MIX Reality Based Media Prototype For Learning Physics of Gravity And Kepler’s Law

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Abstract. Gravity and Kepler's Laws are materials that study natural phenomena, events or phenomena that reveal all the secrets of the universe. Based on the observations of several schools, there are difficulties for students understanding gravity and Kepler's laws because they can not directly present 3D learning media in interactive classes. This study aims to develop a mixed reality-based media prototype for learning gravity physics and Kepler's laws using special VR box glasses and markers to display 3D objects equipped with audio explanations, 3D animations, and evaluation questions. The research was conducted using the ADDIE development model (Analyze, design, develop, implement, and evaluate). To make it easier for students to use mix reality applications, the mix reality software design employs blender version 2.78, unity 5.1, Photoshop, the vuforia AR extension for unity, and the c# programming language. The trial of the feasibility of mix reality media was conducted by averaging the results of the validator's assessment of each aspect of the assessment. Mixed reality media prototypes can help students understand gravity and Kepler's laws.

1. Introduction
Industry 4.0 has become the main topic of the industrial and manufacturing economy with the fourth industrial revolution driven by the advancement of the internet with the main component of cyber physical system [1]. Mix Reality is one such technological advancement. Mix Reality (MR) is a combination of real and virtual that requires special hardware such as glasses (spectacles) [2]. Use of Reality Mix media are limited as the eclipse phenomenon [2]. One of them is the emergence of Mix Reality technology, namely the combination of Augmented Reality (AR) and Virtual Reality (VR) technology [1]. The results of research conducted by [3] Show that Mix Reality (MR) is a digital technology that can provide a more realistic learning sensation. Augmented Reality (AR) is a combination of virtual reality and world reality [4]. The use of Augmented Reality (AR) applications can be used easily by students and teachers anywhere with the help of smartphones by displaying 3D models on markers [5]. Virtual Reality (VR) is a technology that allows users to enter and interact in a virtual (virtual) environment. The use of this VR system can perform an activity many times without fear of damaging the object because it is only a visual illusion [6]. VR technology used in physics is limited to the topic of quantum mechanics [7]. Mix Reality (MR) is a combination of Augmented Reality (AR) and Virtual Reality (VR) where AR is closer to the real world while AV is closer to the virtual world, as shown below: [8]
In this study, a single entity that is becoming Mix Reality (MR) was created using marker color and special tools, and pointers are already available on the display medium of learning Mix Reality (MR) that allows users to learn the material gravity and Kepler's laws.

2. Method
The purpose of this study is to develop a mix of reality media on gravity and Kepler's laws that are appropriate as interactive learning media. The Systematic ADDIE model with a clear framework produces effective, creative, and efficient products (Learning, 2012). ADDIE Model Development Flow [9]. Phase analysis can be subdivided into a needs analysis (needs analysis), analysis of the task (task analysis), analyzing the students (learner analysis) and analysis of the performance (performance analysis) (Cheung, 2016). The development stage is the embodiment of the blue-print or design in the previous stage into reality (Aldoobie, 2015). The implementation phase is a real step to implementing the learning system that we are making. That is, at this stage, everything that has been developed is installed or set in such a way according to its role or function so that it can be implemented. The evaluation stage is a process to see whether the learning system being built is successful, in accordance with initial expectations or not. The procedure in this development research refers to the ADDIE model development research flow. The product development procedure in this study can be seen in the following figure.

Table 1 Steps to develop Mix Reality media

| No | ADDIE Stages | Development Steps |
|----|--------------|-------------------|
| 1. | Analyze      | - Needs analysis questionnaire for students and teachers  |
|    |              | - Study of literature on learning media                     |
|    |              | - Designing the display of Mix Reality learning media       |
| 2. | Design       | - Create components of mixed reality komponen               |
|    |              | - Develop expert validation tools                            |
|    |              | - Creating media that fits the framework                     |
|    |              | - Programming in 3D in Blender, Unity 3D, Vuforia for AR and VR, and C# programming language |
| 3. | Development  | - Testing mixed reality media before being validated by experts |
|    |              | - 2nd SMAN field trial                                       |
| 4. | Implementation | - Filling of response questionnaires by students           |
|    |              | - Conduct a feasibility test for media, material and learning experts |
| 5. | Evaluation   | - Product revision based on validator's suggestion           |
|    |              | - Field test (Gain Test)                                     |
|    |              | - Media enhancements                                         |

Final Product: Mix Reality (MR) Based Media Prototype for Learning Physics of Gravity and Kepler's Law
3. Results and Discussion

Media Mix Reality shows that MR is a digital technology that can give the sensation of learning to be more realistic in a classroom or learning environment. The developed MR media is a mixed reality-based media prototype for learning gravity physics and Kepler's laws. The MR media design is divided into two, namely displays and markers. The first part is the display consisting of 3D objects with audio explanations, 3D animations with audio explanations, and using VR Box Glasses to see the MR display. The second part is a marker that is packaged in HVS size with a standard A4 size made colorfully, equipped with instructions for use, core competencies and basic competencies. The media design that will be developed can be seen as shown below:

![MR media design](image)

**Figure 2.** MR media design

*Software selected to create applications* The software Blender version 2.78, Unity 5.1, Photoshop, Vuforia AR extensions for Unity, and the programming language C# are used in Mix Reality. Making MR media software begins with creating 3D objects in Blender, then exporting 3D objects into .fbx format, then importing 3D objects into Unity 3D, then importing vuforia developer markers, then inputting markers into Unity 3D, then using the C# programming language, then building the application using the android SDK, then connecting to the camera on the smartphone equipped with MR media software.
The process of presenting the MR that will be used begins by providing a *cellphone* that already has the MR application, then attaching the *cellphone* to the VR Box *glasses* (glasses), then attaching the VR Box to the eye directly, then focusing the VR Box glasses to the available *marker*. Then a 3D image will appear according to the material being taught. The following presentation of MR media for gravity and Kepler's laws can be seen in the following figure.

**Figure 3.** The process of making Mix Reality software

The display of the *mixed reality* media prototype is as follows: The first, second and third pages that will appear the first time this application is run are the initial view of the creator of the topic of gravity and Kepler's laws that will be discussed. Then the name of the student and the origin of the school that must be filled in by the student appear. There are instructions for calibrating the gyro. Look at the image below!

**Figure 4.** *Mix Reality* media presentation process
Figure 5. Application Display (a). Initial display, (b). Gyro Calibration

Figure 6. Display of the main menu of Gravity and Kepler’s Law

The main menu consists of a status containing the name and the active simulation. Active simulation is a sign when the augmented reality sub menu is clicked. In addition, on the main menu there are:
1. Core competencies and basic competencies (KI and KD)
2. Material
3. Evaluation
4. Augmented Reality (AR)
5. Lights. The lamp here is used to add light.

Figure 7. (a). Core competencies, (b). basic competencies

Submenu content includes: 1) Newton’s law of gravity, 2) the general gravitational constant, and 3) the resultant gravitational force. 4) Calculating the mass of the earth, 5) Calculating the mass of the sun, 6) Gravitational field and gravitational field strength, 7) Satellite movement, 8) Planets and Kepler’s laws
In the general gravitational constant, it is shown how the Cavendish balance experiment was carried out by Henry Cavendish.

(a)  
Figure 8. (a), (b) Newton's law of gravity

(b)  
(a)  
Figure 9. (a) General gravitational constant (G), (b). Resultant gravitational force

(b)  
(a)  
Figure 10. (a) Calculating the mass of the earth, (b). Calculating the mass of the sun

(b)  
Figure 11. Gravitational field and gravitational field strength

In the image below, the motion of the satellite is accompanied by a visual explanation or recorded.

(a)  
Figure. 12. (a) Motion of the satellite, (b). Planets and Kepler's laws (complete with sound recordings when explaining material).
When using augmented reality, there is a submenu that includes: AR gravity of two bodies, AR resultant two gravity, AR mass of the earth, AR earth around the sun, AR satellite movement, AR geocentric model, and AR heliocentric model.

4. Conclusion

Based on the results of the discussion on the development of the Mix Reality (MR) media prototype for gravity and Kepler's laws, the application of mixed reality media can be used by students optimally because it can display 3D material equipped with audio and practice questions, so that it can make it easier for students to understand the material. This media also uses a point center as a convenience for students to apply it.

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