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# Implementation of Augmented Reality In Biology Learning: Its Effect on Learning Motivation and Retention

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**ABSTRAK**

*Salah satu penyebab rendahnya motivasi dan retensi adalah ketidaktepatan strategi pembelajaran yang diterapkan. Oleh karena itu, perlu dilakukan pemutakhiran pembelajaran agar mampu memberikan keterampilan digital kepada siswa melalui penerapan teknologi. Penelitian ini bertujuan untuk menganalisis pengaruh penerapan augmented reality terhadap motivasi belajar dan retensi siswa dalam pembelajaran biologi. Penelitian ini merupakan penelitian eksperimen semu dengan Non-equivalent Pretest-Posttest Control Group Design. Penelitian ini dilakukan di kelas X SMA dengan jumlah sampel sebanyak 65 siswa. Pemilihan sampel dilakukan secara acak. Motivasi belajar diukur dengan menggunakan angket sebanyak 36 item pertanyaan dan skala Likert sebanyak 5 poin. Retensi diukur menggunakan tes esai. Hasil tes kemudian diukur menggunakan rubrik dengan skala 0-4. Data dianalisis menggunakan ANCOVA tunggal dengan pretest sebagai kovariat. Hasil penelitian menunjukkan adanya pengaruh yang signifikan penerapan AR terhadap motivasi dan retensi siswa dalam pembelajaran biologi. Hasil ini menunjukkan bahwa AR dapat menjadi solusi sebagai sumber daya pedagogis untuk meningkatkan motivasi dan memberdayakan retensi.*

**ABSTRACT**

One of the causes of low motivation and retention is the inaccuracy of the learning strategies applied. Therefore, it is necessary to update learning in order to be able to provide digital skills to students through the implementation of technology. This study aims to analyze the effect of implementing augmented reality on learning motivation and student retention in biology learning. This research is a quasi-experimental study with a Non-equivalent Pretest-Posttest Control Group Design. The research was conducted in class X SMA with a total sample of 65 students. The selection of samples was done randomly. Learning motivation was measured using a questionnaire of 36 question items and a Likert scale of 5 points. Retention was measured using an essay test. The test results were then measured using rubric with a scale of 0-4. Data were analyzed using a single ANCOVA with a pretest as the covariate. The results showed a significant effect of AR implementation on students' motivation and retention in biology learning. These results indicate that AR can be a solution as a pedagogical resource to increase motivation and empower retention.

## 1. INTRODUCTION

Biology has many abstract and complex concepts, and many Latin terms, so biology is considered a frightening and difficult-to-understand lesson (Chiu et al., 2015; Gilbert, 2004; Putu, 2013). This problem greatly impacts the low motivation of students' learning. Motivation is a complex part of psychology that influences a person to prepare for time and energy in completing tasks, conceptualizing, and trying to survive in achieving his task (Aluja-Banet et al., 2017; Anderman & Gray, 2015). Motivation is an element to react and act to meet the need. In the context of learning, motivation involves beliefs, emotions, and strategies so that students can persist in achieving their learning goal (Chiu et al., 2015; DePasque & Tricomi, 2015).

Some studies state that motivation is an essential key in the development of critical thinking skills, learning outcomes, and achievements (Afzal et al., 2010; Loes et al., 2014; Yusuf, 2011). Previous study states that motivation can help direct attention and influence how information is processed so that it can affect all phases of learning and performance (Zhu et al., 2022). Previous study state that motivation regulates neural responses to performance related to feedback, supports learning and memory (DePasque & Tricomi, 2015). Motivating students to study in school and succeed is the biggest challenge and needs educators' special attention. Educators believe motivation influences what students learn and how well they apply these skills and knowledge (Filgona et al., 2020; Phung et al., 2022). However, the facts show that students' learning motivation is still low.

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This low motivation has an impact on low student retention. The studies of previous research and show that motivation has a positive relationship with student retention (Khozaei et al., 2022; Roediger et al., 2011). Increased motivation also follows increased student retention. Retention is related to how memory processes information. Memory represents the total of what we remember and allows us to learn and adapt from previous experiences and build relationships. Memory is the process of storing information constantly, maintaining its usefulness, and retrieving stored information (Boonbrahm et al., 2020; Liu & Tanaka, 2021). This process is the need of every student in order to learn optimally. Student learning retention still needs to be improved and needs to be empowered. The results of previous study show that the science learning outcomes of Indonesian students are still in the low-performance quadrant (Zlotnik & Vansintjan, 2019). The survey result is linked to retention because the tests in the survey were carried out suddenly in order to obtain actual results. The results of the studies of and showed that the student retention rate was still low.

One of the causes of low motivation and retention is the inaccuracy of the learning strategies applied. Learning has yet to be facilitated and adapted to the needs, situations, and current conditions of students with digital characteristics. Therefore, it is necessary to update learning in order to be able to provide digital skills to students through the implementation of technology (Andyani et al., 2020; Khan et al., 2019; Liu & Tanaka, 2021; Zlotnik & Vansintjan, 2019). One of the technologies that have developed rapidly in recent years, namely Augmented reality (AR). Augmented reality (AR) is a technology that can interactively integrate 3D virtual objects in real situations. Through AR, virtual objects or information are added to the real world so that access to the virtual environment and the real world occurs simultaneously (Arslan, R., Kofoğlu, M., & Dargut, 2020; Gilbert, 2004; Hedley, 2017). AR systems have three stages, namely, 1) tracking, 2) registration, and 3) display technologies.

The tracking system tracks the position and orientation of objects in the real world, the next stage is registration, which is the process of superimposing a virtual model to real-world objects, and the latest stage is displaying a virtual model to a physical entity. AR is considered very effective by providing visual interaction opportunities with the object given to the user (Bahri & Corebima, 2015; Cai et al., 2014; Khan et al., 2019). Several AR studies have shown that AR effectively improves student learning motivation in biology and academic achievement. Implementing AR can increase student motivation and attention and also develop student interaction with AR Learning with AR is fun and arouses students' curiosity so that it has an impact on memory comprehension and retention (Gargrish et al., 2021; Patzer et al., 2014).

Based on the background above, research was carried out on the implementation of AR in biology learning: its effect on learning motivation and retention. The AR used in the study was marker-based AR. The AR type is chosen because marker-based AR has proven strong and accurate. So far, almost all AR software development kits support the marker-based method because it provides the marker position that the user wants to focus on. This study aims to analyze the effect of implementing augmented reality on learning motivation and student retention in biology learning.

## 2. METHODS

This research is quantitative research with a quasi-experimental design. The research design used was *Non-equivalent Pretest-Posttest Control Group Design*. The research design can be seen in Table 1.

**Table 1**. Research Design

| Pretest | Treatment | Posttest |
|---|---|---|
| O1 | AR | O2 |
| O3 | Conventional | O4 |

The independent variable in this study is the implementation of AR applications, and the dependent variable is motivation and retention. The research population is public high school students in Pamekasan. Research samples were selected randomly and based on the equivalence test results. Two classes were obtained from the sample equivalence test with a total sample of 65 students. The number of classes with AR implementation is 30 students, and conventional classes are 35 students.

This research was conducted in two classes with the implementation of AR applications and conventional classes. Motivational questionnaires are given at the beginning and end of learning in both classes. The retention test is given after the learning is completed, then the test is re-tested after two weeks later. The retention test results were then measured using the Hart (1994) rubric on a scale of 0-4.

This study used learning tools consisting of a syllabus, lesson plan, student worksheet, and observation sheet on implementing learning syntax. Marker-based AR is implemented in the experimental

class. Marker-based AR is a type of AR that is superimposed digital objects on top of images then students interact with digital objects by rotating objects or pressing the play button. Motivational questionnaires are used to measure student motivation. The questionnaire uses a Likert scale of 0-5, with the number of questionnaires as many as 36 statements. The essay test is used to look at student retention in learning biology. The retention test refers to Bloom's taxonomy of revisions at the levels of C3 (applying), C4 (analyzing), and C5 (evaluating). All research instruments have already passed an expert validation process to check the validity of the test construct. Instrument improvements were made based on expert advice and comment, and 20 questions were obtained. The instruments used are valid and reliable. A retention test is administered two weeks after the postest is performed.

ANCOVA is used to analyze data by involving pretests as covariates. Prerequisite tests of data normality were carried out with the Kolmogorov-Smirnov test and the data homogeneity test with the Levene test. The data was analyzed with the help of IBM SPSS Statistics 23 Software for Windows.

## 3. RESULT AND DISCUSSION

### Results

#### *The Effect of Augmented Reality on Learning Motivation*

A summary of the results of the ANCOVA test on the effect of augmented reality on student learning motivation in class X biology learning is shown in Table 2.

**Table 2**. Ancova Test Summary Student Learning Motivation in AR and Conventional Class

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 988.865 | 2 | 494.433 | 84.553 | 0.000 |
| Intercept | 642.093 | 1 | 642.093 | 109.805 | 0.000 |
| Pretesmotiv | 236.903 | 1 | 236.903 | 40.513 | 0.000 |
| Kelas | 734.416 | 1 | 734.416 | 125.593 | 0.000 |
| Error | 362.551 | 62 | 5.848 | | |
| **Total** | **327647.549** | **65** | | | |
| **Corrected Total** | **1351.416** | **64** | | | |

Based on ANCOVA test results in Table 2. it is known that the significance p-value < 0.05. This means that H0 is rejected, and the research hypothesis states that augmented reality influences students' learning motivation in class X biology learning is accepted.

#### *The Effect of Augmented Reality on Learning Retention*

A summary of the results of the ANCOVA test on the effect of augmented reality on student retention in class X biology learning is shown in Table 3.

**Table 3.** Ancova Test Summary Student Retention in AR and Conventional Class

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 5608.933[a] | 2 | 2804.466 | 250.176 | 0.000 |
| Intercept | 240.295 | 1 | 240.295 | 21.436 | 0.000 |
| PreRT | 2485.024 | 1 | 2485.024 | 221.680 | 0.000 |
| Kelas | 84.974 | 1 | 84.974 | 7.580 | 0.008 |
| Error | 695.018 | 62 | 11.210 | | |
| **Total** | **289049.408** | **65** | | | |
| **Corrected Total** | **6303.950** | **64** | | | |

Based on ANCOVA test results in Table 3 is known that the significance p-value < 0.05. This means that H0 is rejected, and the research hypothesis states that augmented reality influences student retention in class X biology learning is accepted.

### Discussion

#### *The Effect of AR Implementation on Learning Motivation*

The results show an influence of AR implementation on student learning motivation in high school biology subjects class X. Findings of this study show that AR implementation is effective in increasing student learning motivation. These findings are in line with the research of which found that there were

differences in the learning motivation of students who used AR with students who did not use AR (Moreno-Guerrero et al., 2020; Tarng et al., 2022; Tsai, 2020). Previous study stated differences in student learning motivation between classes and learners in AR and control class, especially in anxiety (Chang et al., 2016; Omurtak & Zeybek, 2022). The study also found that AR effectively increases student motivation.

The high student motivation to learn biology through AR is because AR can stimulate students' interest and curiosity. Previous study state that using AR in learning can change students' mindset toward learning to be good, increase interest and motivation, provide joy and happiness, and eliminate boredom (Akçayır & Akçayır, 2016). AR provides new ways to interact with the real world and can create experiences that are impossible in both the real and virtual worlds AR attracts and maintains students' attention throughout learning Students feel relevant between learning and their lives to increase their willingness to learn (Cai et al., 2014; Chen & Tsai, 2012; Civelek et al., 2014; Di Serio et al., 2013; Kamarainen et al., 2013).

***The Effect of AR Implementation on Retention***

The results showed an effect of AR implementation on student retention in classroom X biology learning. The results of this study align with the findings of previous study which state that there is a significant difference in the retention of students who learn to use AR with students who do not use AR also state that student retention increases through AR learning (Fidan & Tuncel, 2019). According to previous study using AR in the classroom helps students maintain more concepts than students in conventional class (Patzer et al., 2014).

The high retention of students is due to the addition of AR in the learning process. The study by previous study states that AR effectively improves student retention (Chang et al., 2016). Through AR learning, students have a deeper understanding and broad knowledge when interacting with virtual objects. According to previous study AR learning environments have proven effective as pedagogical resources because they can transmit information to long-term memory (Challenor & Ma, 2019). The presence of moving images, visible on the phone, having fun, having voice narration, and effectively storing knowledge. The addition of AR in learning reinforces student involvement in biology learning, learning independence, and student collaboration. According to other study retention can be improved by actively involving students in the learning process (Crosling et al., 2009; Yildirim & Kapucu, 2021).

AR implementation can maximize information processing to deliver information into long-term memory. Previous study found that AR can increase cognitive load to make knowledge acquisition more effective and encourage storing information in long-term memory (Tarng et al., 2022). According to students interact with AR and information enters sensory memory through visual, auditorial, or tactile with AR (Challenor & Ma, 2019). The information obtained is initially stored in short-term memory then sensory registers will deliver information into long-term memory. AR applications effectively empower retention because the knowledge gained can be permanent, mainly due to the features of 3D technology.

The implication of this study provides overview related to the implementation of AR in biology learning affects learning motivation and student retention. The results of this study show that AR can be an option as a pedagogical resource in biology learning to increase student learning motivation and empower retention. This research is limited to biology material for class X of high school. Therefore, next research can be carried out on a broader scale. AR can also be implemented on different materials, classes, and variables to examine the role of AR in learning biology.

## 4. CONCLUSION

The effect of AR implementation on learning motivation the results show an influence of AR implementation on student learning motivation in high school biology subjects class X. AR provides new ways to interact with the real world and can create experiences that are impossible in both the real and virtual worlds AR attracts and maintains students' attention throughout learning Students feel relevant between learning and their lives to increase their willingness to learn. The results showed an effect of AR implementation on student retention in classroom X biology learning. The results of this study align with the findings of previous study which state that there is a significant difference in the retention of students who learn to use AR with students who do not use AR also state that student retention increases through AR learning. The addition of AR in learning reinforces student involvement in biology learning, learning independence, and student collaboration.

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