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# Development of Digital Learning Media Applications With Augmented Reality Animalia Material to Improve Understanding of Concepts and Interest in Learning For Class X High School Students

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**ABSTRACT**

This study aims to determine the feasibility and effectiveness of digital learning media with augmented reality which was developed to improve students' understanding of concepts and interest in learning. This research is Research & Development using the Design and Development Research (D&DR) model which consists of four stages, namely analysis, planning, production, and evaluation. This research was conducted at SMAN 1 Prambanan, Sleman. The test subjects were students of class XI MIPA to obtain student response data, while the research sample was class X students to obtain data on the effectiveness of using media. Data collection techniques include questionnaires to obtain product feasibility data, while multiple-choice tests and learning interest questionnaires are used to obtain data on the effectiveness of media use. The results of the media feasibility questionnaire were analyzed descriptively, while the results of the data for the media effectiveness test were analyzed by the Mann-Whitney test and the Independent Sample T-test. The results showed that the development of augmented reality media on animalia was declared feasible with a score of 95.3% (media expert), 96.5% (material expert), 93.2% (biology teacher), and 81.2% (student response). The effectiveness of learning animalia material by using AR media is not effective compared to learning without AR media in increasing students' understanding of concepts and interest in learning. However, there is a tendency to increase understanding of concepts and students' greater interest in learning with AR media. The developed AR media is suitable for use in learning biology, especially animalia material, but it is not effective. This is because AR media can only be used on smartphones with the Android operating system, for this reason, it is necessary to develop AR media that can be used with other operating systems.

## Introduction

In the current 21st-century era, the development of science and technology is increasingly advanced and has an impact on various fields including education (Sujana & Rachmatin, 2019; Ghavifekr & Rosdy, 2015). Examples can be seen from changes in the way to get more diverse information, including through online learning, mobile learning, social networking learning, and other 3D-based technologies (Serdyukov, 2017). The role of technology in learning, among others, can improve the quality of learning and facilitate flexibility in the student learning experience (Lawrence & Tar, 2018). The use of technology can also help students understand and retain concepts better (Raja & Nagasubramani, 2018). Thus, learning becomes more flexible and efficient (Zhu et al., 2016).

Learning by utilizing information and communication technology is very relevant to current conditions. This is caused by two things, the first is the rapid development of information and communication technology systems. Second, the situation and condition of the world that is being faced with the Covid-19 pandemic. During a pandemic, all human activities around the world are limited, including in the field of education (Coal, 2021). Likewise, in Indonesia, a policy has been set that the learning process that is usually carried out in schools is changed to distance learning with an online system. The implementation of distance learning can be assisted using applications, digital platforms, and other media that can support learning (Far et al., 2020).

Such conditions turned out to cause problems in learning. Quoting from the Puspendik website (2019) related to data on mastery of national high school exam materials in Indonesia, it is known that the percentage of students who answered correctly on the indicator identifying certain groups of animals based on their characteristics on a national scale was 30.16%, on the D.I provincial scale. Yogyakarta is 32.44% and on the scale of Yogyakarta City is 39.55%. Based on these results, the mastery of the material is still relatively low. Low mastery of the material is also associated with low concept understanding. Sidiq & Karnia (2018) stated that the lack of understanding of the concept causes low mastery of the material. Windriyati et al. (2017) added that in the learning process for students mastery of the material is very important because if students cannot master the material then basic competence (KD) cannot be achieved.

Based on the results of interviews with teachers of biology subjects at SMA N 1 Prambanan, Sleman, it is known that the teachers stated that the animalia material, especially the invertebrate group, is quite difficult because the scope of the material is too much. In addition, based on the results of the needs analysis questionnaire for class X students, it was found that 61% of students said that biology was difficult to learn and 67% of students stated that animalia, especially invertebrates, was difficult to understand. Students also said that this material contained a lot of memorization with a percentage of 94%.

Latifa et al. (2022) stated that the difficulties experienced by students were due to the many confusing terms and objects that could not be observed directly. Fikriyya & Sulistiyawati (2019) added that this material is material in the field of taxonomy so students are expected to be able to classify living things. However, this material cannot be learned just by reading, so it is necessary to have learning facilities that can support students in learning it.

Based on the needs analysis, it is also known that the teacher said that the difficulty in teaching animalia material was because the media used to teach the material was still inadequate. The media that teachers use so far are powerpoint, video, and preserved media. In line with that, students said that the media used by the teacher had not been able to help students understand the material being taught.

The need for learning support facilities that can visualize the material so that students can understand the concept can be fulfilled by using learning media, one of which is AR. Mustaqim (2016) states that AR media is a medium that can visualize concepts for understanding the structure of an object model. Nistrina (2021) adds that AR can convert information into visual forms that can display small, large, fast, and slow objects and can be seen with the naked eye clearly so that students will receive

learning in a visual form that is easy to understand.

Regarding AR media, when asked about the media, the teacher said that he had never used or even heard of the media. In addition, 80% of students said that they had never heard of the media. When asked about whether they needed other media (AR media) to help understand animalia (invertebrates), 96% of students said they needed it. Related to this, the results of data analysis on student ownership of smartphones are also known that 98% of students have Android-based smartphones, so it is assumed that if learning uses AR media, students can access the media for use in learning.

The results of the needs analysis related to students' interest in learning showed that during online biology learning 53% of students stated that they were not actively involved. This happens because students are less enthusiastic about distance learning activities. Students said that with the distance learning system, they found it difficult to understand the material.

The use of AR can be applied to various learning models, one of which is the discovery learning model. The selection of media and models is based on problems in learning. The problems found are the need for material visualization so that students can understand the concept and the low interest in student learning. The need for learning support facilities that can visualize the material so that students can understand the concept can be fulfilled by using learning media, one of which is AR.

About AR media, this media is 3D-based media. Abubakar et al. (2021) explained that media that has a high level of visualization skills such as 3D media can improve students' understanding. Wang et al. (2018) stated that related to this, AR media itself can increase students' understanding of the material being studied. In addition, Rozikin et al. (2018) state that AR has a considerable influence in increasing student interest in learning because it has an entertainment aspect and involves the interaction of all five senses, and can optimize the performance of the right brain with the visualization of colors and three-dimensional shapes. This statement is in line with the research by Ledyana et al. (2017) who succeeded in developing an augmented reality application to help and facilitate students in introducing animals.

Regarding the learning model, Septiawan et al. (2016) stated that one of the functions of the discovery learning model is to help students improve and enhance cognitive processes. This cognitive process is related to the ability of students to understand certain materials or concepts. Kelana & Wardani (2021) added that the discovery learning model also aims to generate interest in learning in students.

AR media that can visualize the material and objectives of the discovery learning model to improve the thinking process can be an alternative to overcome learning problems related to understanding concepts. In addition, the purpose of the discovery learning model is in line with the ability of AR media to increase student interest. Based on this explanation, the combination of discovery learning models and AR media is considered suitable to be used to overcome problems in learning. Purnamasari et al. (2016) added that through the application of AR with a discovery learning model, it is hoped that it can help students understand their concepts and apply ICT as a biology learning aid.

Based on these problems, to increase the interest in learning of Class X students, and change the learning process in the classroom to be more active and interactive when the teacher delivers animalia material. So, it is necessary to research the development of AR on animalia material to improve understanding of concepts and learning interest of Class X high school students.

## Method

This research uses the Design and Development Research (D&DR) development model. Richey & Klein (2009) refer to it as Design and Development Research, namely the systematic study of the design, development, and evaluation process to establish an empirical basis for the creation of instructional and non-instructional products and tools and new or improved models that govern their development. DRR consists of DDR type one and DDR type two. This research is

included in DDR type one. Susilawati et al. (2021) explained that DDR is type one, namely development research that directly produces products under certain conditions such as software for teaching materials. In addition, type one is used contextually, the product development process is based on the conditions described in the needs analysis and the evaluation of the final product. The stages of the D&DR model can be seen in Figure 1.

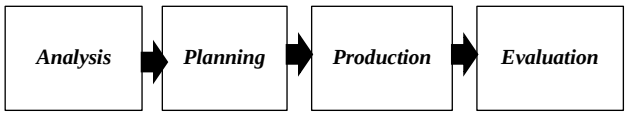


**Figure 1.** D&DR Model Stages
Source: Richey & Klein (2009)

Based on the development model used, the procedure for this development research is as follows:

**Analysis**

This stage begins with preliminary research. Activities carried out include measurement of learning needs, small-scale research, literature studies, and considerations of various existing problems.

**Planning**

After the analysis stage is carried out and finds the problems that exist in the field are, the next stage is planning. Planning in research includes activities to formulate research objectives, estimate funds, labor, and product development time.

**Production**

The next stage is production, namely developing Augmented Reality (AR) media on animalia material. The finished product is then validated by material experts, media experts, and biology teachers. The validation results in the form of suggestions and comments are used as the basis for revising the product phase 1. The revised product is then tested on students through limited trials. The results of student responses in the limited trial were then used as a basis for revising product phase 2. After the product was revised, a field test was then carried out using AR media in learning animalia material. Field trials were conducted using a quasi-experimental design, namely the Nonequivalent Control Group Design. At the production stage, researchers need 8 months

**Evaluation**

At this stage, an evaluation is carried out which aims to find out how high the product has met the specified specifications. In addition, this stage is carried out to see whether the product developed is by initial expectations or not and as a reference for further development processes.

The trial design in this study consisted of limited trials and field trials. The limited trial phase was carried out on one class of XI class high school students who had studied animalia material, while the field trial phase was carried out on X grade students of SMA Negeri 1 Prambanan Sleman which consisted of one experimental class and one control class. Sampling was done by non-random sampling with a purposive technique. The consideration in choosing the two classes is that the two classes have relatively equal cognitive abilities, the same number of students, or relatively the same, and are taught by the same teacher.

Data collection in this study used non-test and test techniques. Forms of non-test techniques used by researchers include observation, interviews, and questionnaires. The non-test technique was used at the stage of needs analysis, validation by experts, taking responses during limited trials, and getting responses related to student interest in learning. The test technique was used by researchers during field trials to obtain data on understanding the concept of animalia through pre-test and post-test, the test instrument used was in the form of multiple choice questions totaling 20 questions.

The questionnaire data in this study were analyzed descriptively. Furthermore, the questionnaire data in the form of scores (quantitative data) is then qualitative. The range of percentages and categories of qualitative assessment can be seen in table 1. While the results of the data for the AR media effectiveness test were analyzed by the Mann-Whitney Test and the Independent Sample T-test.

Table 1. Percentage Range and Qualitative Assessment Category

| No | Percentage Range (%) | Category level |
|---|---|---|
| 1 | 75 < Skor ≤ 100 | Very good |
| 2 | 50 < Skor ≤ 75 | Good |
| 3 | 25 < Skor ≤ 50 | Not good |
| 4 | 0 ≤ Skor ≤ 25 | Not very good |

Source: Modification of Riduwan (2015)

**Analysis of Increasing Students' Concept Understanding and Interest in Learning**

Data collection was carried out for 5 days, and the data collected amounted to 284 data. The data analysis technique of increasing students' conceptual understanding ability and interest in learning was carried out using the n-gain score by Hake 1999. The gain score value can describe how much the increase in student's conceptual understanding ability and interest in learning after using AR media in this study. The normalized n-gain score formula can be seen as follows:

$$g = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score}$$

The calculation results on the gain score value, it is then interpreted into the value (g) in Table 2, which is as follows:

Table 2. Gain Score Interpretation

| No | Score (g) | classification |
|---|---|---|
| 1 | g < 0.3 | low |
| 2 | 0.7 ≤ g ≤ 0.3 | currently |
| 3 | g > 0.7 | high |

Source: Susanto (2012)

**The Effectiveness of Using Augmented Reality (AR) Media**

The effectiveness of using AR media is done by testing the hypothesis. Hypothesis testing in this study aims to compare the mean of two unpaired sample groups. Fitria et al. (2021) state that the Independent Sample T-test is used if the parametric requirements are met (data in the form of ratios or intervals, the data comes from a population that is normally distributed and homogeneous). If the parametric requirements are not met, then the hypothesis testing is carried out with a non-parametric test using the Mann-Whitney test. The hypotheses in the research are:

a. H0: there is no difference in increasing the ability to understand concepts between students who are taught using AR media and students who are taught without using AR media
   H1: there is a difference in increasing the ability to understand concepts between students who are taught using AR media and students who are taught without using AR media
b. H0: there is no difference in increasing interest in learning between students who are taught using AR media and students who are taught without using AR media
   H1: there is a difference in the increase in learning interest between students who are taught using AR media and students who are taught without using AR media.

Decision-making basis:

1. If the significance value or sig.(2-tailed) > 0.05, then H0 is accepted and H1 is rejected
2. If the significance value or sig.(2-tailed) < 0.05, then H0 is rejected and H1 is accepted (Susanti, 2021)

## Results and Discussion

The product produced in this study is Augmented Reality (AR) animalia material to improve students' understanding of concepts and interest in learning. The display of the developed AR media application can be seen in Figure 2.

Figure 2. AR Media Display

The media that has been developed is then validated by media experts, material experts, and biology teachers to determine the feasibility of the product. The results of the validation of material experts in table 3, media experts in table 4, and biology teachers in table 5 are in the very good category. These results indicate that the developed AR media is suitable for use in biology learning activities, especially on animalia material.

Table 3. Feasibility Assessment Results by material experts

| No | Assessment Aspect | Score | Criteria |
|---|---|---|---|
| 1 | Relevance | 94% | Very good |
| 2 | Construct | 92% | Very good |
| 3 | Presentation Equipment | 100% | Very good |
| 4 | Language | 100% | Very good |
| | **Average** | **96.5%** | **Very good** |

Table 4. Results of Feasibility Assessment by media experts

| No | Assessment Aspect | Score | Criteria |
|---|---|---|---|
| 1 | Efficiency | 96% | Very good |
| 2 | Appearance | 90% | Very good |
| 3 | Achievement | 100% | Very good |
| | **Average** | **95.3%** | Very good |

Table 5. Biology Teacher Assessment Results

| No | Assessment Aspect | Score | Criteria |
|---|---|---|---|
| 1 | Appearance | 90% | Very good |
| 2 | Theory | 88% | Very good |
| 3 | Language | 100% | Very good |
| 4 | Application | 88% | Very good |
| 5 | Achievement | 100% | Very good |
| | **Average** | **93.2%** | **Very good** |

The results of expert validation are then used as a reference for revising the product. After the product was revised, a limited trial was conducted on students. Based on Table 6, it is known that the student assessment results are in the very good category. Viewed from the aspect of usefulness, students feel the benefits of AR media and learning activities become more fun. These results indicate that the developed AR media is suitable for use in biology learning activities, especially on animalia material, these results are in line with the research of Weng et al. (2016) that AR technology is a better tool for students in learning activities.

Table 6. Student Assessment Results

| No | Assessment Aspect | Score | Criteria |
|---|---|---|---|
| 1 | Appearance | 79% | Very good |
| 2 | Theory | 82% | Very good |
| 3 | Application | 77% | Very good |
| 4 | Usefulness | 84% | Very good |
| 5 | Achievement | 84% | Very good |
| | **Average** | **81.2%** | **Very good** |

After the limited trial was carried out, the next step was to revise the

product based on student suggestions and comments. The revised product is then used in learning biology for animalia. This stage is a field trial that aims to determine the effectiveness of using AR media in animalia learning to improve student's conceptual understanding skills and interest in learning. The data on the results of student's ability to understand concepts can be seen in Figure 3, and the results of the test for increasing the ability to understand concepts can be seen in Table 7.

Based on the results of the ability to understand the concept of the experimental class and control class, it is known that the minimum pre-test value of the experimental class is higher than the control class. Meanwhile, the minimum post-test scores for the experimental and control classes were the same. Meanwhile, the maximum pre-test and post-test scores for the experimental class were higher than the control class. The average pre-test score for the control class is higher than the experimental class, but the post-test score for the experimental class is higher.

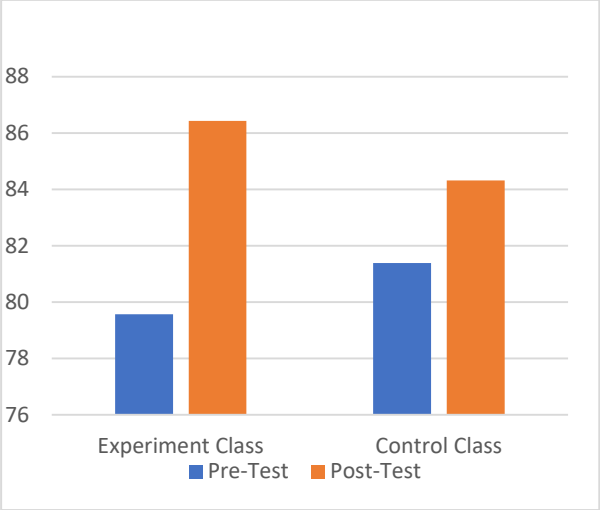


Figure 3. Concept Understanding Ability Result Data

Based on Table 7, it is known that the increase in student's conceptual understanding in the experimental class is moderate, while in the control class, it is low. These results also indicate that the increase in the experimental class was higher than the control class.

Table 7. Test Results for Improving Concept Understanding Ability

| Average value | Experiment Class | Control Class |
|---|---|---|
| ***Pre-Test*** | 79.57 | 81.39 |
| ***Post-Test*** | 86.43 | 84.31 |
| ***Gain*** | 0.34 | 0.16 |
| ***Interpretation*** | Currently | Low |

The effectiveness of using AR media is known based on hypothesis testing. On the variable of concept understanding ability, hypothesis testing uses the Mann-Whitney test. Based on the results of the Mann-Whitney test in Table 8, it is known that the sig. (2-tailed) > 0.05 then H0 is accepted and H1 is rejected, meaning that there is no difference in increasing the ability to understand concepts between students in the learning process using AR media and students in the learning process without using AR media. Although there is no significant difference in effectiveness between the two classes, there is a tendency to increase students' conceptual understanding skills using AR media compared to those without AR media, with an increase in the medium category. Based on these results, it can be seen that the AR media used in learning has an impact on students' understanding of concepts. This result is in line with research by Aripin & Suryaningsih (2019) that the results of implementation in Biology learning the AR media developed are classified as effective and can improve of student learning completeness.

Table 8. Mann-Whitney Test Results

| | Learning outcomes | Conclusion |
|---|---|---|
| **Asymp. Sig. (2-tailed)** | .180 | H0 Received |

Data on the results of student interest in learning can be seen in Table 9, and the test results for increasing student interest in learning can be seen in Table 10. Based on these data it is known that the increase in learning interest in the experimental class is higher than in the control class, but the increase that occurs is included in the low category.

Table 9. Learning Interest Questionnaire Results

| No | Aspect | Average % | | | |
|---|---|---|---|---|---|
| | | Experiment Class | | Control Class | |
| | | Before | After | Before | After |
| 1 | Feeling happy | 66 | 71 | 70 | 68 |
| 2 | Attention | 71 | 73 | 71 | 71 |
| 3 | Interest | 72 | 73 | 70 | 71 |
| 4 | Involvement | 70 | 71 | 69 | 71 |
| | **Average** | **69.75** | **72** | **70** | **70.25** |

Table 10. Learning Interest Improvement Test Results

| Average | Experiment Class | Control Class |
|---|---|---|
| Before | 75.54 | 72.89 |
| After | 77.49 | 73.39 |
| *Gain* | 0.08 | 0.018 |
| Interpretation | Low | Low |

The effectiveness of using AR media is known based on hypothesis testing. On the variable interest in learning, hypothesis testing using the Independent Sample T-test. Based on the results of the Independent Sample T-test in Table 11, it is known that the sig. (2-tailed) > 0.05 then H0 is accepted and H1 is rejected, meaning that there is no difference in increasing interest in learning between students in the learning process using AR media and students in the learning process without using AR media. Although there is no significant difference in effectiveness between the two classes, there is a tendency to increase student interest in learning using AR media compared to those without AR media, with an increase in the low category. Based on these results, it can be seen that the AR media used in learning also has an impact on students' interest in learning. This result is in line with the research by Monita et al. (2019) that the use of augmented reality-based learning media in biology subjects is proven to be able to increase students' interest in learning biology which results in the expected learning outcomes being achieved.

Table 11. Test Results Independent Sample T-test

| | Questionnaire Results | Conclusion |
|---|---|---|
| **Sig. (2-tailed)** | .081 | H0 received |

The AR media developed was declared feasible but not effective in increasing the ability to understand concepts and students' interest in learning. There are many possibilities for this to happen, including the learning process does not run optimally because there are some students who are less cooperative in participating in learning. When asked to do tests, install applications do other activities, students do not work immediately, so the learning time is not as planned.

Another possibility is that students are not used to learning by using learning models. Moreover, the model used is discovery learning which requires students to be able to learn independently following the existing syntax, because when the learning process uses the discovery learning model students seem confused in following the learning. Alfitry (2020) explains that the shortcomings of the discovery learning model are that teachers and students are very accustomed to using the old style, so this discovery model will disappoint them. Manik et al. (2022) added that weak students tend to study below the desired standard. In addition, it can lead to misconceptions among students.

Another problem that occurs during the learning process is that some students have difficulty installing applications because their smartphones are not based on Android and smartphone memory is full so they cannot access AR media. Researchers deal with this problem by asking students to join their friends when learning using AR media. Based on this explanation, it can be concluded that the use of AR media which is classified as ineffective is also caused by various things such as student conditions, device conditions, and conditions during learning. Prastowo (2017) explains that there are no single media that is truly effective and efficient for all learning

situations and conditions, so it is necessary to combine learning media so that learning objectives can be achieved effectively and efficiently.

# Conclusion

The application of digital learning media with Augmented Reality (AR) animalia material developed is feasible to use to increase the understanding of concepts and learning interests of Class X high school students, but the use of digital learning media with augmented reality animalia material is not effective to increase the understanding of concepts and learning interests of high school students Class X Nonetheless, the development of AR media had an impact on understanding concepts and increased interest in learning. It was proven that learning using AR media showed better results than learning without using AR media.

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