PROCEEDINGS OF INTERNATIONAL CONFERENCE ON EDUCATION
TEACHER TRAINING & EDUCATION FACULTY
UNIVERSITAS SERAMBI MEKKAH
NO. ISSN 2987-4564

# AUGMENTED REALITY BASED ON PROBLEM SOLVING FRAMEWORK TO SCIENTIFIC EXPLANATION ABILITY: VALIDITY AND PRACTICALITY

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## ABSTRACT
The scientific explanation is the ability to express or write scientific explanations. So, developing Augmented Reality media based on the Problem Solving Framework can affect the Scientific Explanation ability of students. This study aims to determine the validity and practicality of Augmented Reality media based on the Problem-Solving Framework to improve students' Scientific Explanation skills. The type of research used is research and development with ADDIE (Analysis, Design, Development, Implementation, Evaluation) model research procedures. Material experts of the Human Circulation System, question development experts, and learning media development experts at the development stage carry out the validity test. Biology teachers and students assess practicality tests through limited trials at the development stage. Based on the analysis of validity test data, an average material validity test was obtained at 94.6% and a media validity test at 94.75%. The teacher's practicality test got a score of 100%, and the student practicality test was 73.30%. Based on the validity and practicality test of Augmented Reality Media based on problem-solving frameworks, it is declared feasible to be used for further research.

Keywords: *Scientific Explanation, Augmented Reality, Problem Solving*

## 1. INTRODUCTION
The current learning requires students to have scientific abilities (Talib et al., 2018). The ability to explain scientifically is a skill that must be possessed by students because it can advanece their future potentials (Jacquart et al., 2016). The scientific explanation requires students to understand statements, explore problems, provide evaluations of problems, and improve misstatements (McNeill & Krajcik, 2011). A person's ability to write or express scientific explanations is called a scientific explanation (McNeill & Krajcik, 2009)(McNeill & Krajcik, 2009)(McNeill & Krajcik, 2009)(McNeill & Krajcik, 2009).

An event can be explained scientifically by writing down the event, the reason for its occurrence, and the process of its affair (Osborne & Patterson, 2011). Three indicators in scientific explanation are claim, evidence, and reasoning (McNeill & Krajcik, 2011). A claim is an idea or hypothesis obtained from an observation of an event that is happening (Kaya et al., 2012). Evidence is obtained from data collected to defend claims made (Tama et al., 2016). Reasoning is used to link the evidence possessed with the ideas made (Tama et al., 2016).

Based on PISA scores in 2018, Indonesia occupies the low category for science (OECD, 2019). Indonesian students' average science ability score is 389, with an OECD average score of 489. Indonesian students who can reach level 2 in science ability are approximately 40%, while the OECD average is 78%. Level 2 on scientific ability includes explaining phenomena scientifically, being able to identify, and making conclusions based on data (OECD, 2019). The PISA results prove that most Indonesian students cannot write scientific explanations.

In the initial observations made by researchers to teachers and students, it was found that some teachers did not know the scientific explanation indicators. Teachers still use power point-based learning media and 2D images. As well as the lack of student response in learning affects the understanding they have.

## 2. LITERATURE REVIEW
Scientific explanation skills can be improved by involving active students in education (Hitchcock, 2017). (Hitchcock, 2017). (Hitchcock, 2017). (Hitchcock, 2017). In abstract learning materials, actively engaging students is difficult to achieve (Blikstein & Worsley, 2016). Scientific activities such as observing and analyzing can encourage students to be actively involved in learning abstract material (Park et al., 2018). Observing and analyzing are activities included in problem-solving (Park et al., 2018).

The problem-solving framework has four stages: identifying problems, analyzing the information provided, understanding what is needed to be solved, suggesting problem-solving initiatives, evaluating the solutions obtained, and critically reflecting on the solutions obtained (Alkhatib, 2019). Problem-solving framework is a process to get solutions (Hesse et al., 2015). In addition, problem-solving frameworks can help recognize abilities, solve problems through thinking, and take responsibility for choices (Chin & Wang, 2021). Problem-solving frameworks can help students achieve scientific explanations (Hoffman et al., 2016).

Augmented Reality is a technology that combines reality and virtuality to describe an object (Akçayır & Akçayır, 2017). Augmented Reality provides real-life visualization of organs to facilitate theoretical concepts in the abstract matter (Abdinejad et al., 2020). Augmented Reality-based 3D media makes it easier for students to explain phenomena (Kholiq, 2020).

Augmented Reality-based 3D learning media with a problem-solving framework on abstract material can improve students' scientific explanation skills (Nikolai et al., 2019). From the background of the problem and the results of preliminary observations, the researcher developed Augmented Reality learning media based on Problem Solving of Human Circulation System material to improve the ability of Scientific Explanation in students.

# 3. METHODS

This research is development research using Branch's ADDIE model (2009). The ADDIE model consists of five stages: analysis, design, development, implementation, and evaluation (Branch, 2009). The first analysis stage involves preliminary observations, interviews, and literature reviews. The second stage is design, to verify the desired performance and the appropriate test method. The next step is to develop, produce and validate Augmented Reality media based on problem-solving frameworks.

The validity test on quantitative data begins with changing quantitative data in percentages. The results of the percentage calculation of all components are analyzed descriptively. The validity test categories can be seen in Table 1.

**Table 1. Validity Test Categories**

| Level of achievement (%) | Qualification | Information |
|---|---|---|
| 81 – 100 | Excellent | No need to revise |
| 61 – 80 | Good | No need to revise |
| 41 - 60 | Enough | Revision |
| 21 - 40 | Not Good Enough | Revision |
| 0 - 20 | Very Less | Revision |

Source: (Suwastono, 2011)

Material experts and media experts carry out the validity test. Material expert validators are selected based on their capacity as lecturers who are experts in the material of the human circulation system. The aspects assessed in the validity test of the material expert can be seen in Table 2.

**Table 2. Aspects of Material Expert Validity Test**

| Aspects of Media Expert Validity Test | |
|---|---|
| 1. | Correctness of the content of the material |
| 2. | Free from misconceptions |
| 3. | Current material |
| 4. | Scope and depth of the matter |
| 5. | Reference adequacy |

The validity test of media is carried out by lecturers who teach courses in the innovation and technology of Biology learning media. The aspects assessed in the validity test to media experts can be seen in Table 3.

**Table 3. Aspects of Media Expert Validity Test**

| Aspects of Media Expert Validity Test | |
|---|---|
| 1. | Product determination |
| 2. | Product design |
| 3. | Implementation |
| 4. | Experiment |
| 5. | Material |
| 6. | Learning design |
| 7. | Learning media and communication |
| 8. | Implementation power and user responsiveness |

The Practicality Test in this study is aimed at teachers and students as a response to the development of Augmented Reality media based on problem-solving frameworks. Two biology teachers conducted the teacher's practicality test. The aspects assessed in the teacher practicality test can be seen in Table 4.

**Table 4. Aspects of Teacher Practicality Test**

| Aspects of Teacher Practicality Test | |
|---|---|
| 1. | Ease of Use |
| 2. | The level of interest and motivation of students |
| 3. | Individual learning and teacher aids |
| 4. | The degree of likelihood encourages critical thinking and problem-solving skills |
| 5. | The degree of contextuality with application in real life |

A limited trial of students was conducted by a small group of students who piloted Augmented Reality media based on a problem-solving framework. The aspects assessed in the student practicality test can be seen in Table 5.

**Table 5. Aspects of Student Practicality Test**

| Aspects of Student Practicality Test | |
|---|---|
| 1. | Ease of Use |
| 2. | Media display |
| 3. | Increased enthusiasm for learning and curiosity |
| 4. | Motivation |
| 5. | Completeness of the material |
| 6. | Delivery of materials related to daily life |
| 7. | Discussion |
| 8. | Illustration |
| 9. | Make understanding easier |
| 10. | Language |
| 11. | Term |
| 12. | Train scientific explanation |
| 13. | Present the problem in case form |

# 4. RESULTS & DISCUSSION

## 4.1 Analysis

Based on the gap validation analysis results through the literature review, PISA results show that most Indonesian students cannot write scientific explanations. The fact that it has been found through several similar studies shows that the level of scientific explanation is low, and student reasoning can still not provide objective

evidence of natural phenomena that reinforce claims (Duncan et al., 2018). Indonesian students only achieve approximately 40% of the average 78% at level 2 of the ability to explain phenomena scientifically. Identifying and making conclusions based on data is still classified as low criteria. In the early stage observations, the teacher stated that the ability to provide scientific explanations on the grounds is an ability that students must have.

The results of interviews with teachers and students found that teachers still use 2D media that integrates images or videos through power points to provide material to students. Students respond less to learning due to the lack of understanding gained from the teacher's explanation. Innovation in teaching media is needed so that biology learning resources are not only limited to module books; students still need other learning resources. Augmented Reality media is based on a problem-solving framework developed as an application that allows students to access primary and additional resources simultaneously.

## 4.2 Design

Based on the initial needs analysis, researchers developed Augmented Reality media based on the Problem-Solving Framework. Media Augmented Reality based on Problem Solving Framework aims to improve students' Scientific Explanation skills. The material contained in the media includes material on the Circulation System in Humans.

Development is carried out using product carried out using tools in the form of software and hardware. The software used is Visual Studio Code version 1.167.1, Unity version 1.18, Corel Draw version X7, and Blender version 2.7. The hardware used is a laptop with an Intel Core i5 5th Gen CPU @ 1.60 GHz 2.30 GHz processor, 4GB RAM and an Android Smartphone and IOS.

Problem-solving framework-based Augmented Reality media teaching media comprises cover pages, menus, competencies, materials, Augmented Reality features, 3D animation, games, videos, and evaluations. The cover page contains the title of the application and several button features that can be used in the application in Figure 1.


**Figure 1. Home Page**

The menu page contains menus that can be accessed through the application. There are menus of Competencies, Materials, AR, Animation, Games and Videos. The menu page can be seen in Figure 2. The competency page contains an explanation of the core competencies and basic competencies according to the 2013 curriculum. The competency page can be seen in Figure 3.


**Figure 2. Menu Page**


**Figure 3. Competency Page**

The material page contains the subject matter of the human circulation system that has been adapted to the 2013 Curriculum. The material page can be seen in Figure 4. The feature's Augmented Reality page contains a camera app that can be used to highlight images that can turn into AR-based 3D images. The Augmented Reality feature page can be seen in Figure 5.

**Figure 4. Material Page**

**Figure 5. Augmented Reality Fiture page**

The 3D animation page contains 3-dimensional images relating to the material of the human circulation system. The 3D animation page can be seen in Figure 6. The game page contains puzzle-shaped games that students can use to find solutions to problems in evaluation questions. The game page can be seen in Figure 7.

**Figure 6. 3D Animation Page**

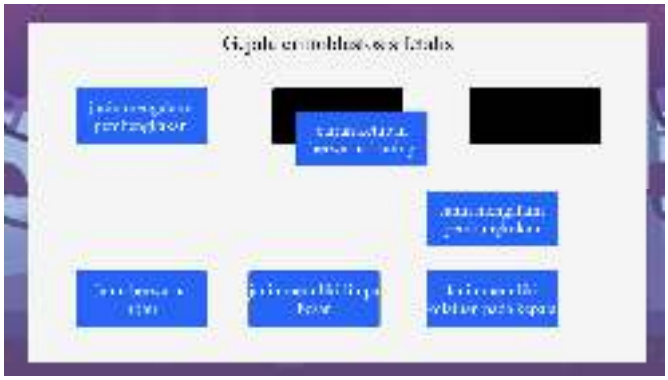

**Figure 7. Game Page**

The video page contains a summary of some of the material presented in the video to make it easier for students to understand. The video page can be seen in Figure 8. The evaluation page contains problem-based questions that are presented following human circulation material, and evaluation questions are expected to train students in analyzing problems. The evaluation page can be seen in Figure 9.

**Figure 8. Video Topic Page**

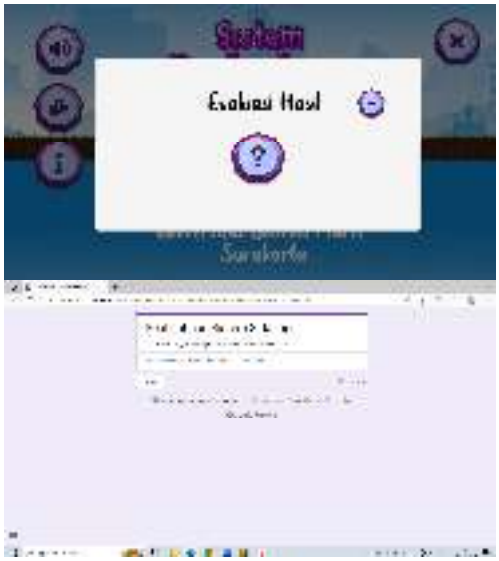

**Figure 9. Evaluation Page**

## 4.3 Development

The validity test of material experts is carried out on five aspects: the correctness of the material content, free from conceptual errors, the current material, the scope and depth of the material, and the adequacy of references. Material expert validators are selected based on their capacity as lecturers who are experts in the material of the human circulation system. The results of the media validity test can be seen in figure 10.

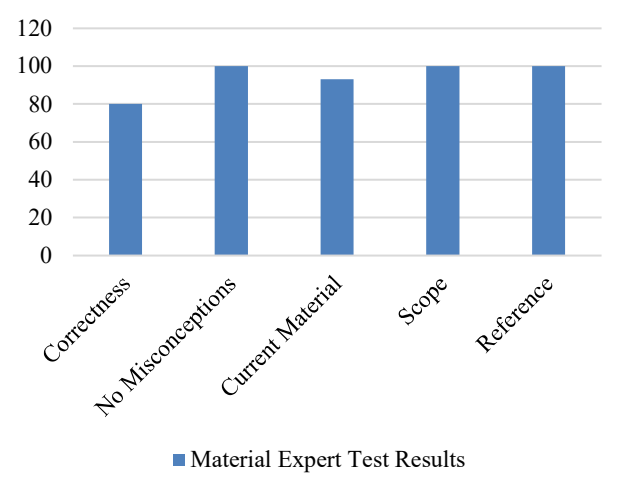


**Figure 10. Material Expert Test Results**

The material validity test is carried out by one expert in their field, namely a lecturer who teaches courses in zoology, anatomy, and animal physiology. Based on the material validity test results above, Augmented Reality teaching media based on the problem-solving framework obtained an average test value of 94.6%, which is included in the excellent category.

The validity test of media experts is carried out on eight aspects: product determination, product design, implementation, experiments, materials, learning design, learning media and communication learning, and user response implementation power. The results of the media validity test can be seen in Figure 11.

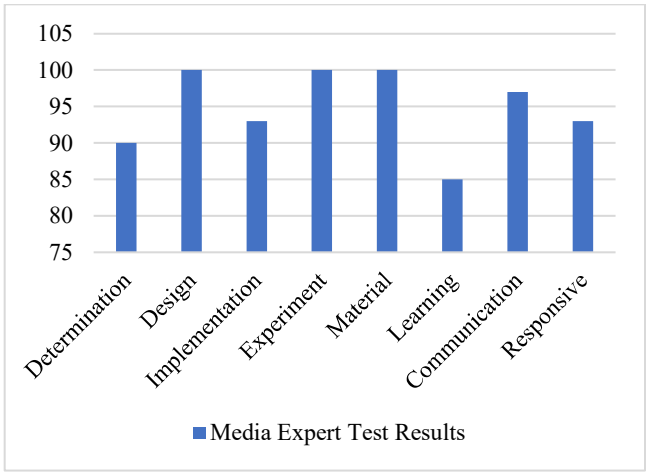


**Figure 11. Media Expert Test Results**

The validity test of media is carried out by lecturers who teach courses in the innovation and technology of Biology learning media. Based on the media expert assessment results, an average value of 94.75% was obtained, which is included in the excellent category.

The teacher's practicality test consists of five aspects, namely ease of use, the level of student interest and motivation, the teacher's learning and aids, the degree of likelihood of encouraging critical thinking and problem-solving skills, and the level of contextuality with application in real life. Two biology teachers conducted the teacher's practicality test. The results of the teacher's practicality test can be seen in Figure 12.

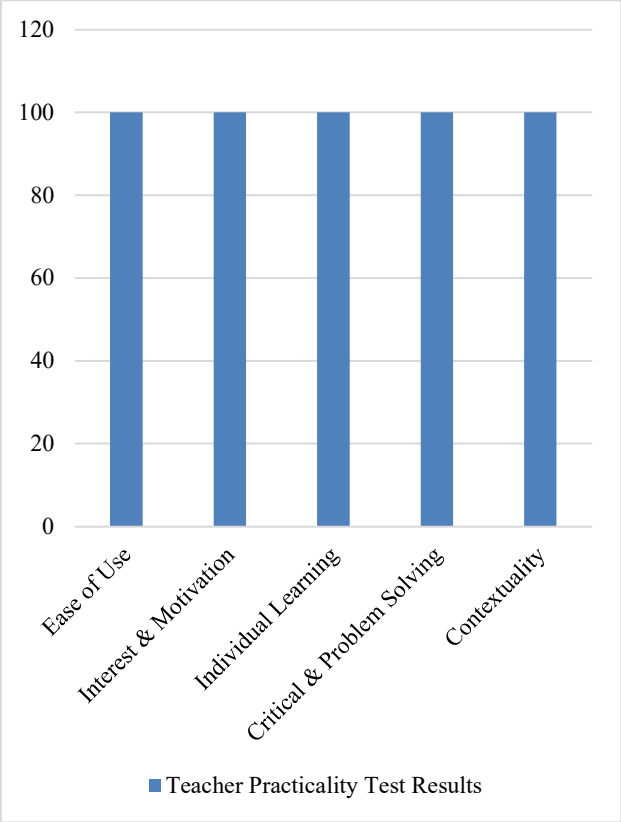


**Figure 12. Teacher Practicality Test Results**

The appointed education practitioner expert in this study is a class XI biology teacher. Based on the expert assessment of education practitioners, the average score of the practicality test by teachers was obtained at 100%, which was included in the excellent category.

Limited student trials were carried out on aspects of ease of use, media display, improvement of learning and curiosity, motivation, completeness of the material, delivery of material related to daily life, discussions, illustrations, facilitating understanding, language, terms, training scientific explanations and presenting questions in the form of cases. The limited trial of students was conducted by a small group of students who piloted a problem-solving framework-based AR media development product. The results of the practicality test can be seen in Figure 13.

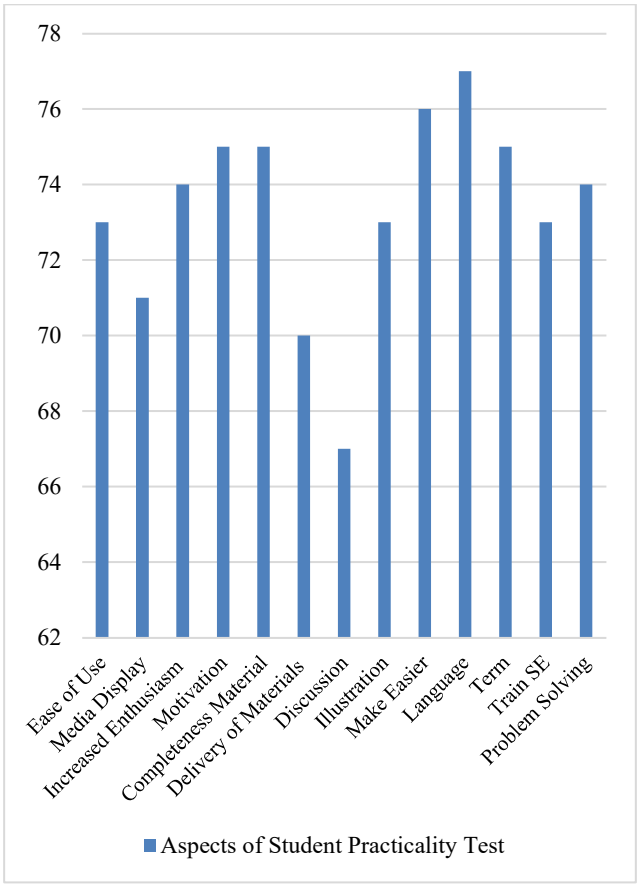


**Figure 13. Student Practicality Test Results**

The test was limited to 30 students of class XI. The results of the student trial obtained an average score of 73.30% which was included in the good category.

The results of the validity and practicality tests that have been carried out obtain a very decent category average. From the results of the validity and practicality test declared valid and practical, the problem-solving framework-based Augmented Reality media can be used as teaching material.

## 5. CONCLUSION,

The validity test for Augmented Reality media based on the problem-solving framework of the Human Circulation System Material got an average of 94.6%, contact a media validity test got an average of 94.75%. The practicality test conducted by teachers earned an average of 100% and by students by 73.30%. Based on the validity and practicality tests that have been carried out, Augmented Reality media products based on problem-solving frameworks on Human Circulation System Materials to improve Scientific explanations in students are feasible for further research.

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