

## Utilizing Android-Based Augmented Reality Assessment to Improve Student's 4C Capabilities in the 21<sup>st</sup> Century

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### ABSTRACT

*The development of technology and science also has an impact on the development of learning media. The evaluation media is no exception, which is one of the complementary learning tools. Continuing previous research in the development of Augmented Reality-based learning media, this study aims to design an android-based assessment tool using Augmented Reality which was later called Augmented Reality Assessment (ARA). ARA is designed as an assessment medium to improve 21st century skills, namely 4C (Critical thinking, Creative thinking, Communication and Collaboration). This application was created as an effort to answer the demands of technological advances and online learning during the pandemic. In addition, to increase the creativity of researchers in developing evaluation media. From 32 respondents, 100% of students felt that augmented reality was needed during the online process. 93.75% of students answered that the application was practical to use. The use of the ARA application as a learning medium is also easy to apply in learning. Because  $t_1 > t_2$  then reject  $H_0$  so that the average student learning outcome test using Mobile-based ARA is more than the average learning outcome test not using Mobile-based ARA) which answers that ARA is effective for improving students' 4C skills.*

**Key Word :** Augmented Reality, 21<sup>st</sup> century skills, Assessment

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### PRELIMINARY

The world of education has now entered the 21st century which is a shift from the industrial revolution 4.0 slowly leading to the era of society 5.0 which provides a description where the concept of society is human-centered and technology is expected to create new value and solve social problems through advanced technology. Changing perspectives The 21st century has also changed the perspective of 21st-century education. 21st-century education is not just a teaching concept, but is far more essential, namely a change in perspective on the concept of education itself [1]. therefore the world of education requires greater input to adjust technology intake. This is because education has an important role in determining the progress of the nation.

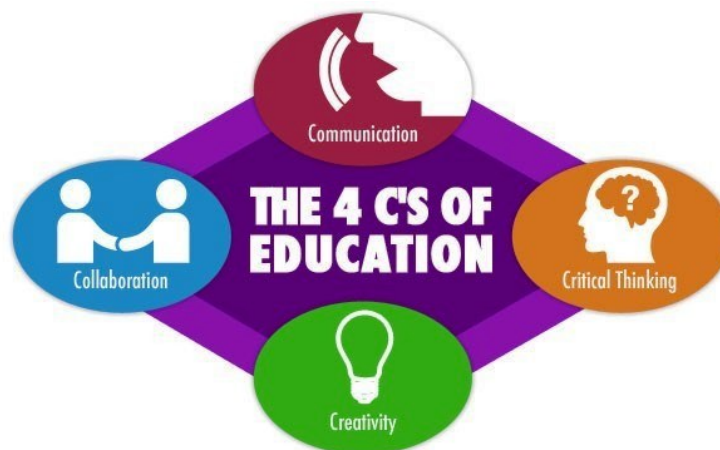
Education is the main means of improving the quality of a country's human resources. Indirectly educational technology has a role in improving the quality of human resources individually and also in organizations [2]. Quality education will produce quality human resources as well as the competitiveness. The more advanced the quality of education, the smarter the people, and the more advanced the country will be [3].

Universities have an important role in preparing human resources, namely by increasing the competence of graduates who have skills according to the 21st century (*Learning and innovation skill 0* in addition to mastering science and technology under the fields they are involved in.) create a 21st-century learning framework where students are expected to have 4c skills, namely *critical thinking, communication, collaboration, and creativity*. It is explained that this P21 document was first introduced in 2002 as a conclusion from the input received from teachers, education experts, and business leaders in the U.S. This clearly describes the skills, knowledge, and expertise that 21st-century students must possess to succeed in the job market and life. Therefore, it can be said that 4c skills are soft skills mastery whose daily implementation is more meaningful than mastering hard skills[5]. The framework for 21st-century learning competencies was proposed by the Partnership for 21st-Century Learning (P21) in 2009.



**Figure 1.** 21st Century Competency Framework

Every individual must have thinking skills starting from the simplest to the highest level. Critical thinking abilities include basic clarification skills, basic decision-making, conclusions, providing further explanations, estimation, and integration, as well as additional abilities [6]. Critical thinking is the ability to systematically evaluate the weight of personal opinions and the opinions of others [7]. In simple terms, critical thinking is a process in which a person receives information, makes logical and rational judgments, and makes decisions about that information.



**Figure 2.** 4C Skills

The US-based Partnership for 21st Century Skills (P21) suggests that the competencies that human resources must possess in the 21st century are: critical thinking skills (Critical Thinking Skills), creative thinking skills (Creative Thinking Skills), communication skills (Communication Skills), and collaboration skills (Collaboration Skills) [8].

Critical thinking skills (Critical Thinking Skills) are thinking skills to solve problems or skills in making decisions on the problems at hand. In addition, critical thinking skills include the ability to distinguish truth or lies, facts or opinions, or fiction and non-fiction [8].

Creative thinking skills (Creative Thinking Skills) are the ability to create new ideas or ideas that are different from those that already exist. Creativity is the ability to develop (create) new ideas and ways that are different from before. While creativity is a person's ability to create new things, either in the form of ideas or works. Creativity or creativity can have a positive impact on everyone and the community. Creativity and innovation are the ability to create something new, either an idea or a work [9].

Communication skills are skills to convey new thoughts, ideas, knowledge, and information to others through oral, written, symbols, pictures, graphics, or numbers. These skills include listening skills, obtaining data or information, and conveying ideas in front of many people [4].

Collaboration skills are skills to work together, synergize with each other, adapt to various roles and responsibilities, and respect differences [8]. Assessment can be defined as a process for making decisions using information obtained through measuring learning outcomes, both using test, and non-test instruments. Augmented reality is a technology that combines 2D or 3D virtual objects in a real 3D environment and then projects these virtual objects in real time. Unlike Virtual Reality (VR) which adds real objects to virtual objects, Augmented Reality (AR) is adding virtual objects to real objects at the same time. Augmented Reality was first used in 1957-1962 by a cinematographer named Norton Heilig, who was named Sensorama [10]. Sensorama is a simulator that can simulate visuals, vibrations, and smells.

The purpose of implementing *augmented reality* is to enrich the user experience and assist the user's perception and interaction with the real world. The function possessed by the application is that it can detect images in books and carry out these functions on the device, some of which are simulating questions in books and simulating tutorial material contained in books [3].

By using *Augmented Reality* as an alternative learning media, it is hoped that a learning activity can be more interesting for students. Another benefit obtained is a more advanced learning media by utilizing current technological developments. *Augmented Reality* can be one solution to overcome the module

To achieve the objectives of this study, the analysis was guided by three questions, namely:

- a. What is the feasibility of mobile-based *Augmented Reality Assessment* (ARA) to improve students' 4C abilities?
- b. What is the practicality of mobile-based *Augmented Reality Assessment* (ARA) to improve students' 4C abilities?
- c. How effective is the mobile-based *Augmented Reality Assessment* (ARA) in improving students' 4C abilities?

## RESEARCH METHODS

Based on the formulation of the problem and the research objectives that have been set, this research includes development research (*Developmental Research*). This development research was carried out to produce the necessary Android-based *Augmented Reality Assessment* (ARA) media. This research was carried out in the Mathematics Department of Unimed in semester g from the 20 21/2022 school year in the Differential Calculus course.

The subjects in this study were students of the Mathematics Education Department of Unimed in the first semester. The object of this study was the Android-based *Augmented Reality Assessment* (ARA) media in the form of applications that could be downloaded by students' smartphones.

This ARA design uses a qualitative descriptive approach at the research stage and the method used is a development of the ADDIE (*Analysis, Design, Develop, Implement, and Evaluate*) model developed by Reiser and Mollenda. Addie's model framework is a cyclical process that develops over time and is continuous from the entire instructional planning and implementation process.

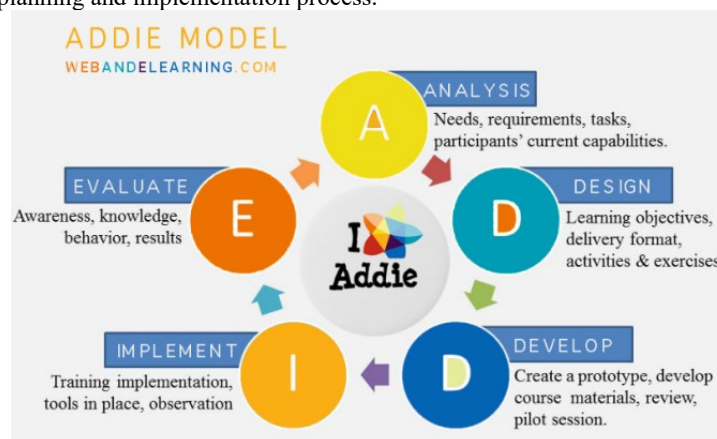


Figure 3. ADDIE Model Model

## RESULTS AND DISCUSSION

The initial results of the research that will be explained in this paper are a description of the analysis stages of the ADDIE research stage procedure. The needs analysis was carried out from initial observations during the online learning period and through questionnaires. From the observations, it was previously explained that the learning that took place was almost 2 years online. Mathematics education students in the Class of 2020/2021 who take 100% differential calculus and integral calculus courses have devices, either laptops or mobile phones, to attend lectures.

The results of the TPMJ monitoring report, it was obtained in SIPDA online learning with a percentage of 55% and then Google Classroom at 43%. While the use of applications to support virtual interaction (*video conferencing*), lecturers chose Google Meet with a percentage of 46%, Zoom with 43%, and Big Blue Button SIPDA with 9%. Finally, for non-e-learning support applications used by lecturers, the majority of lecturers use WhatsApp as much as 79%. The monitoring results show that the online learning process is strongly supported by the use of mobile phones or laptops. The evaluation process carried out so far only uses available media such as sending questions in WA, GCR, or SIPDA. From the results of the TPMJ Ma thematic monitoring, it was found that 34.33% of students stated that they were very satisfied and 46.50% of students stated that they were satisfied with the evaluation process carried out by the lecturer. However, there are still more than 15% of students stating that they are not satisfied with the process.

The results of the needs analysis using a questionnaire given to students who have taken the 2020 differential calculus course are obtained as follows:

| Analysis Questions |  |
|--------------------|--|
| 1.                 | 100% of students answered that they have Android as an online learning tool                            |
| 2.                 | 72% of students answered that they had no difficulty using LMS as an online learning medium            |
| 3.                 | 100% of students have experienced <i>Augmented Reality</i>   |
| 4.                 | 44% of students are satisfied with the online learning instrument system that has been going on so far |
| 5.                 | 84% Students want evaluation instruments that are practical and can be used anywhere                   |

**Table 1.** Analysis of Student Needs

From the results of the questionnaire analysis of students, it appears that all students have been familiar with AR as a learning medium. However, there are still a small number of students who are satisfied with the evaluation system, which so far only uses questions that are sent in the form of a word or google form and then sent back to the lecturer via SIPDA, GCR, or WA. Students expect practical evaluation instruments. Because students have been familiar with AR, the assessment media that utilizes AR is deemed able to answer the student's desire for a practical evaluation media using Android. This is supported by 100% of students who already have an android. The use of AR is supported by previous research by researchers who have developed AR media and received positive responses from students who use it.

The *Augmented Reality application* that has been completed was tested on a large-scale sample of 32 students. The results of the practical analysis of the use of mobile-based AR media were carried out using the distribution of student response questionnaires who had taken differential calculus courses and were obtained from the value of working on questions using ARA and not using ARA, obtained as follows

| Analysis Questions |   |
|--------------------|---|
| No                 |   |
| 1                  | 96.87% of students answered that the application is easy to use.  |
| 2                  | 93.75% of students answered that the application was practical to use.  |
| 3                  | 100% of students answered that the application was effectively used as a learning medium in differential calculus courses |
| 4                  | 100% of students answered that the application was useful for learning differential calculus courses                      |
| 5                  | 93.75% of students answered that the interface design of the application looks attractive and interactive                 |
| 6                  | 93.75% of students answered that the application is easy to understand (user friendly)                                    |
| 7                  | 100% of students answered that the application was in accordance with the needs of students majoring in mathematics       |
| 8                  | 93.75% of students answered that learning by using the application sparked curiosity                                      |
| 9                  | 93.75% of students answered that learning with the help of this application encourages them to find new ideas             |

**Table 2.** Practical Analysis of ARA

From the results of the analysis of the questionnaire given to students majoring in mathematics in learning integral calculus courses, it was found that the use of the application as a learning medium is a practical matter to use. This is supported by the opinion of 93.75% of students who answered that the application was practical to use. The use of the ARA application as a learning medium also easy to apply in learning. Currently, in learning, students are led to think critically in solving an existing mathematical problem. The use of this application is certainly able to support students' mathematical abilities so that they can better understand the learning. Based on the results of the previous analysis of student needs, it can be seen that it seems that all students have been familiar with AR in learning media. This is also supported by 100% of students answering that the application is effectively used as a learning medium in the differential calculus course. It is said to be a practical application, meaning that this ARA is carried out based on a practice (producing media). In addition, it is also practically said to be efficient in use due to several related reasons. ARA is practically used in learning because the application is easy to understand (user-friendly). This is obtained based on the results of the questionnaire, which 93.75% of the students had a positive response to the statement. With the interface design from ARA, it gives its interest to students, so it is feasible and practical to be used by students. The results of the analysis of student adaptation tables related to learning in the differential calculus course obtained the following data:

| Analysis Questions |  |
|--------------------|--|
| 1.                 | 78.1% of students have difficulty understanding the material in general  |
| 2.                 | 92.7% of students really have difficulty when learning by using only dictation   |
| 3.                 | 68.7% of students feel that the lecture process is not conducive   |
| 4.                 | 86.4% of students choose <i>augmented reality</i> as a tool to increase the effectiveness of understanding differential calculus |
| 5.                 | 100% of students feel that <i>augmented reality</i> is needed during the online process.   |

**Table 3.** Student Adaptation Analysis

From the results of the questionnaire analysis of students, it appears that students have problems in the online learning process by rationalizing the use of *augmented reality* as a solution to the problem. This is supported by the poll results that 100% of students feel *augmented reality* is needed during the online process. Following its use, *Augmented reality* can also maintain student engagement, because it is interesting and

challenging to interact, create, and manipulate objects in a virtual environment. The advantages of animation contained in *augmented reality learning media* make objects look clearer and more real so that students seem to see the object actually in front of them. Animations displayed in *augmented reality learning media* can be viewed for a longer time and repeatedly. Therefore, learning using *augmented reality* is considered effective to improve students' 4C skills. Given the analysis of student value data as a comparison of student scores using ARA and not using ARA:

$H_0 : \mu_1 \leq \mu_2$  (the average student learning outcomes by using Mobile-based ARA is less than the same as the average student learning outcomes by not using Mobile-based ARA).

$H_1 : \mu_1 > \mu_2$  (the average student learning outcome test using Mobile-based ARA is more than the average learning outcome test not using Mobile-based ARA).

To test the hypothesis above, the researcher used the pooled variance *t-test formula*.

Excel output :

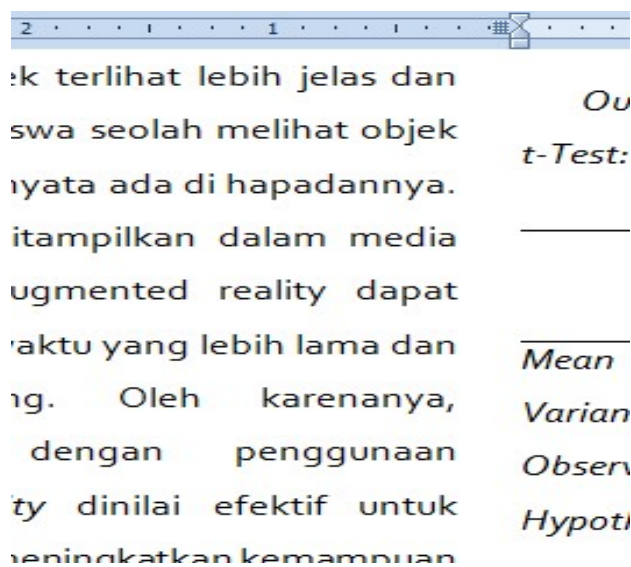


Figure 4. Excel Output

Because  $\mu_1 > \mu_2$  then reject  $H_0$  so that the average student learning outcome test using Mobile-based ARA is more than the average learning outcome test not using Mobile-based ARA).

## CONCLUSIONS AND RECOMMENDATIONS

The use of android in utilizing *augmented reality media* in calculus courses following conditions that during the pandemic require students to learn to use cell phones and laptops. So the ARA in calculus learning is very supportive. In addition, the ARA design in calculus learning is also one of the efforts to respond to the state and development of the Industrial Revolution 4.0.

Because students have been familiar with AR, the assessment media that utilizes AR is deemed able to answer the student's desire for a practical evaluation media using Android. This is supported by 100% of students who already have an android. Of the 32 respondents, 100% of students felt that *augmented reality* was needed during the online process. 93.75% of students answered that the application was practical to use. The use of the ARA application as a learning medium also easy to apply in learning. Because then reject  $H_0$  so that the average student learning outcomes test using Mobile-based ARA is more than the average learning outcome test not using Mobile-based ARA) which answers that ARA is effectively used as an assessment medium.

Suggestions in this study are for students to practice more questions to improve learning outcomes and continue to develop themselves in various kinds of learning media that support the Education 4.0 revolution.

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