

AUGMENTED REALITY FOR LEARNING BIOLOGY IN DISTANCE EDUCATION

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ABSTRACT

Augmented reality (AR) is an added virtual object on real object. An advantage of Augmented Reality (AR) is that it is a combination of virtual and real object, interactivity, and collaboration. AR may enrich learning experience, while it is not to replace real practice or object. DNA replication is one important topic of genetics. DNA is the blueprint of genetic traits of every organism. It's replication, transcription, and translocation will affect metabolism. The authors developed an AR for supporting students to learn DNA replication. The topics of the AR are beginning site of replication and separation of double helix DNA. There are two AR objects produced in this study, the first explain how DNA replication begins and the next one explains how double helix DNA separate prior to the replication. The AR is included in online tutorial of BIOL4219 and BIOL4115 Genetics and General Biology. A survey was conducted to 35 students who take the course in 2021. The questions in the survey are open ended questions about how they learn using the AR and how AR can help them learning. The survey was sent online. There are 10 students replied the survey. Most students feel that the AR help them by showing DNA replication as three- dimensional object. Instead of imagining the DNA replication process as abstract process, this AR allows students to see it like a real object. Another student pointed out that a benefit of using AR is that it allows observation of DNA components which are involved in the replication.

Keywords: *Augmented Reality, Biology, Distance Education.*

1. INTRODUCTION

Universitas Terbuka is a pioneer of open distance education at the tertiary level in Indonesia. UT has a specialty as a university that only provides remote empowerment. One advantage of UT is that it has a very large capacity and can reach various corners of the country.

Augmented Reality (AR) is a virtual display that is added to real objects. The advantages of AR are the combination of reality with virtual displays, interactive nature, and collaboration (Chazopoulos, et al, 2014). AR is useful for expanding the learning experience and not for replacing practical activities with real materials or tools (Torregrosad et al, 2014). DNA replication is one important topic of genetics.

DNA is the blueprint of genetic traits of every organism. It's replication, transcription, and translocation will affect metabolism process (Diki & Dwisatyadini, 2020; Hartl, 2020; Pierce, 2020).

Department of biology at Faculty of Science and Technology at UT provides learning material and learning support system for their students. For example, students attend laboratory practice to get practical experience. In addition, students can utilize different multimedia to learn biology (Diki et. al, 2015; Diki, 2007; Hardjojo et. al, 2007)

The use of AR at UT can be started by making AR based on mobile phones (HP). AR is used to explain concepts in Basic Material Book. The advantage of AR based on mobile phones is that the equipment is owned by many students and is easy to use. So far, UT has not used AR as a complement to the Basic Material Book. Therefore, there needs to be research to develop AR as a complement to the illustrations in Basic Material Book. This research was conducted to develop AR as a complementary illustration in the Basic Material Book course for the BIOL4115 and BIOL4219 General Biology and Genetics course. Both courses require AR and can be used as examples for AR development in other subjects and in other study programs.

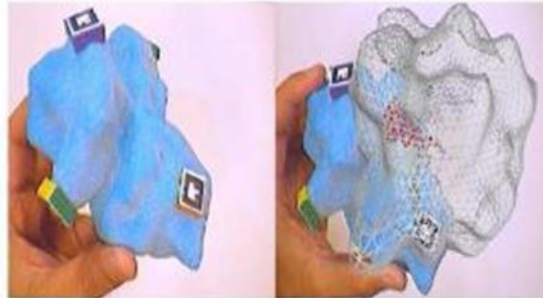
2. METHODOLOGY

The stages of the research are as follows:

- a. Identification of BIOL4115 and BIOL4219 Basic material book materials that require AR. The BIOL4115 Basic material book materials that will be identified for their AR needs are: DNA transcription (Module 5 KB1), Translation (Module 5 KB 3), Regulation of gene expression in bacteria (Module 6 KB 1), and Regulation of gene expression in eukaryotes (Module 6 KB 2). The BIOL4115 Basic material book materials that will be identified for their AR needs are: Model, properties, and composition of plasma membrane (Module 2 KB 1), The role of the plasma membrane and communication between cells (Module 2 KB 2).
- b. Determining which ICT requires AR.
- c. Development needs inventory.
- d. Preparation of outline of teaching program. Preparation of story boards (determination of LO, LA, and Assessment).
- e. AR program development.
- f. Selection of three-dimensional objects, the selected objects are objects that are already available either free or purchased. Thus, the AR development process can run faster than developing the object itself.
- g. Preparation of three-dimensional objects into AR objects;

Figure 1.

Example of a physical model of a ribosome without AR and with AR. (Marzouk, 2013)



Courses whose Basic material book requires AR include:

- a. BIOL4115 Cell Biology
- b. BIOL4219 Genetics
- c. The Cell Biology course requires AR because it uses a lot of illustrations about cell structure, cell metabolism processes and cell division. So far, the illustrations in the module are not clear. Students have difficulty understanding the concept without adequate tools.
- d. Genetics courses require AR because it describes a lot of replication, transcription, and translation. So far, the illustrations in the module are not clear. There needs to be AR material so that students can understand the role of each component of DNA, RNA and protein in the process of replication, transcription and translation.
- e. The material in the genetics module can also be used for AR material in the cell biology module. Thus, AR development for these two courses can be done simultaneously for these two courses. The use of this AR material can be used for both courses.

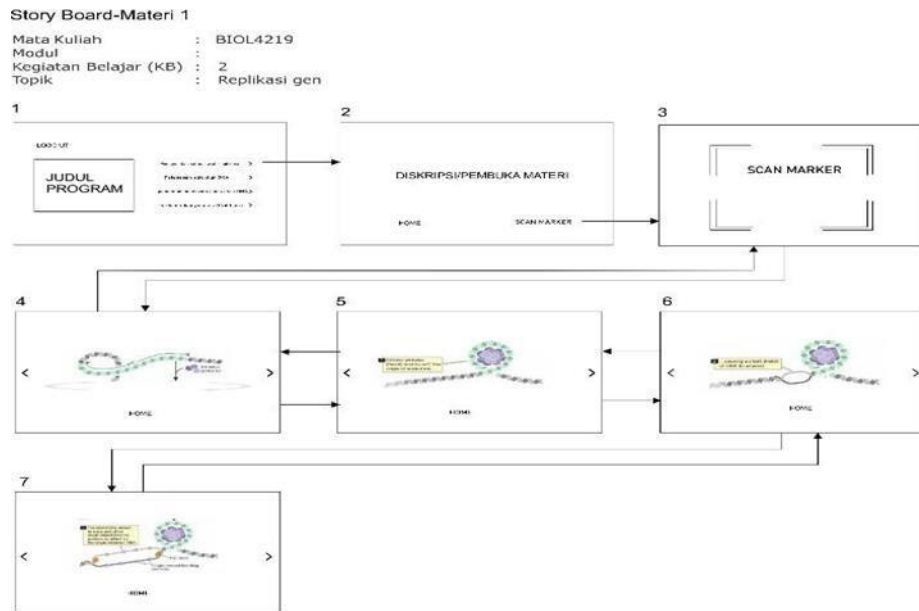
3. FINDINGS AND DISCUSSION

Utilization of augmented reality materials for biology students, Faculty of Science and Technology, Universitas Terbuka :

a. Story Board Material 1

This research is an initial research in the form of two main activities, namely the development of AR materials and the development of Moodle-based AR materials. Research that applies this R&D method needs to be followed up at the expert trial stage and field trials to obtain input for improving product prototypes. Sub-subsection: Guidelines for Abbreviations and Acronyms.

Figure 2.
Sample Story board material 1



Designing the program interface (cover display and program navigation layout:

Figure 3.
Example of the initial/cover program interface



Figure 4.
Example of a button design for navigation

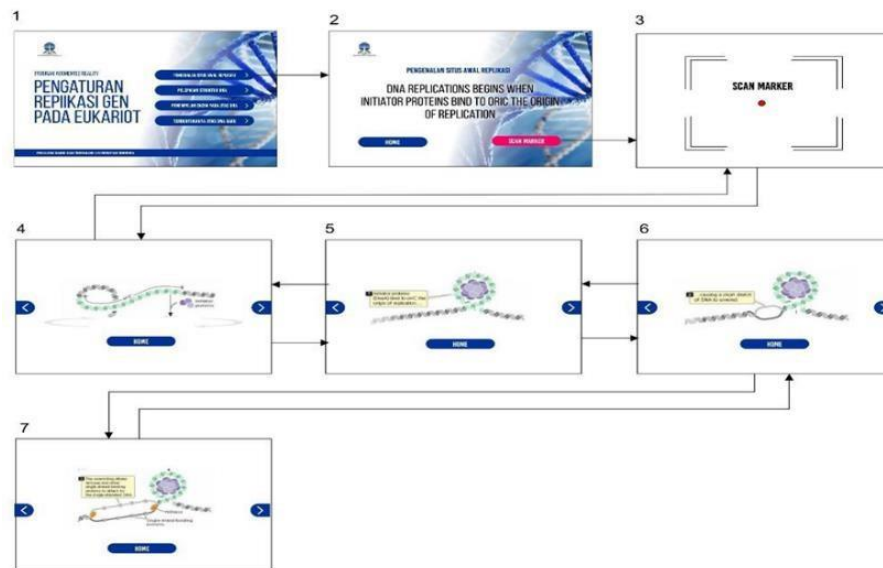


Material one architect information.

Figure 5.
Material one architectinformation

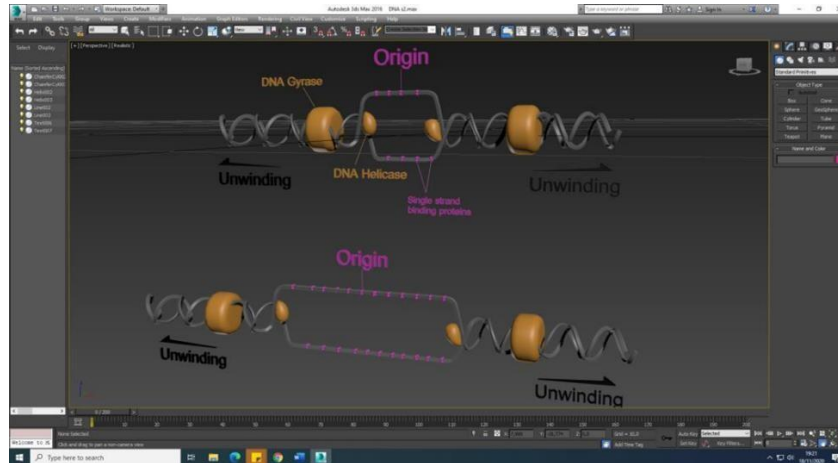
ARSITEKTUR INFORMASI MATERI 1-PENGENALAN SITUS

Mata Kuliah : BIOL4219
Modul :
Kegiatan Belajar (KB) : 2
Topik : Replikasi gen



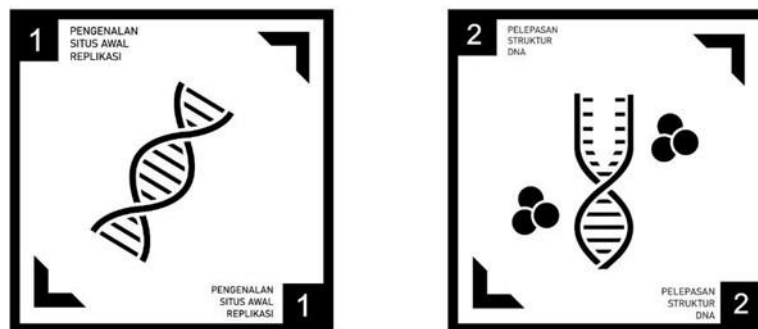
Modeling 3D objects/assets according to the object image in this figure 6.

Figure 6.
Example of modeling material 2



Designing Markers

Figure 7.
Example of material marker



Design 1 and 2 Programming the results of modeling 3d objects in the unity software.

- 1) AR menu display layout
- 2) Generating AR+3D+layout menu
- 3) Compile AR android version
- 4) Phase 1 trial (Video is on WA)

Stages still in progress

- 1) Modeling material 3 and 4
- 2) Programming for material 3 and 4

Result and discussion problems in design

- a. Object/asset references are very diverse, so it is difficult to determine the shape or character of the object that best corresponds to the actual object
- b. Reference images presented in the manuscript are not very clear. So it is difficult to modify or redesign objects to be more informative.
- c. Technical 3D modeling and animation with 3d Max software is still limited.
- d. Technical AR programming is still limited to displaying the form and providing a description of the form without displaying the concept of more interactivity.

The next step of this study is gaining feedback from students. A survey was conducted to 35 students who take the BIOL4219 course in 2021. All students took BIOL4219 online tutorial that includes videos of the AR.

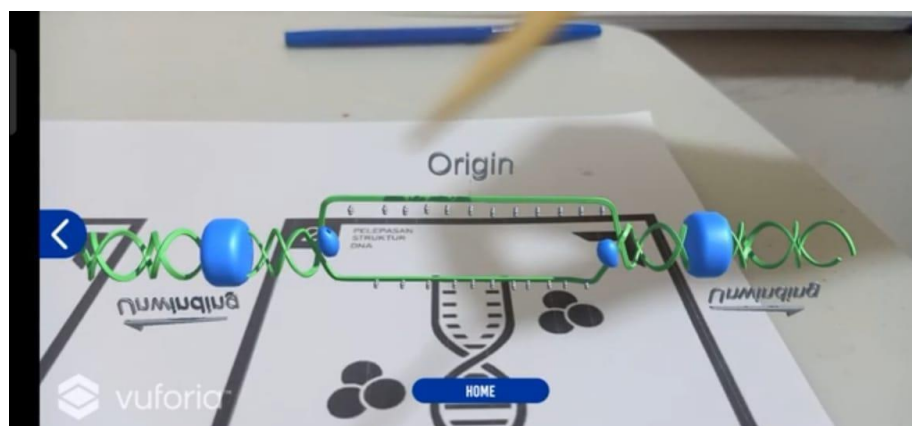
The questions in the survey are open ended questions about how they learn using the AR and how AR can help them learning. The survey was sent online. There are 10 students who replied the survey.

Most students feel that the AR help them by showing DNA replication as three-dimensional object. Instead of imagining the DNA replication process as abstract process, this AR allows students to see it like a real object. This result is supported by previous study by Diki et. al (2015) that students learn biology by connecting subjects they learn into a real object. In this case, the AR help them as a virtual object of a model of DNA.

Another student pointed out that a benefit of using AR is that it allows observation of DNA components which are involved in the replication. The components of DNA within the AR are described in Figure 6. This result is in line with a study by (Diki, 2015) that students are more likely to succeed when they learn to understand the content. The AR that include components of DNA in a three-dimensional object help students to learn more thoroughly.

Figure 8.

Components of DNA in the AR



4. CONCLUSION

AR helps students learn abstract concept. An abstract object can be presented like a real object in AR. AR showed details of an object.

Further studies are required to measure students' satisfaction as well as feedback to improve the AR.

5. ACKNOWLEDGEMENTS

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