



## Development of Android- Based Biodiversity Learning Media on Application of A Project-Based Learning Model to Increase Student Motivation and Learning Outcomes

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### Abstract

The problem of low learning motivation affects student learning outcomes. This is still found in biology learning about biodiversity material in various schools, including SMA N 12 Semarang. These problems can be anticipated by implementing appropriate learning models and applying science and technology to learning. The development of Android-based learning media in project-based learning (PjBL) was chosen as an alternative problem solving. This research aims to produce Android-based learning media for biodiversity material in the application of a project-based learning model to increase student motivation and learning outcomes which is declared effective and valid for increasing student motivation and learning outcomes, as well as knowing student responses to this media. This type of research is Research and Development (R&D) with reference to the ADDIE model. Sampling in this study used a purposive random sampling technique using 2 classes as the experimental and control classes. Data collection was carried out through interviews, questionnaires, test and non-test instruments. Data were analyzed descriptively quantitatively and independently sample t-test or Mann Whitney, and N-Gain. The research results showed that the Android-based learning media developed was declared very valid and suitable for use based on the assessment of expert lecturers and teachers. Learning media was stated to be effective in increasing students' motivation and knowledge learning outcomes with moderate N-Gain, and improving students' skills, but was not effective in increasing attitude scores. The results of students' responses to the practicality of the media include quite practical criteria.

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## INTRODUCTION

The problem of low learning motivation affects student learning outcomes. This problem is often faced by biology subject teachers in various materials, including biodiversity material. Many students feel that learning biology is difficult, boring, seems monotonous, the learning is less contextual, based on memorization, and less interesting in learning biology (Adawiyah, 2019). One of the less interesting aspects can be caused by less interesting learning media. Another problem encountered is the lack of interest in biology learning, which is one of the factors causing low student learning motivation, for example teacher-centered learning is one of the factors causing low student learning motivation (Garnasih, 2018). Based on the results of observations and interviews at SMA N 12 Semarang, the teacher revealed that the learning media used there for biodiversity material was still in the form of PowerPoint (PPT) and learning videos, with learning in the form of discussions, presentations and quizzes. According to the teacher, the minimum level of completion is still around 60-75% of all students and motivation to learn is still considered sufficient.

Responding to the problem of low learning motivation which influences student learning outcomes, can be anticipated by applying science and technology to biology learning. Apart from that, implementing the right learning model can also have a positive impact on biology learning. One implementation of these efforts is innovation in learning media and the application of appropriate learning models. The development of Android-based learning media and the application of a project-based learning model is considered to be the right effort to address these problems.

The development of Android-based learning media in biology is an innovation in itself, for example the development of application-based biology learning media on circulatory system material (Asikin et al, 2020), virus material (Irpandi, 2020), and the respiratory system (Damanik, 2021). Android-based learning media makes it easy for students to access and study material without limitations of space and time. Android-based learning media is considered more efficient than books, where books are large and impractical to carry directly, making students need special time and place to study (Lestari & Saputro, 2020). Apart from that, several previous research states that Android-based learning media can maximize learning so that it can increase student motivation and learning outcomes. Research by Pujiasih et al (2021) revealed that the use of technology in learning, in this case Android-based learning media, can have a positive impact on students' interest in learning.

The research results of Lestari & Saputra (2020) revealed that the Android-based mobile learning developed had valid, practical and effective criteria. This shows that this media can improve learning outcomes. Similar results were revealed in research by Setiawati et al., (2019) regarding E-Atlas media on cell structure and function, based on learning effectiveness showing an increase in aspects of knowledge. Another research by Amalia (2020) related to Android-based interactive media being developed, with the level of effectiveness showing an increase in knowledge with an average N-gain of 0.49 (medium) and students' classical completeness reaching 100%.

The implementation of PjBL in learning biodiversity material is in line with the characteristics of the 2013 curriculum (before and after the pandemic), and the independent curriculum (after the pandemic) which emphasizes student-centered active learning. The application of PjBL or project-based learning can improve student learning outcomes, as stated by Saepudin, (2022) if the Project Based Learning model is implemented, it can improve student learning outcomes in growth and development material. Another research by Muktisari, (2017) applying PjBL to biodiversity material, revealed that the Project Based Learning learning model with Fotonovela media was effective in improving student learning outcomes.

As time progresses, the trend of 21st century science learning, which was initially limited to the 4C aspects, is now starting to make adjustments. This adjustment takes the form of transformation into 6C abilities or skills. The 6C skills which were originally 4C consisted of critical thinking, creative skills, communication skills, collaborative skills, as well as additional computing skills and compassion. There are 2 additional skills in the form of computation skills and compassion. These changes are based on the demands of current developments. The addition of these 2 aspects is due to the fulfillment of the achievements to be achieved, namely 21st century skills that foster HOTS (high order thinking skills), which include Communication, Collaboration, Critical Thinking, Creative Thinking, Computational logic, Compassion and Civic Responsibility (Martini *et al.*, 2022).

The media development designed by the research not only focuses on solving the problem of low motivation and student learning outcomes, but also learning outcomes are viewed from 3 aspects, namely the cognitive aspect which is commonly discussed, the affective aspect related to environmental care attitudes and the psychomotor aspect of biodiversity material. In the research to be carried out, the researcher took one of the 6Cs, namely compassion, this choice is in accordance with the material that will be used in the learning, namely biodiversity. Compassion or awareness taken in this material is awareness of protecting the environment in order to preserve existing diversity. This awareness of protecting the environment is expected to foster a conservative attitude or character in students, so that it can have a positive impact in the future.

Based on the description above, it is felt that there is a need to develop Android-based learning media for biodiversity material integrated with project-based learning models to increase student motivation and learning outcomes. This is done in response to the problem of low motivation and student learning outcomes in biodiversity material. Media development is adapted to developments in science and technology so that it is hoped that it can further maximize learning about biodiversity material, besides that it can become a new innovation in the development of learning media in the education sector.

## RESEARCH METHODS

The type of research used is Research and Development (R & D) with the development model used in this research being the ADDIE model, namely: Analysis, Design, Development, Implementation, Evaluation. The subjects of this research were class X students at SMA N 12 Semarang. The sample in this study was students in classes XE-6 and XE-9. Class XE-6 was used as the control class and class XE-9 as the experimental class with the number of students in each class being 36 people. The sample was selected using a purposive sampling technique, taking into consideration the academic abilities and characteristics of students in the two classes. Data obtained through test instruments in the form of test questions and non-test instruments in the form of student learning motivation questionnaires, student product assessment sheets, student learning motivation observation sheets, student response questionnaires on learning models, student and teacher response questionnaires to learning media, and observation sheets presentation of student products that have been.

Research data was analyzed descriptively qualitatively and quantitatively. The technique used is percentage calculation and qualitative descriptive analysis in the media development process, expert lecturer validation data and student and teacher response questionnaire results. The validity percentage validity equation is as follows:

$$V\text{-expert/response} = \frac{\text{total score achieved}}{\text{expected total score}} \times 100\%$$

The quantitative descriptive data on learning motivation (motivational questionnaires and observation sheets), knowledge learning outcomes (test questions), attitudes (environmental care attitude questionnaire) and skills (product assessment sheets and product presentations) were analyzed using different tests, t-test (parametric) on knowledge learning outcomes data, attitude values (environmental care attitudes) and learning motivation as well as the Mann Whitney test (non-parametric) on student skills data, N-Gain test on students' knowledge learning outcomes. The media developed by researchers is declared effective if the t-test and Mann Whitney test results have a significance value of  $<0.05$ , and the average N-Gain value in the experimental class reaches at least the medium category.

$$N\text{-Gain} = \frac{\text{post-test score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}$$

## RESULTS AND DISCUSSION

The results of research on the development of Android-based learning media for biodiversity material integrated with project-based learning models to increase student motivation and learning outcomes are as follows.

### 1. Validity of Android-Based Learning Media

The validity of learning media is obtained based on the validation results of media experts, material experts, research instrument validation and also teacher responses to the media developed by researchers. The following is a description of the results of each validation:

### 1. Media Expert Validation

Media expert lecturers provide assessments and input on learning media products. The following are the results of media expert validation.

**Table 1.** Summary of Media Expert Validation Analysis Results

Rated aspect	Score obtained	Maximum Score	Percentage (%)
Presentation Aspect	23	24	95,8
Effectiveness Aspect	8	8	100
Graphic Aspects	23	24	95,8
Total score achieved	54		
Maximum total score		56	
Overall percentage			96,4
<b>Criteria</b>			<b>Very Valid</b>

The final results of the media expert validation obtained an average of 96.4% which is included in the very valid category.

### 2. Material Expert Validation

Material expert lecturers provide assessments and input on learning media products. Below are the results of material expert validation.

**Table 2.** Summary of Material Expert Validation Analysis Results

Rated aspect	Score obtained	Maximum Score	Percentage (%)
Conformity of application content to the curriculum	8	8	100
The truth of the concept of matter	4	4	100
Accuracy of material coverage	3	4	75
Sequential delivery of material	4	4	100
Material suitability with technological development	4	4	100
Suitability of images to clarify the material	3	4	75
Suitability of the level of difficulty with the cognitive development of class X students	4	4	100
Total score achieved	30		
Maximum total score		32	
Overall percentage			93,75
<b>Criteria</b>			<b>Very Valid</b>

The final results of the material expert validation obtained an average of 93.75% which is included in the very valid category.

### 3. Validation of Research Instruments

The research instruments used consist of test and no-test instruments. The following are the results of the validation of the test instrument.

**Table 3.** Summary of Test Instrument Validation Analysis Results

Rated aspect	Score obtained	Maximum Score	Percentage (%)
Clarity	8	8	100
Content Accuracy	8	8	100
Relevance	4	4	100
Validity	4	4	100
No Bias	8	8	100
Language Accuracy	12	12	100
Total score achieved	44		
Maximum total score		44	
Overall percentage			100
<b>Criteria</b>			<b>Very Valid</b>

The final results of the validation of the test instrument obtained an average of 100% which is included in the very valid category. The results of the non-test instrument validation are as follows.

**Table 4.** Summary of Non-Test Instrument Validation Analysis Results

Rated aspect	Score obtained	Maximum score	Percentage (%)
Material	7	8	87,5
Construction	11	12	91,6
Language	7	8	87,5
Total score achieved	25		
Maximum total score		28	
Overall percentage			89
<b>Criteria</b>	<b>Very Valid</b>		

The final results of the non-test instrument validation obtained an average of 89% which is included in the very valid category.

#### 4. Biology Teacher Response

The Biology teacher who provides assessment and input on this learning media product is a biology teacher in class X. The following is a presentation of the data from the validation of the teacher's assessment.

**Table 5.** Summary of Teacher Response Results

Rated aspect	Average Score Percentage (%)		Final average (%)
	Teacher 1	Teacher 2	
Practicality	75	87,5	81,25
Clarity	75	75	75
Curiosity	81	75	78
Spirit	75	75	75
Convenience	75	75	75
Interest	81,3	81,3	81,3
Overall percentage			78
<b>Criteria</b>	<b>Quite Practical</b>		

Based on the assessment of biology teachers in all aspects, an average percentage of 78% was obtained, which was included in the quite practical category. So it can be stated that Android-based biology learning media on biodiversity material is considered practical. Based on this validation, several inputs and suggestions were obtained which were then evaluated on the resulting product. The following displays the results of the development of learning media in Figure 1.

As for revision notes, such as writing scientific names in material that was previously found to be not in accordance with the correct procedure for writing scientific names of species, namely not written in italics. Writing scientific names is usually called Binomial Nomenclature (Anofrizen, 2020). There are other notes from the material validator in the form of examples of biota names, some parts of which are equipped with plant and animal names, so that the examples given are more comprehensive and complete. Another thing that is used as material for evaluation and advice from media experts is input related to paying more attention to content so that the displays in the media are proportional.

After the process of improving and revising the product according to the validation results, it continues with a small-scale trial process which is a stage of the ADDIE process. Small group trials were carried out in class XI F-4 SMA N 12 Semarang. Small group trials obtained results from student media response questionnaires, stating that the media developed was declared quite practical with a gain of 70%. The following is a view of the media before and after revision in Figure 2.

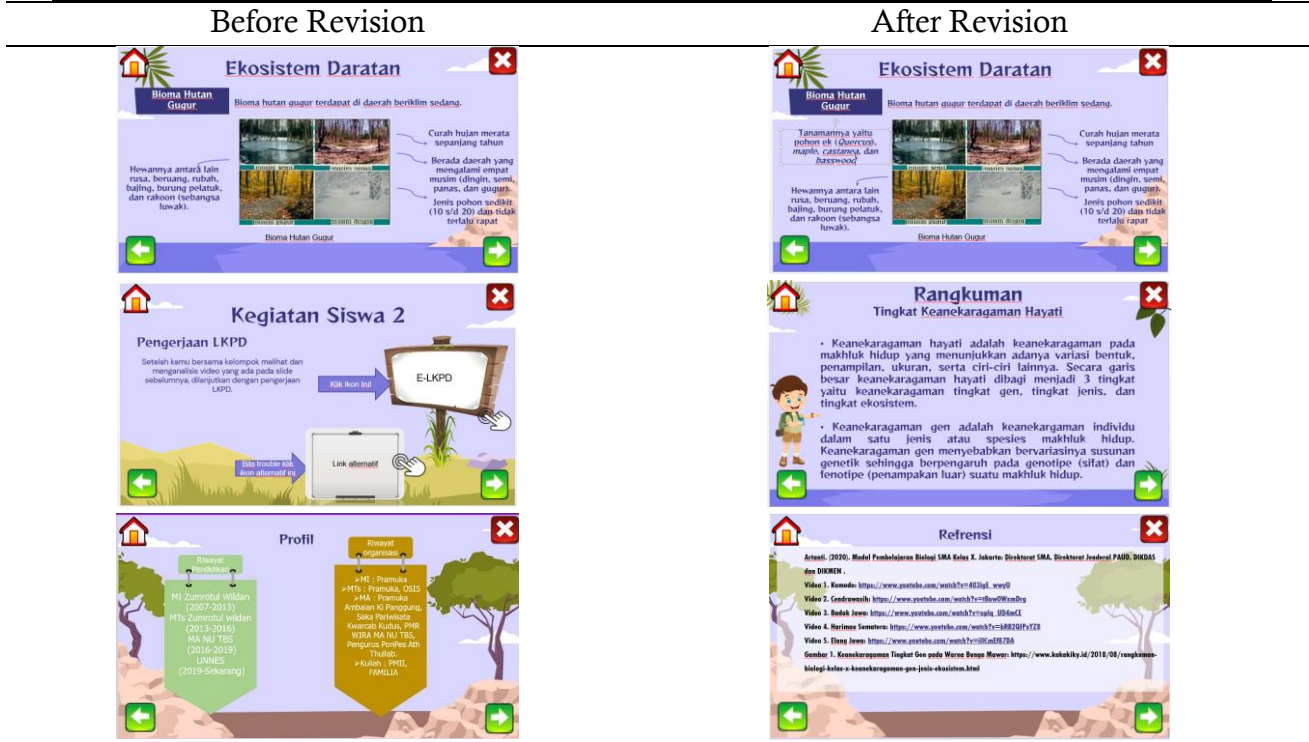
The implementation stage was carried out with the aim of testing the practicality and effectiveness of Android-based biology learning media with biodiversity material which was also integrated with the PjBL model during its implementation. In other words, this implementation stage is a large-scale trial stage in the experimental class which uses the learning media, compared to the control class which only applies the PjBL model without using the media developed by the researcher.

Figure 1 Media Product Display

Product Display



Figure 2. Comparison before and after revision



## 2. Effectiveness of learning media to increase motivation and learning outcomes

The effectiveness of learning media is measured at the large-scale media implementation stage. Implementation was carried out in both classes, namely the experimental and control classes, which implemented the same project-based learning model for biodiversity material, while the difference was that the experimental class used Android-based learning media for biodiversity material integrated with the project-based learning model. The two classes were seen to be different in terms of motivation and learning outcomes. Furthermore, learning outcomes are described into 3 domains, namely cognitive, affective and psychomotor domains.

Researchers use the project-based learning (PjBL) model in learning biodiversity material, because they see the implementation of an independent curriculum which is in line with the characteristics of PjBL, where students are required to be active and teachers act as facilitators in learning. The learning flow as a series of research begins with the initial learning session, where the teacher provides an introduction to the learning material, and apperception to recall students' memories regarding the material that has been studied. Followed by the teacher conveying the learning objectives and explaining the guidelines for using biodiversity media applications (in the experimental class). Explanation of media usage guidelines is very important, so that students can operate the media smoothly without any difficulty in navigating the media or understanding the existing features. After that, a pre-test was carried out in both classes to determine students' initial knowledge regarding the material being taught. The pre-test is carried out before delivering the material with the aim of determining the level of mastery of the material by students (Magdalena *et al*, 2021). The application of media to learning is expected to improve learning outcomes and student motivation, where innovation applied to Android-based learning media integrated with project-based learning models is assumed to be able to maximize student learning experiences, so that it can support the learning process, increase learning outcomes and student learning motivation.

The use of Android-based learning media in the experimental class received a positive response and increased student activity, this was because students were motivated and interested in the media they used when learning. Similar things were also found in research by Fawziah *et al.*, (2018), biology learning that implements Android-based learning media can simplify the material and make learning more interesting and innovative, this makes students more active when learning in class. There is more detail in implementing the PjBL model through 7 stages, namely, (1) determining basic questions; (2) organizing students into learning; (3) designing project planning; (4) prepare a manufacturing schedule; (5) monitor project activity and development; (6) test results; (7) evaluation of learning experiences.

Testing the effectiveness of Android-based learning media, researchers gave a pre-posttest at the beginning and end of the lesson, to determine the effect of Android-based learning media between the control

class and the experimental class, in measuring learning outcomes in the cognitive domain. The measurement of student learning motivation between classes that use media and those that do not, is measured by looking at the level of learning motivation through a learning motivation questionnaire and observing learning motivation during the implementation of learning in class. Measurement of learning outcomes in the affective domain related to attitudes towards caring for the environment is measured by filling in a questionnaire regarding attitudes towards caring for the environment. The questionnaire is filled in by both classes, both control and experimental, after which the results of the questionnaire are compared between the two classes with the differentiating aspect, namely the use of Android-based learning media. As for learning outcomes in the psychomotor domain, they were measured based on the results of student project assignments, these assignments had previously been carried out in groups, then based on the results of the project assignments of the two classes they were compared to find out the differences in learning outcomes in classes that used Android-based learning media and those that did not use the media.

### 1. Effectiveness of Media to Increase Student Learning Motivation

The effectiveness of the media in increasing students' learning motivation is seen based on the results of students' learning motivation scores in the experimental class and control class. The comparison of the average student learning motivation score in the experimental class was 83, while in the control class the average project assignment score was 75. Furthermore, in measuring the effectiveness of media to increase student learning motivation, in this case it was measured through a student learning motivation questionnaire and student learning motivation observation sheet, statistical data analysis was carried out. Statistical data analysis using the independent sample *t-test*. This independent sample *t-test* was used to determine whether there was an effect of treatment using Android-based learning media in the class that was used as the research subject.

The existing student learning motivation data has gone through the prerequisite tests, the results are that the data is normally distributed and homogeneous, so it can proceed to the independent sample *t-test*. Based on the results of the independent sample *t-test*, the sig. (2 tailed) value was 0.000, less than 0.05, which means that the treatment given had an effect on increasing student learning motivation. The use of Android-based learning media in experimental classes makes students more enthusiastic and active in learning and completing assignments. This was observed by researchers during learning, where the media aroused students' curiosity about the existing material.

Apart from that, the Android-based learning media developed has the advantage that it can be operated by users easily, because this media is equipped with a controller so that users can choose what they want for the next process which inspires students' active attitudes. This media also consists of audio, visual and motion (interactive). This media is able to provide direct experience for students to be more active in learning. Apart from that, learning media produced by iSpring Suite 10 can be exported into several file forms such as executable (exe), HTML5 (Hanisah *et al*, 2022).

Apart from that, the attractiveness of the media makes students enthusiastic about learning. This was expressed by students that the Android-based learning media developed was interesting and good, easy to use. These results are in line with research by Andayani (2021) which explains that the ease of operation of a learning media will influence students' desire to use it (Andayani, 2021). This is reinforced by research by Nofindra, (2019) that repetition of material can help students process information from short memory to long term memory. Good memory will cause students to be able to learn easily and obtain optimal learning results.

### 2. Media Effectiveness in Improving Knowledge Learning Outcomes

Knowledge Learning Outcomes are one of the aspects assessed in this evaluation stage. Student learning outcomes in the cognitive domain are measured using test research instruments, namely test questions. The results of the summary of students' level of completion are as follows.

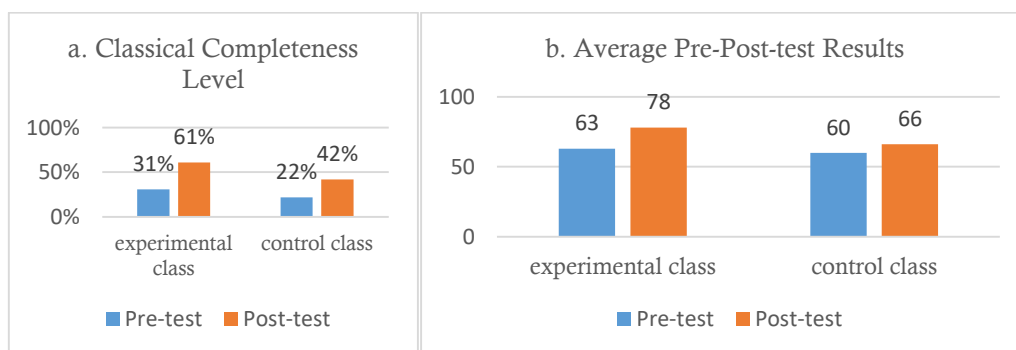




Figure 3. Pre-Post-test Results Summary Graph; a. Classical completion level graph; b. Pre-Post-test Average

The learning carried out in both classes was carried out according to the research design designed. After the learning was carried out, the researcher gave a post-test to the two classes. In both classes there was an increase in learning outcomes, seen based on the post-test achievements in both classes. This is similar to the findings of Mundaeng *et al.*, (2023) who stated that the application of the PjBL learning model in biology subjects regarding the growth and development of living creatures can improve student learning outcomes and achieve maximum results.

Higher learning outcomes in experimental classes that use Android-based learning media indicate better student understanding when using this learning media, where the media is equipped with explanations and pictures for each topic as a visualization of material related to biodiversity. This is in line with the research findings of Yuliana *et al.*, (2019), there was an increase in student learning outcomes in classes that used booklet media based on conservation attitudes equipped with attractive pictures and complete explanations compared to classes that used picture media on biodiversity material.

The effectiveness of the media in improving student learning outcomes in the cognitive domain (knowledge) is seen based on the implementation of the posttest. In the Experiment Class, the percentage of students completing the posttest was 61%, while in the control class, the percentage of students completing the posttest was 42%. So it can be seen that classes that use Android-based learning media developed by researchers and apply the PjBL model to their learning show better results than classes that apply the PjBL model without using Android-based learning media.

Apart from comparing the average post-test results between the experimental class and the control class, it was further analyzed statistically to determine the effectiveness of the media in improving learning outcomes in the cognitive domain, namely by using the independent sample *t-test*. This independent sample *T-test* was used to determine whether there was an effect of treatment using Android-based learning media in the class that was used as the research subject. The existing student learning outcomes data has gone through the prerequisite tests, the results are that the data is normally distributed and homogeneous, so it can proceed to the independent sample *t-test*. The results of the independent sample *t-test*. The result obtained was a sig.(2 tailed) value of 0.001, less than 0.05, which means that the treatment given had an effect on improving student learning outcomes in the cognitive domain.

Furthermore, regarding the level of effectiveness of Android-based learning media in improving student learning outcomes in the cognitive domain, reviewed based on the N-Gain value for the experimental class, the average N-Gain value was 0.4, which is in the medium category, while in the control class without using Android-based learning media, the average N-Gain value is 0.1, which is included in the low category. The difference in existing and superior cognitive learning outcomes in the control class indicates that the use of learning media can improve learning outcomes. In Lema & Dewi's research, (2023) also revealed that the use of learning media can improve student learning outcomes, where the media used in their research is the Biodiversity E-module. Research by Pujiasih *et al* (2021) also revealed that classes that use Android-based e-booklet media on biodiversity material can improve students' knowledge learning outcomes with an N-Gain value of 53% or 0.53.

The application of the project-based learning (PjBL) model in both classes, both the experimental class and the control class, has had a positive impact, seeing that student learning outcomes in both classes have increased. By looking at the comparison of the pre-post results in the two classes, there was an increase and it was higher in the experimental class. Similar results showing a positive impact on the implementation of PjBL were expressed by Mulyani *et al.*, (2023) in their research if the level of effectiveness of implementing the project-based learning model on students' creative thinking abilities in biodiversity material was included in the effective category with an average gain percentage of 78.53%.

### 3. Media Effectiveness to Improve Student Attitude Value (Environmental Care Attitude)

The affective Student Attitude Value (Environmental Care Attitude) referred to in this research are students' environmental care attitudes related to environmental awareness in the context of preserving biodiversity. Students' environmental caring attitudes were measured using an environmental caring attitude questionnaire. Based on the results of the recap of the environmental care attitude questionnaire, the results for the experimental class were obtained with a percentage of student answers of 76% which was included in the good category. Meanwhile, the control class had a percentage of student answers of 75% which was included in the good category.

**Table 6.** Summary of Environmental Concern Attitude Questionnaire Results

Rated aspect	Percentage of Class Results (%)			
	Experiment	Category	Control	Category
Concern for environmental conservation	72,8	Good	72,9	Good
Support and agreement to care for and maintain biodiversity	78,7	Good	76,5	Good
Average	75,75=76	Good	74,7=75	Good

Aspects of concern for environmental conservation, based on the results of the environmental care attitude questionnaire, the average percentage in the experimental class was 72.8%, while in the control class it was 72.9%, both of which were in the good category. Proper ecological knowledge will create awareness or action to care for and preserve the environment (Sopiani *et al.*, 2019). Where in this aspect students were given several statements regarding their understanding of environmental conservation knowledge, the results of the questionnaire revealed that both classes were in the fairly good category for their environmental conservation knowledge. In agreement with the research of Pujiasih et al (2021), the application of Android-based e-booklet media obtained an average environmental care attitude score of 81.8%, which is included in the very good category.

Aspects of support and approval for caring for and preserving biodiversity, based on the results of the environmental care attitude questionnaire, the average percentage in the experimental class was 78.7%, while in the control class it was 76.5%, both of which were in the good category. A person's support and approval in an environmental conservation effort, which in this case is taking part in protecting the surrounding biodiversity. Getting used to caring about the environment will help preserve the environment (R. Tanjung *et al.*, 2023). Instilling an attitude of caring for the environment can be done with basic things, namely aspects of students' knowledge regarding biodiversity and its threats and how to preserve it. Knowledge is closely related to students' attitudes towards biodiversity conservation (Leksono in Yuliana *et al.*, 2019). An attitude of caring for the environment is obtained through learning process treatments that are linked to events that match the reality of the environment to maintain and preserve existing biodiversity. So that students are more sensitive to the surrounding environment and there is a willingness to participate in preserving the environment, which in this scope is biodiversity so that it does not experience extinction.

The effectiveness of the media in improving student learning outcomes in the affective domain (attitudes) can be seen based on the results of the environmental care attitude questionnaire in the students' experimental class and control class. Furthermore, in measuring the effectiveness of the media in improving student learning outcomes in the affective domain (attitudes) related to environmental care, statistical data analysis was carried out. Statistical data analysis was carried out using the independent sample *t-test*. Data on student learning outcomes in the affective domain have gone through the prerequisite tests, the results of which are normally distributed and homogeneous. Based on the results of the independent sample *t-test*, the results obtained were a sig. (2 tailed) value of 0.692, more than 0.05. The results of the independent sample *t-test* showed that there was no difference in the average student learning outcomes in the affective domain (attitudes) related to attitudes about caring for the environment.

This indicates that if the treatment given in the experimental class does not significantly improve students' learning outcomes in the affective domain, it could be due to the cultivation of an environmentally caring attitude related to aspects of students' knowledge regarding biodiversity and its threats as well as ways of preserving it, which is less than optimal, thus affecting the environmentally caring attitude. is on the students. Another aspect that can cause students' lack of environmental care is in the form of students' personal internal and external factors that influence their environmental care attitude. For example, students' internal factors in the form of a sense of individual responsibility, where a sense of individual responsibility in protecting the environment can make a difference in the results of environmental care attitudes in both research classes, this was also expressed by Aprilia *et al.*, (2024) internal factors that influence the process implementation of the Adiwiyata school program in forming environmentally caring character at SMP N 1 Labuapi apart from teachers are students who are related to a sense of individual responsibility.

External factors from the student's personality that influence the attitude of caring for the environment are the environment around the student, the environment around the student which supports and exemplifies, getting used to an attitude of caring for the environment will support the implementation of an attitude of caring for the environment, and vice versa, the environment around the student does not support the implementation of an attitude of caring for the environment. make students' environmental care attitudes low. Aspects of the surrounding environment influence students' attitudes, for example the school

environment (Mu'minin *et al.*, 2021). Apart from the school environment as well as the family environment, the community environment influences students in getting used to an attitude of caring for the environment. When the surrounding environment does not support the implementation of an attitude of caring for the environment, it will be difficult to develop an attitude of caring for the environment which will further influence a person's awareness of caring for the environment.

#### **4. Media Effectiveness to Improve Learning Outcomes in the Psychomotor Domain (Skills)**

In this case, student learning outcomes in the psychomotor (skills) domain are measured through students' work on project assignments. The project assignments are a series of student activities that were previously discussed during class learning sessions regarding the topics worked on by each group. The project assignment takes the form of a paper/article related to biodiversity conservation, and also the final product in the form of a digital campaign on student social media in the form of a short video or poster to campaign for the importance of preserving biodiversity in Indonesia. The final results of the assessment are a summary of individual student scores. The results of the assessment in the experimental class obtained an average project assignment score of 82, while those in the control class obtained an average project assignment score of 79.

Project-based learning is carried out in accordance with the PjBL syntax. Project assignment activities consist of several main activities in the form of an initial discussion related to the material topic where at the first learning meeting as a prologue to the assignment, namely about the distribution of flora and fauna in Indonesia and a lighter video as a learning aid, related case studies preserving biodiversity, especially protected animals in Indonesia. As stated by Filla & Mudinillah, (2022) the use of learning aids during learning can generate new desires and interests, raise enthusiasm for the learning process, and can even have an effect on students' mental health. Students' knowledge of biodiversity, which is directly related to an attitude of caring for the environment, is an important aspect in fostering an attitude of caring for the environment. As stated by Chutte & Bhullar (in Cendikia *et al.*, 2023) environmental knowledge will have an impact on changing individual attitudes towards preserving the surrounding environment.

The effectiveness of media in improving student learning outcomes in the psychomotor (skills) domain is seen based on the results of project assignment scores in the experimental class and control class. The comparison between the average project assignment scores in the experimental class was 82, while in the control class the average project assignment score was 79. Based on the results of the average project assignment scores for the two classes, there was a slight difference in the average results, a difference of 3 points.

Furthermore, in measuring the effectiveness of media to improve student learning outcomes in the psychomotor domain (skills), which in this case is measured through project assignments carried out by students, statistical data analysis was carried out. Statistical data analysis was carried out using the Mann-Whitney test. The Mann-Whitney test was used to determine whether there was an effect of treatment using Android-based learning media in the class that was used as the research subject. In statistical analysis, the Mann-Whitney test is used because the data prerequisites that must be met for the independent sample *t-test* are not met, in the form of data that is normally distributed and homogeneous. Data on student learning outcomes in the psychomotor (skills) domain have gone through the prerequisite tests, the results of which are that the data is not normally distributed and homogeneous. so it cannot proceed to the independent sample *t-test*, and finally uses the Mann-Whitney test. Based on the results of the Mann-Whitney test, the Asymp value was obtained. sig.(2 tailed) is 0.005, less than 0.05, which means that the treatment given has an effect on improving student learning outcomes in the psychomotor (skills) domain.

This is because the use of Android-based media in experimental classes makes learning more interesting and students gain their own experience in operating this media. The existing media features and content make it easier for students to understand the material, where understanding the material is one of the factors that influences the results of students' project work. Understanding biodiversity material will have an impact on changing individual attitudes towards preserving the surrounding environment (Cendikia *et al.*, 2023), and the direct action of individual students in expressing their attitude of caring for the environment in the form of work, namely the task of a digital campaign project for biodiversity conservation.

### **3. Student response to the media and learning applied**

#### **1. Student Response to Learning Media**

One aspect that is discussed in the evaluation regarding media is students' responses to the practicality of the media. To see student responses, suggestions and input regarding the media developed, researchers provided a questionnaire on student responses to the media which students filled out at the end of the lesson. The following are the results of a large-scale trial response questionnaire on learning media in the experimental class.

**Table 7.** Recapitulation of Analysis Results of Student Responses to Media (Large Scale Trial)

Rated aspect	Score obtained	Maximum score	Percentage (%)
Interest	491	700	68,2
Material	484	700	67,2
Language	506	700	70,4
Total score achieved	1.481		
Maximum total score		2100	
Overall percentage			69
<b>Criteria</b>			<b>Quite Practical</b>

The aspect of interest in media gets quite practical results, which shows that students are interested in using the media. One of the attractions is the material content which is rich in images, icons and animations which supports students' understanding of biodiversity material. Ritonga *et al.*, (2023) also expressed the same thing in the results of responses to the media they developed, where students stated that the media contained illustrations that could provide motivation to study the material with a percentage of 83%, including the appropriate category.

The material aspect also gets quite practical responses from students, where the material published in the media is related to everyday life which makes it easier to find your own concepts. The media developed also contains images that make it easier for students to understand the material. Similar results were also expressed by Isnawati, (2020) regarding the accuracy of media content with a percentage of 94.2%, student responses stated that the overall appearance of the electronic booklet was attractive and the concept of the material contained was easy to understand. The media developed by researchers makes students' understanding of the material broader, this is because the content of the material is easy for students to understand.

The language aspect also received quite practical student responses, where these results indicate that the media developed in terms of the language used is simple, and the material presented is easy to understand. Ritonga *et al.*, (2023) also stated that the language used in interactive media is simple and easy to understand with a percentage of 86%, including the appropriate criteria.

## 2. Student Response to Learning

Student responses to learning implemented in class are another evaluation criterion. The response of students in both the experimental and control classes in implementing classroom learning to the learning model applied was measured using a response questionnaire regarding learning. The results of the questionnaire on student responses to learning in the experimental and control classes showed that the average percentage of student answers was 74% which was included in the good category. Similar results were also found in research by Boru & Qomariyah, (2021) regarding E-modules based on project based learning on ecological material with a percentage of student responses of 85% including the good category, apart from that the application of project based learning keeps students from getting bored and teaches students to solve problems. own problem. Similar results were also expressed by Susanti et al (2022) regarding student responses to interactive teaching material supplements on the digestive system material that were developed with an average student response score of 85.5% which was included in the very suitable category.

Students respond well and are enthusiastic in learning in class. Student activity is observed when working on LKPD assignments and project assignments in class, where the teacher monitors the work on these assignments and guides students when there are difficulties or questions regarding things they do not understand. However, when working on group assignments and project assignments, students are still found who are less active in the work because they are not used to working on group assignments and still feel comfortable in traditional classes where the teacher explains the material and the students listen.

The research findings of Tamimu *et al.*, (2022) revealed that students had difficulty finding information, they were still used to conventional learning models. This is reinforced by the results of the PjBL model response questionnaire, which found several suggestions regarding the work on quite a lot of assignments and the relatively short duration of work for students as well as limited time for consultations with teachers. Based on this problem, there needs to be coordination between students and teachers with efficient time management in working on the project. Apart from that, students still encounter several difficulties in completing assignments, both in the form of technical work which is something new for students, for example working on LKPD on live worksheets and creating digital campaign content.

Another aspect that makes the implementation of PjBL less than optimal in learning is due to the lack of teacher ability, in this case the researchers implemented the PjBL model, causing students to be less

motivated and active in learning. This is similar to what was stated by Tanjung *et al.*, (2022), one of the obstacles for teachers in implementing the PjBL model during learning is the lack of maturity in the concept of the project being implemented.

## CONCLUSION

Based on the results of the research and discussion, it can be concluded that the Android-based learning media for biodiversity material in the application of the project-based learning model to increase student motivation and learning outcomes is declared very valid and practical based on validation by experts and teachers. The Android-based learning media developed was declared effective in increasing learning motivation, learning outcomes in the cognitive domain (knowledge) with medium criteria based on the N-Gain value, learning outcomes in the psychomotor domain (skills), and was not effective in increasing learning outcomes in the affective domain (attitudes that care about the environment). Student responses to learning media were stated to be quite practical and good.

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