# Development of Learning Media for Force and Work for Junior High Schools with AR and VR Technology

**Fendi Aji Purnomo[1*], Prima Ammaray Baroo[1], Darmawan Lahru Riatma[1], Nanang Maulana Yoeseph[1], Agus Purbayu[1], Arrofvianti Nurwindha Kusuma[2]**

[1] Sebelas Maret University
[2] Al Azhar Syifa Budi Junior High School

[1*] fendi_aji@mipa.uns.ac.id

**Abstract:** Force and work are secondary level teaching materials. The things learned in the material consist of the understanding of force and work, calculation formulas and examples of application to everyday life. There are obstacles in the laboratory, namely the tools and experimental materials are limited so that students do not all get the freedom to learn. In designing this application using the MDLC method (Multimedia Development Life Cycle) such as drafting, making a storyboard design, making materials, uniting all objects, testing applications, and distribution. By packing force and work teaching materials, this research develops android products that are packaged with augmented reality and virtual reality technology that displays illustrations of three-dimensional (3D) virtual objects. The results of this application can be run on an Android device with a minimum specification of 2GB of memory and has a Gyroscope sensor. The results of the questionnaire given to 10 respondents who are junior high school students have the following results: Design Aspects get 23.3% Very Good and 76.7% Very Good. Information Aspect got 46.7% Very Good and 53.3% Very Good. And Navigation Aspects get 32.5% Very Good and 67.5% Very Good.

***Keywords:*** *media for learning, force and work, AR, VR*

## INTRODUCTION

Force and work is one of the learning materials that are taught in junior high school. By studying the material, students are expected to be able to know the daily phenomena related to pull and push forces. The observation that we have made for junior high school students in Solo that in learning in the classroom students often encounter obstacles in learning the material. The unavailability of simulation and illustration media makes the understanding of force and work material less optimal. The material that was felt was not optimal based on observations namely for the topics of Gravity, Newton's Law II, and Fixed Pulleys.

In studying Force and work so far only done by providing material through books and exercises. In the observations made, students are more interested in learning force and work if there is animation so that the illustrations of learning force and work can be understood.

To overcome these problems the role of multimedia is very important in helping interactive learning. With Augmented Reality (AR) and Virtual Reality (VR) technology, learning can be packaged attractively, which is capable of displaying learning content with models and animations both 2D and 3D (Aditya, Trisno, Nurwijayanti, & Fitriana, 2018; Sunarni & Budiarto, 2014). The advantage of learning media that is built with this technology is that it can improve student learning experiences in understanding teaching material (Kiryakova, Angelova, & Yordanova, 2018).

Augmented Reality is a technology that is able to combine virtual objects in two dimensions or three dimensions into a real environment and is presented with (real time). This technology is one of the technologies that is both interesting and easily understood by students in the learning process. The object to be displayed using the AR card media tools. This is the user's interaction with the real world to the displayed object. The packaging of teaching media with AR technology has been proven by (Fleck, Simon, & Bastien, 2014), namely the AR application is able to increase student engagement and enjoyment of learning. Whereas virtual reality is a technology that is able to present real objects into 3-dimensional fiction objects directly (realtime) as if we were seeing an object in plain sight. This technology uses media in the form of VR glasses so that they are able to see in 3 Dimensions. The use of virtual reality in the transfer of learning material can increase student understanding, this has been proven by (Ahmad, Wan, & Ahmad, 2017). The use of learning media with virtual technology for seventh grade junior high school students in guiding teaching material is stated to be able to improve learning outcomes by 4% compared to using real teaching media (Wijayanti, Ashadi, & Sunarno, 2018). The effectiveness of the use of virtual media in transfer of learning has also shown an increase in the group of students using VR courseware with the signaling principle of 8.6 points compared to the group of students using courseware without signaling (Ahmad et al., 2017). Other researchers have also stated that the development of collaborative-creative learning models using virtual laboratory media has proven to be effective at a 95% confidence level and can be used to improve the quality of learning in the classroom, overcoming the limitations of lab instruments for real instrumental analysis (Zurweni, Wibawa, & Erwin, 2017). According to research on AR application usability tests, it significantly shows that female teachers prefer to use AR in their classrooms rather than their peers. In addition, differences between urban and rural schools still exist, where rural teachers find that AR technology will be complicated to use in the context of rural schools. According to research on AR application usability tests, it significantly shows that female teachers prefer to use AR in their classrooms rather than their peers. In addition, differences between urban and rural schools still exist, where rural teachers find that AR technology will be complicated to use in the context of rural schools (Putjorn, Nobnop, Buathong, & Soponronnanarit, 2018).

Several learning media have been developed with AR and VR technology such as the development of science teaching media for elementary students (Saputri, Annisa, & Kusnandi, 2018), work and energy teaching media for high school students (Mayangsari, Iswanto, & Susanti, 2018) and AR geometry learning media for junior high schools (Aditya et al., 2018). In this research an interactive teaching media will be developed which combines AR and VR technology in packaging force and work material for junior high school students. AR technology is used to deliver material and competency tests, while VR technology is used to deliver simulations in the form of animation.

## METHOD

This research makes interactive multimedia applications using AR and VR technology in introducing force and work material. The application development stage is carried out using the Multimedia Development Life Cycle (MDLC) method which consists of the concept, design, material collecting, assembly, testing and distribution stages (Luther, 1994).

The concept stage, learning force and work comes from the 2013 curriculum syllabus for junior high schools. The material will be packaged using AR technology in explaining force and work, so it requires print markers to bring up virtual objects both 2D and 3D. Whereas force and work simulations and animations are packaged with VR technology, allowing students to independently explore material in the 1st person games environment mode. The design phase, the user interface is made in the storyboard model for each menu display. Material collecting stage requires illustration of images, audio, 2D and 3D object icons and models that support the learning of Newton's laws, levers and pulleys. Software requirements needed are Blender, Corel, Vuforia and Unity. Assembly Phase is the creation of all 3D objects for force and work material based on a predetermined storyboard. The testing phase is done by black box by ensuring that all navigation is functioning properly. The testing phase is also carried out testing applications on smartpone devices that have gyroscope sensors with other RAM memory, aiming to find out the minimum criteria the application can run. . The last stage, distribution is done by publishing programming scripts into an application ready to install in the form of APK and then tested to respondents through questionnaire form in the experience of trying to force and work learning applications including aspects of information delivery, aspects of visual design goodness and aspects of audio clarity. If in this stage there is a shortage then immediately corrected and republished. The respondents chosen in this test were junior high school students.

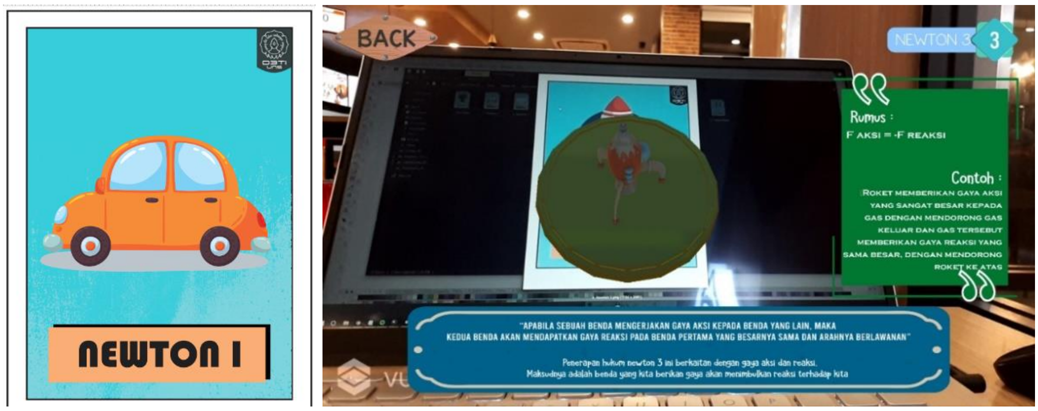
## RESULT

Interactive learning media in packaging force and work teaching material is built with AR and VR technology. The results of making the main menu interactive teaching media application are presented in Figure 1.


(a) (b)

**Figure 1.** Display of interactive learning applications force and work on the start page (a) and main menu (b)

In Figure 1 there are four main menus, namely the first education menu. In this menu there is an Augmented Reality implementation and users can get material from force and work. Both of the experiment menu, in this menu there are implementations of Virtual Reality and users can see and interact with 3 materials namely Gravity, Newton II, and Fixed Pulley material. Third is the training menu, in this menu there is an Augmented Reality implementation and users can practice the questions provided with the help of the designed marker book. Bookmarks and display of vitural objects are shown in Figure 2.




(a) (b)

**Figure 2.** Book marker (a) and the results of application detection of the marker will appear virtual objects in 2D and 3D forms (b).

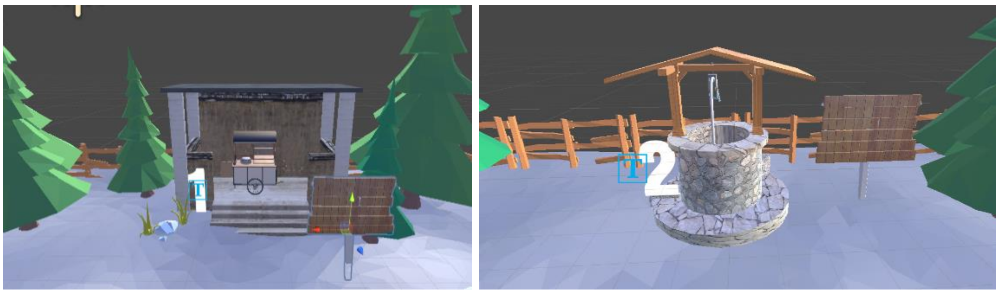
Markers are created with the help of the Vuforia application. The ease of detection of markers is determined by the maximum rating value for each marker image uploaded to Vuforia. If the image has been converted as a marker, the key marker can be downloaded and then used to create an AR application using Unity. Marker criteria that are easily detected by AR applications if they have a maximum rating as shown in Figure 3.

Add Target | Download Database (All)

| Target Name | Type | Rating | Status | Date Modified |
|---|---|---|---|---|
| Katrol-Bebas | Single Image | ★★★★★ | Active | Mar 27, 2019 21:12 |
| Katrol-Majemuk | Single Image | ★★★☆☆ | Active | Mar 27, 2019 21:08 |
| Katrol-Tetap | Single Image | ★★★☆☆ | Active | Mar 27, 2019 21:07 |

**Figure 3**. Types of markers with rating values in vuforia

An experimental menu built with VR technology is shown in Figure 4.



(a) (b)

(c) (d)

**Figure 4.** Three experimental menus for VR topics namely Newton II (a), Fixed Pulley (b) and Gravity (c), Stereoscopic display in VR mode (d).

Black box testing results have been performed on mobile devices with variations in the value of RAM memory values from 2GB, 3GB and 4GB RAM. The test results obtained that the application can run on a minimum of 2 GB of RAM and is equipped with a gyroscope sensor. Tests were also carried out with variations of light provided from 20 lux to 364 lux. The greater the intensity value, the stronger the detection marker and easier to do.

The results of tests carried out through the survey of the questionnaire stated that for the Design aspect, they got 8 points in the Good rating (B). Then there are 35 points on the Very Good (SB) rating. And there are a number of 2 points in the assessment of Very Good (SBS). With the results of the questionnaire, for the design aspect it can be concluded that it has an excellent design.

The test results on the information aspect, this application gets 10 points on Good rating (B), then gets 30 points on Very Good rating (SB), and gets 5 points on Very Good rating (SBS). With the final results of the questionnaire, for the Information Aspect it can be concluded that having Very Good Information. In the navigation aspect get 7 points on Good rating (B), then get 45 points on Very Good rating (SB), and get 8 points on Very Good rating (SBS). With the results of the questionnaire, for the navigation aspect it can be concluded that it has ease in navigation. Illustration of testing on users is shown in Figure 5.

Figure 5. Application testing atmosphere with the help of a VR headset

## CONCLUSION

Augmented Reality Application and Virtual Reality Force and work As a Middle School Student Learning Media is the result of the implementation of the Augmented Reality and Virtual Reality technology based on the Android Platform. Application content Augmented Reality and Virtual Reality Force and work As a Middle School Student Learning Media in the form of an overview of the material Force and work on Physics Subjects in Junior High Schools. This application is a file with a .apk extension. This application is very smooth and optimal to run on mobile phones with Exynos 7880 Octacore 1.9 GHz Processor device specifications and has 3 GB of RAM. But this application can be run on an Android device with a minimum specification of 2GB of memory and has a Gyroscope sensor. The results of the questionnaire given to 10 respondents who are junior high school students have the following results: Design Aspects get 23.3% Very Good and 76.7% Very Good. Information Aspect got 46.7% Very Good and 53.3% Very Good. And Navigation Aspects get 32.5% Very Good and 67.5% Very Good.

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