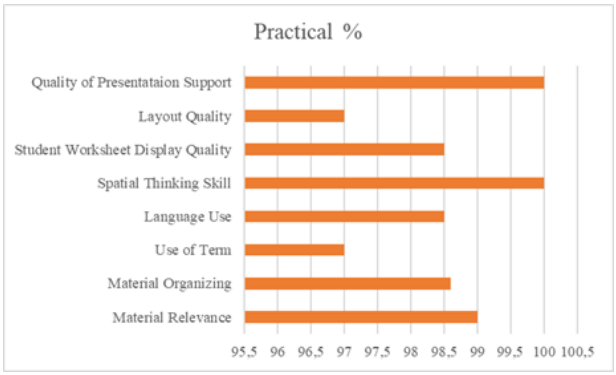

Figure 7. Results of Student Response Questionnaire Analysis

Based on the figure above, students responded positively to the Student Worksheet based on Mangrove Root Augmented Reality application media that was developed. The results of calculating students' positive responses based on choosing the answer "Yes" to each component in the response questionnaire obtained an average percentage of 98.74% in the very good category. The practicality of learning media that gets positive responses has a good impact on improving students' spatial thinking skills (Putri et al., 2021).

CLOSING

Conclusion

Based on research on the development of Student Worksheet Based on Augmented Reality Mangrove Roots it can be declared valid with an average percentage of 100% very good category, practicality in terms of student response questionnaires getting an average percentage of 98.74% with a very good category, and effectiveness in terms of N-gain results score 0.61 medium category. Based on the data above, the Mangrove root Augmented Reality application is said to be suitable for use in learning for class XI high school students.

Suggestion

It is necessary to use the Augmented Reality application. Mangrove roots are used regularly to maximize the results of increasing learning motivation and spatial thinking skills possessed by students. The Mangrove Root Augmented Reality application media is limited to material structure and function of plant tissue on the topic of mangrove roots so that it can still be developed on other learning materials.

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