

---

# Augmented Reality As a Basis For the Development of Student Worksheets to Study Biology

Wan Syafii<sup>1</sup>, Zulfarina<sup>1</sup>, Ade Diana Kharisma<sup>1</sup>  
Magister of Biology Education, University of Riau  
Wansya\_ws@yahoo.com

**Abstract.** The purpose of this research was conducted to develop student worksheets based on Augmented Reality (AR). This type of research is descriptive and it was carried out with the ADDIE model. Development is carried out on the concept of a virus. The results of the development were validated using a validation sheet consisting of didactic, construct and technical aspects. The validator consists of 5 people namely a media expert, a material expert, an education expert and two practical people (teachers). Validation results show a value of 3.8 with a very valid category for the didactic aspect, a value of 3.8 with a very valid category for the construction aspect and a value of 3.7 with a very valid category for the technical aspects. Conclusion, the research has been successful to developed student worksheets based on Augmented Reality (AR).

Keywords: Augmented reality, student worksheets

## 1. Introduction

Learning is the process of transferring information from teachers to students through learning media. The transfer of this information can be done in various ways, one of them by using the development of learning media. In the era of the industrial revolution 4.0 which had an influence on the learning process to utilize technology, one of which is Augmented Reality (AR).

Augmented reality (AR) is a technology that can combine a 3D object into a real environment using webcam media (Bitter & Corral, 2014). Utilization of AR can be innovated and developed through learning media or teaching materials, one of which is the development of Student Worksheets in which is equipped with 3D animation (in the form of AR) and helps students in the learning process. Augmented Reality media can be an option for teaching biological concepts that cannot be directly observed to be observable. One of them is the concept of a virus. The results of observations in one of senior high schools in Pekanbaru showed that the percentage of students' daily test scores for the concept of virus <75 was 48% with an average value of 71.84. This is supported by Siti Sapuroh (2010) which states that some concepts in learning biology are difficult to understand by students, one of them is an abstract concept, as in the concept of viruses known to 51.67% of students think that the concept of viruses is difficult to understand. understood.

This innovation in the form of students' worksheets based on Augmented Reality is expected to attract the attention of students to follow the learning process. According to Alvian (2017) AR media is good to be applied in schools, based on his research it shows that 76% of students give positive responses and are interested in AR learning media used by teachers when learning.

## 2. Methodology

This research is descriptive research. The development of students' worksheets based on Augmented Reality was carried out with the ADDIE model, in the previous research the analysis and design stages

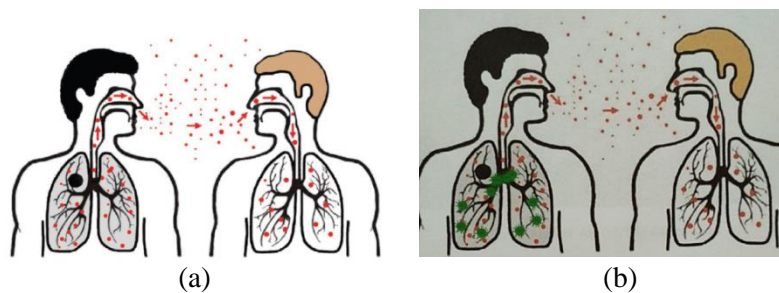
---

had been carried out and in this study the development phase was carried out. The development of AR-based student worksheets utilizes a variety of computer software namely blender, vuforia and unity, and other supporting software. Development is carried out on Basic competencies 3.3. related to the concept of the virus. The results of the development were validated by 5 validators. The validator consists of a media expert, a material expert, an education expert and two practical people (teachers). Validation is done using a validation sheet consisting of didactic, construct and technical aspects and consists of 36 statement items.

### 3. Result and Discussion

#### 3.1. Development of student worksheets based on Augmented Reality (AR)

Virus Concepts in Basic Competence 3.3. consists of two meetings, so the number of student worksheets developed is two. Learners Worksheet for virus material at the first meeting, learns about the characteristics of the virus, the structure and function of the body parts of the virus, the body shape of the virus and the classification of the virus. Questions in the students' worksheets can be answered by students with the help of the 3 dimensional animation Augmented reality that has been developed in the students' worksheets. The characteristics of the virus in the students' worksheets that results of the development are equipped with pictures that contain a 3d virus animation database as an aid in finding the characteristics of the virus. 3D animation for the characteristics of viruses can be seen in Figure 1.



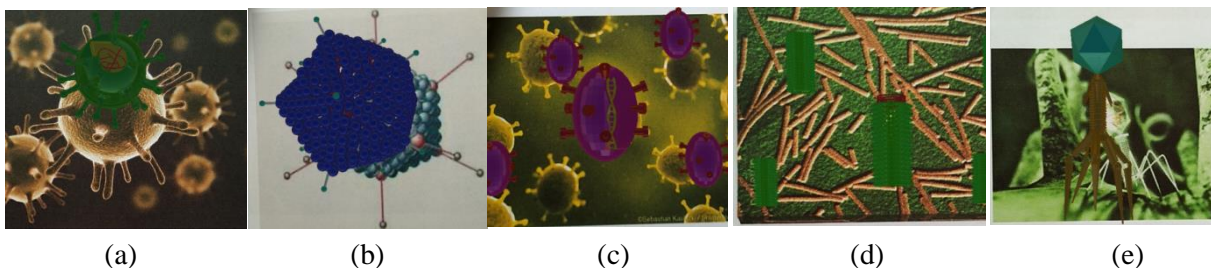
**Figure 1.** Display animation before using the Augmented Reality application (a), Display after using the Augmented Reality application (b)

The characteristics of viruses are that they have microscopic sizes that cannot be seen directly, but the worksheets of students who are developed can illustrate that very small viruses cannot be seen, and by using the Augmented Reality (AR) application we can observe the virus. In addition, 3D animations that appear show changes in color and movement of the virus. It aims to show / illustrate that viruses can only live in living cells (intracellular obligate parasites) displayed in green and in motion. Viruses can also be said to have the nature of death because it can be crystallized. This is illustrated in 3d animation when there is a change in the color of the virus when outside the body of the organism. Then for the structure and body parts of the virus can be helped with 3d AR animation as in Figure 2.



**Figure 2.** Display the structure of the virus before using the AR application (a), Display the structure of the virus using the AR application that displays 3d animation (b).

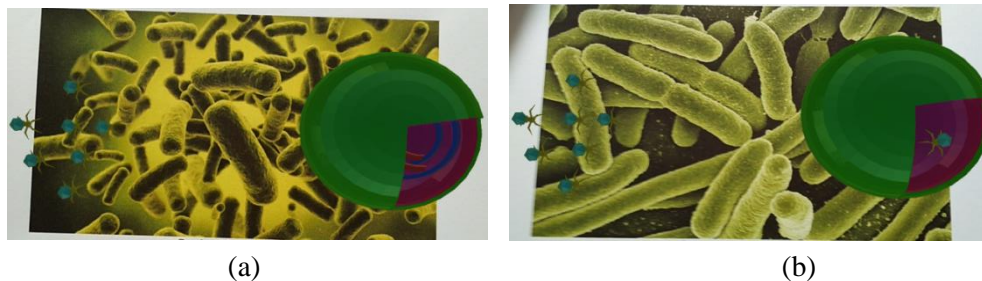
The structure and function of the body part of the virus most often studied as an example is from the type of bacteriophage virus as in Figure 2. The structure and body part of this virus consists of a capsid (protein envelope) that functions to envelop the viral nucleic acid, Nucleic Acid (DNA ) serves as genetic information at the time of replication (multiplication), the neck as a link between the head and tail of the virus. The tail sheath as a tail wrapper which consists of rings totaling 12 or 24. The tail fibers function as a means of movement. Base plate as a place to puncture needle in the form of an extension of the tail fibers used during adsorption. The function of the pointer is to inject the genetic material of the virus into the bacterial cell. The indicators studied next are related to various forms of the virus body. Various forms of this virus are illustrated in several 3D animations in the development worksheet. The 3d animation can be seen in Figure 3.



**Figure 3.** Round virus (a), polyhedral (b), oval (c), stem (d) bacteriophage (complex virus) (e)

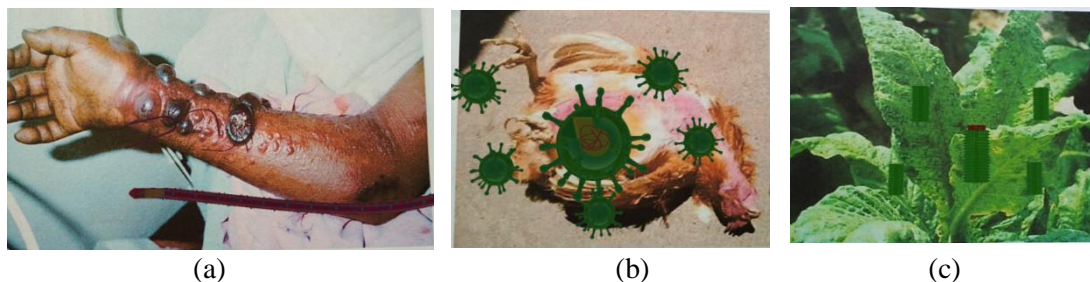
The forms of the virus are divided into various forms, namely round, oval, polyhedral, stem and complex. On the worksheets of students developing the results to find out various forms of the virus in 3 dimensions can be seen using the AR application that has been integrated in the images available on the student worksheet. The animations available will help students to be able to see the shape of the virus in 3 dimensions and increase students' motivation in learning about the virus material. The last indicator in the virus meeting 1 is the classification of viruses. Viruses can be classified based on the type of nucleic acid they have, that is, there are viruses that have only RNA and some that have only DNA in the form of nucleic acids. Observation of virus classification based on its nucleic acid can be compared between the 3d animation that appears in Figure 2 (b) with Figure 3. (b). Then the classification of other viruses can also be based on the presence or absence of the sheath. Observation of AR on the worksheet of students who developed results comparing the veiled virus with the uncovered virus can be observed in Figure 3. sections a and b. So with the 3d animation on the worksheet based on Augmented Reality students can enrich students' insights related to the concept of the virus being studied.

Augmented Reality Worksheet based on virus material at the second meeting (2), has several indicators to be studied. These indicators are related to the process of lytic and lysogenic virus reproduction and determine the positive and negative roles of viruses in life. 3D animation for the lysogenic and lithic replication of the virus can be seen in Figure 4.



**Figure 4.** Lysogenic cycle (a), Lytic Cycle (b)

Figure 4 shows the 3-dimensional animation in the process of lysogenic and lytic virus reproduction. Lysogenic reproduction in viruses consists of the stages of adsorption, penetration, merging and cell division. While lytic virus reproduction consists of the stages of adsorption, penetration, synthesis, assembly and lysis or the production of virions (new viruses). AR-based Learners Worksheets display 3-dimensional illustrations of the process of reproduction of the virus directly so that students can more easily understand the concept of reproduction directly. The next indicator to be studied at the meeting 2 LKPD virus is related to the role of viruses in life. 3D animation for this role can be seen in Figure 5.



**Figure 5.** Ebola virus (a), Avian Influenza virus (b), TMV (c)

The role of viruses in life is positive and negative. In the LKPD the results of the development are given an example of the negative role of viruses in life including viruses that attack humans exemplified by the Ebola virus, a virus that attacks animals, avian influenza virus and a virus that attacks plants, namely tobacco mosaic virus. So, 3-dimensional animation is integrated into 2-dimensional images that direct students to guess what viruses are being shown in 2d images and the 3D animation that is displayed. Viruses are shown as representative examples for the negative role of viruses in life, students can add more complete information through the book used or other references.

The development of student worksheets that are equipped with 3-dimensional animation of biological objects that are studied can trigger students' motivation in participating in the learning process. It also can make learning more real and contextual. According to Ivanova & Givanov (2011), Sigit (2014), Sanikov et.al (2015) said that AR is a promising and effective technology that enables better understanding of theories and facts and supports creative thinking and the development of more realistic 3D models and scenes. which allegedly can trigger an increase in student motivation in following the lessons.

### 3.2. Student Worksheet Validation Results

The validation of Student Worksheets based on Augmented Reality is done using a validation sheet consisting of 3 aspects of assessment according to Prastowo, (2013) and Hendro Darmodjo & Jenny R.E Kaligis, (1992) which consists of didactic, constructive and technical aspects. Validation results Worksheet based on Augmented Reality (AR) for each meeting and for the three aspects of validity that have been done can be seen in Table 1.

**Table 1.** Validation Results for the Three Aspects of Validity of Each Student Worksheet

No	Validation Aspects	Student Worksheet		Average	Category
		1	2		
1	Didactic	3,9	3,8	3,8	Very Valid
2	Constructive	3,8	3,8	3,8	Very Valid
3	Technical	3,7	3,8	3,7	Very Valid
Average		3,8	3,8	3,8	Very Valid

Table 1 shows that overall five students' worksheets that have been developed obtain an average score for the didactic aspect of 3.8 with a very valid category, then for the construction aspect a score of 3.8 is obtained with a very valid category and for the technical aspects it obtains an average a score of 3.7 with a very valid category. Based on the results of the validation it can be said that the worksheet of students resulting from the development can be continued to be used at a later stage. According to Prastowo (2013) explained that the worksheet of students gives considerable influence in the teaching and learning process, so the preparation of the worksheet of students must meet various requirements namely didactic requirements, constructive requirements, and technical requirements. During the validation process the students' worksheets also get some improvements, such as the construction and technical aspects. Improvements related to word selection, systematic worksheet of students and color combinations in the images used. Student worksheets have been improved according to the suggestions of the validator.

Based on the results of the validation, the validator stated that the worksheet based on Augmented Reality students is interesting to develop and has many benefits. According to Ng Giap Weng, (2016) and Ilmawan Mustaqim, (2016) AR can be helpful and good at learning material that cannot be directly observed. In addition there are many advantages of using this Augmented Reality media in the learning process that is more interactive and effective in use, can be widely implemented in a variety of media, object modeling is simple because it displays multiple objects, its making does not require a lot of costs, and is easy to operate. This is supported by Army M Kamarainen, et al (2013), Tri Yuliono, et al, (2017) and Didik Wahyu Hidayat, et al (2017), who state that AR media has many benefits for teachers and students in the learning process so that the process learning becomes effective, efficient and fun for students.

### 4. Conclusion

This Research has been successful to developed student worksheets based on Augmented Reality (AR). Validation results show a value of 3.8 with a very valid category for the didactic aspect, a value of 3.8 with a very valid category for the construction aspect and a value of 3.7 with a very valid category for the technical aspects. Research can be continued at the implementation and evaluation stages.

---

## Acknowledgement

- a. To Faculty of Education and teachers training of Riau University as a contributor to funding this research.
- b. To all colleagues who has given contribution and participated in this research

## References

- Andi Prastowo., 2013, Panduan Kreatif Membuat Bahan Ajar Inovatif, Diva Press, Yogyakarta.
- Amy Kamarainen, Shari Metcalf, Tina Grotzer, Allison Browne, Diana Mazucca, M. Shanne Tutwiler, Chris Dede., 2013, Integrating Augmented Reality and Probeware with Enviromental Education Fields Trip, Elsevier, Harvard University, USA.
- Bitter Gary and Coral Allen., 2014, The pedagogical potential of augmented reality apps, dalam International Journal of engineering science invention, Arizona State University, USA.
- Campbell, Jane B. Reece & Lawrence G. Mitchell., 2008. Biologi, jilid 3, edisi ke-8, Erlangga, Jakarta.
- Didik Wahyu Hidayat, Dedi Kuswandi, dan Saida Ulfa., 2017, Pembelajaran Organisasi Makhluk Hidup Berbasis Gamification Menggunakan Mobile Augmented Reality, JINOTEP, Universitas Negeri Malang, 4 (1).
- Gyorgy Molnar., 2014, Three Dimensional Applications in Teaching and Learning Processes, Elsevier (Procedia - Social and Behavioral Sciences).
- Ilmawan mustaqim dan Nanang K., 2017, Pengembangan media pembelajaran berbasis augmented reality, Jurnal edukasi elektro, Universitas Negeri Yogyakarta.
- Ivanova Malinka and Ivanov George., 2011, Enhancement of learning and teaching in computer graphics through marker augmented reality technology. International journal on UNCAA 1 (1).
- Sergey Sannikov, Fedor Zhdanov, Pavel Chebotarev, Pavel Rabinovich., 2015. Interactive educational content based on augmented reality and 3d visualization, Elsevier. 66, 720-729.
- Sigit Ady P., 2014. Augmented reality Tata Surya sebagai Sarana Pembelajaran Interaktif Bagi Peserta didik Sekolah Dasar Berbasis Android. Laporan Penelitian. Universitas Muhammadiyah Surakarta.
- Siti Sapuroh., 2010. Analisis Kesulitan Belajar Siswa dalam Memahami Konsep Biologi pada Konsep Monera. Program Studi Pendidikan Biologi Jurusan Pendidikan IPA. Fakultas Ilmu Tarbiyah dan Keguruan. UIN Syarif Hidayatullah. Jakarta.
- Tri Yuliono, Sarwanto, Peduk Rintayani., 2017, Keefektifan Media Pemelajaran Augmented Reality terhadap Penguasaan Konsep Sistem Pencernaan Manusia. Jurnal Pendidikan Dasar (JPD), Universitas Sebelas Maret Surakarta. P-ISSN 2086-7433 E-ISSN 2549-5801.
- Weng Ng Giap, Oon Yin Bee, Lee Hong Yew, Teoh Ee Hsia, 2016, An Augmented Reality System for Biology Science Education in Malaysia, Universiti Teknologi Malaysia (UTM). International Journal of Innovative Computing 6(2) 8-13,
- Wenggita M P, Fauzi Bakri, Andreas H P., 2016, Pengembangan Media pembelajaran berbasis multimedia augmented reality pada pokok bahasan alat optic. Prosiding seminar nasional fisika, ISSN 2339-0654 .