

EFFECTIVENESS SCIENCE LEARNING INNOVATION THROUGH ANDROID-BASED LEARNING MEDIA AND WATER PURIFICATION PRACTICE WITH PROBLEM-BASED LEARNING MODELS

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ABSTRACT

Sustainable Development Goals (SDGs) is the *United Nations'* effort to ensure that by 2030 all people in the world can enjoy peace and prosperity. One of the SDGs goals is *clean water and sanitation*. This provides opportunities for science learning innovation. The development of IT can make learning interesting and improve academic performance. This provides an opportunity to develop Learning Media which is an android operating system. The objective of this study is to analyse the effectiveness of the development of learning media in Indonesian Ecology and Biodiversity material that is integrated with SDGs, and test its effectiveness. The study was done in class VII at the even by using research and development method with 4D (define, design, develop, dissemination). The result of the study from the "define" stage, science learning in the form of Android Powerpoints and water purification practice had to potential to develop. In the "design" stage, learning media design using Water Biota's theme and turquoise green background, black font, and font size that adjusts with layout size. In the "develop" stage, the score of media feasibility was 8 (valid) and material feasibility was 8.56 (valid). The score of the water purification device was 9.22 (valid). In the "disseminate" stage, the achievement of knowledge is measured from the results of pre-test (58.8) and post-test (68.8). The N-Gain score of the test was 0.23. From the result, the score of student worksheets was 94.34 and practice was 78.03. Finally, the innovations through Android-based learning and water purification practices were effective (> 3.40).

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1. INTRODUCTION

Learning is a combination of human elements, namely teachers, students, education staff and materials, books, photos, videos, and also innovations (Rahmawati et al., 2018; Tapilouw, 2023). Media helps educators who have limited information and limited time in learning. According to Yektyastuti & Ikhsan (2016), effective and efficient information technology is needed in the education world, because information technology plays a role in the world of education (Maghfiroh, 2020). According to Husaini (2014), information technology in education has been used to produce qualified human resources recently. Through learning media,

students are given the freedom to process learning information with teacher guidance through understanding, and observing. Android is the most popular *platform* in the world. It is recorded that 190 countries around the world use Android. Every day, more than 1 million Android devices around the world are active (Nyimas & Usman, 2015). Based on this statement, Android has the potential to be used in learning innovation because technological developments must be in line with education. (Riyan, 2021) suggests that one of the reasons the Android operating system is widely used because of its friendly user features. Learning innovation aims to balance development and create a new atmosphere in learning (Riyan, 2021). Educators must be creative and innovative so that the delivery of learning materials is interesting and fun.

Sustainable Development Goals (SDGs) or known as global goals were initiated and managed by the United Nations in 2015 to end poverty, protect the earth. It is ensured that by, 2030 all the people of the world can enjoy peace and prosperity on earth. One of the goals of the SDGs is sanitation and clean water. According to Tapilouw (2023), student and teacher should be involved in SDGs achievement through environmental theme. The definition of water pollution in general is a change in conditions in a water reservoir such as lakes, rivers, oceans and groundwater, due to human activities (Dadan, 2017). Water pollution is caused by industrial activities, agriculture, and household activities. This opinion supports the development of learning innovation.

The problem of potential environmental pollution is brought into science learning. This is contextual learning in a problem-based learning model. Based on (Tapilouw, 2017), teachers can introduce problems and help students learn in terms of knowing the information needed to solve problems. Various environmental problems related to water and sanitation in Indonesia and Salatiga in particular, potential to allow teachers to use problem-based learning, guide students to work in groups, focus on problems and find ways to solve environmental problems. This statement refers to learning innovation. According to research's background explanation, the objective of this research was to develop an Android operating system with a problem-based learning model and water purification practices as a form of learning innovation on the material "Indonesia Ecology and Biodiversity". The second objective was to test the effectiveness of learning innovations on the material "Indonesian Ecology and Biodiversity" in order to answer the challenges of *Sustainable Development Goals* (SDGs).

2. METHOD

The type of research used is R&D (*Research and Development*). According to Hanafi (2017), the concept of a development research is to expand and deepen existing knowledge, and is used to develop or make a product. *Research and development* (R&D) is a research method to develop and test a product to be developed in the world of education (Maydiantoro, 2019). This research was carried out at SMP Negeri 9 Salatiga in the even academic year in class VII with material on Indonesian Ecology and Biodiversity. The sample of this study was 30 students class VII with purposive sampling. The sample in this research involved learning using water purification and Android PPT, and learning using only the conventional method. The learning was carried out in two different classes. Research results can be obtained from tests carried out in both classes. The R&D (*Research and Development*) stages in this study are described in Figure 1.

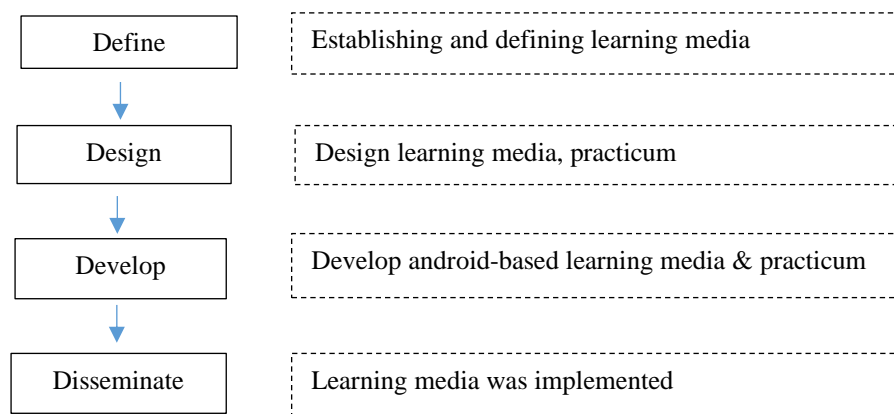


Figure 1. 4D Research Steps (Fajri & Taufiqurrahman, 2017).

Data collection was carried out by interview, questionnaire, and test techniques. The technique used to analyse the data was quantitative descriptive. Assessment used the Guttman Scale, and *Likert* Scale. The data analysed with the *Guttman* Scale were initial data analysis (questionnaire), student response analysis, RPP implementation analysis, and SDGs understanding analysis. The data analysed with the *Likert* Scale were, Android-based PowerPoint media validation analysis and water purification tools. Analysis of Knowledge Competency Attainment was measured from cognitive test results. The test was carried out before and after learning with android learning media and water purification practice. The achievement of knowledge competence was carried out using the N-Gain method.

After the average value of the pre-test and post-test has been known, the final value of both results will be obtained, using the following formula:

$$N - Gain = \frac{skor\ posttest - skor\ pretest}{(skor\ idela - skor\ pretest)} \tag{1}$$

Source : (Nira et al., 2020)

Categories of analysis of the achievement of knowledge competence acquisition of N-Gain value in Table 1.

Table 1. N-Gain equation analysis category (Hidayah, 2021)

No	Criteria	Gain score
1	High	$g > 7$
2	Medium	$0,3 < g < 7$
3	Low	$g < 0,3$

Furthermore, the results of learning media are tested for effectiveness based on Table 2.

Table 2. Criteria for the effectiveness of using learning media (Sugiyono, 2015)

No	Range	Effectiveness criteria
1	1,00 – 1,79	Very Ineffective
2	1,80 – 2,59	Ineffective
3	2,60 – 3,39	Quite Effective
4	3,40 – 4,19	Effective
5	4,20 – 5,00	Highly Effective

3. RESULTS AND DISCUSSION

3.1. Define Stage

At this stage, five analyses were carried out, including front end analysis, student analysis, material analysis, material analysis, task analysis, and learning objectives specifications.

3.1.1. Front-end Analysis and Student Analysis

Front end analysis and student analysis were obtained from interviews with the science teachers at SMP Negeri 9 Salatiga.

Table 3. Results of interviews with science teachers at SMP Negeri 9 Salatiga

No	Statement	Response
1	Making and asking opinions about Android-based learning media	Digital learning media in the form of Android applications has not yet been developed. If learning media is developed, it can make interesting learning materials.
2	The use of Android-based learning media to support the objectives of the Independent Curriculum	Learning materials packaged in the form of Android applications can help convey the purpose of learning
3	SDGs “Clean Water and Sanitation”	In science learning, the SDGs has never been mentioned of SDGs. It has the potency for SDGs to be inserted in science learning materials so that aspects of theory and practice are balanced.

Based on the interview’s result, innovations in the form of Android-based PowerPoints and water purification practicums have the opportunity to be developed. The interview results showed that teachers knew less about SDGs, and had never innovated learning media by utilizing emerging technology. This provides an opportunity for SDGs goals on clean water and sanitation to be introduced, with focusing on students’ need and attention. Then, learning innovations could help in answering phase D learning outcomes in the Independent Curriculum. In line with the opinion of (Fajri & Taufiqurrahman, 2017), teacher need to keep paying attention and adjusting students’ needs in learning preparation.

The results of students’ responses about the needs of learning media and science learning media innovations in the form of water purification practice are presented in Table 4. Based on Table 4, the results of filling out questionnaires by grade 7 and grade 8 students, students’ responses about learning with practicum in science learning (24%) and linking SDGs with learning materials (33%) were less. This student response provides opportunities for the development of learning media, namely PowerPoint (PPT) which is converted into an Android-based application. In addition, it also opens the chances of learning innovations in the form of water purification practicum, and achieving SDGs (*Sustainable Development Goals*) on Clean Water and Sanitation. In the learning outcomes in the “Kurikulum Merdeka”, it was aligned with Problem Based Learning during the implementation of Android-based learning media, water purification practicum, and achieving SDGs (*Sustainable Development Goals*) on clean water and sanitation.

Table 4. Results of student’s response for VII and VIII grade

No	Indicators	Percentage of Answers	
		VII	VIII
1	<i>Mobile Phone</i> Utilization	73%	75%
2	Utilization of learning media as learning aids	84%	72%
3	Utilization of technology from the Android operating system for learning media	84%	65%
4	Linking SDGs to learning materials	37%	33%
5	Learning with Practice in Science Learning	24%	42%

3.1.2. Material Analysis

The next analysis was material analysis, the flow of material to the water pollution sub-material and the relationship with SDGs, a concept map was made (Figure 2.). According to (Tapilouw, 2017), environmental problems can be a potency for the development of problem-based learning. According to Fig. 2, water pollution was the source of Android-based learning media.

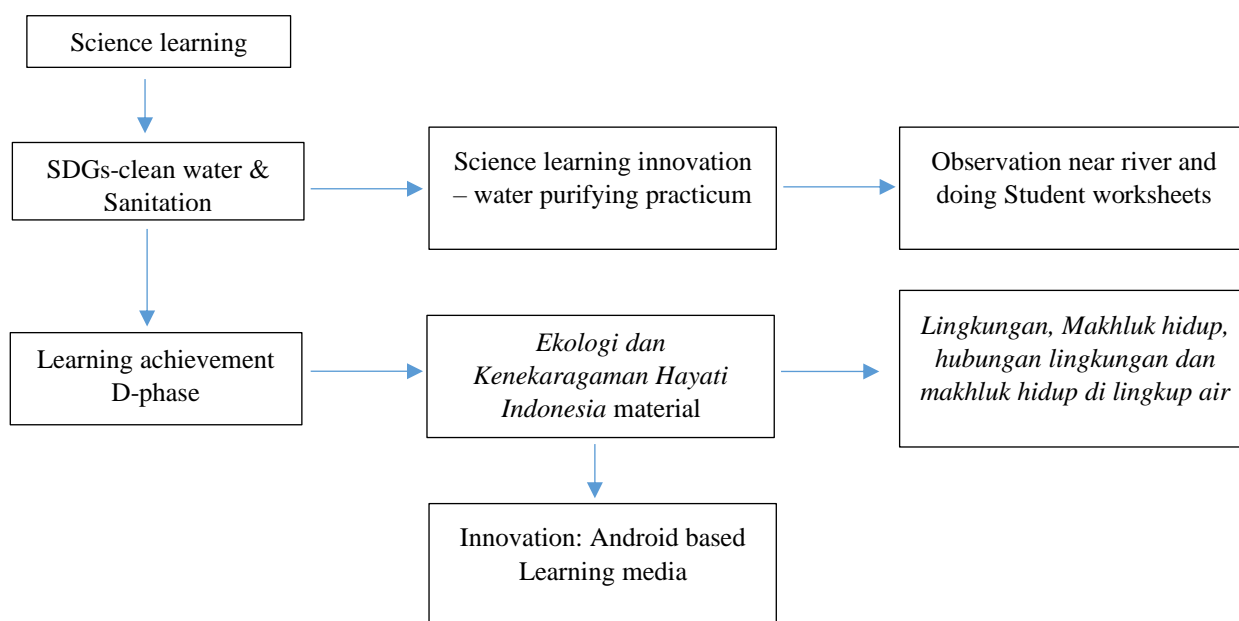


Figure 2. Material analysis concept map

(Fajri & Taufiqurrahman, 2017) In the development of a learning, the needs of students are considered and adjusted so that the terms and needs as a form of data can be determined (Fajri & Taufiqurrahman, 2017). Material analysis aims to align the needs of students with the development to be carried out. This is related to the role as a teacher, because the teacher provides information as well as directs and provides facilities for learning (Zein, 2016).

3.1.3. Purpose Specifications

The last step in the *Define* stage is the specification of learning objectives. Learning Outcomes in the material that will be studied are Phase D "Students identify interactions between living things and their environment, and can design efforts to prevent and overcome pollution and climate change" (<https://guru.kemdikbud.go.id/>). This goal can be achieved by innovating learning in the form of Android-based PowerPoint and water purification tools. The needs of students are seen from the Learning Outcomes of Phase D in the "Kurikulum Merdeka". The backgrounds of students are diverse and also the efforts of teachers to meet these needs. Therefore, teachers as educators must know the needs of students in the field of education. In the other hand, the teacher knows the steps that can be taken so that these needs are met so that learning becomes meaningful (Anggraeni et al., 2021).

3.2. Design Stage

There are three steps in designing learning media innovations, namely media selection, format selection, and initial design. Water biota theme was selected in the media for PPT that will be converted to Android-based applications. This was done in accordance with the material to be studied, the Tosca green colour background was also adjusted to the learning material.

Colour determination is not only to improve the design of a product, but also as a communication tool that can be used to convey messages and ideas (Vidhyanti & Agustin, 2020). In addition, learning innovations are carried out, namely the creation of water purification devices, the tools to be designed will pay attention to several aspects, namely efficiency, aesthetics, accuracy, and quality of purified water.

3.2.1. Format Selection

The format selection step in the *Design* stage aims to make the fun, interesting and various learning content. The type of writing used for making Android PPT is formal. This aim gave comfort in reading the writing and it does not seem excessive. The material was written in Android PPT uses the *Arial typeface/font*. According to Zunaidah & Amin (2016), the aspect of assessing a product on the design aspect is to be able to pay attention to the suitability of the type and size of the font.



Figure 2. Initial PPT design converted to Android

The selection of media and format is considered so that learning material can be delivered, and application users can understand the purpose of the explanation of the material. In order to

learning materials can be delivered, the selection of the right media and format will attract students to learn. The purpose of designing learning media is to assist teachers in delivering learning materials, improving the quality of learning (Riyan, 2021).

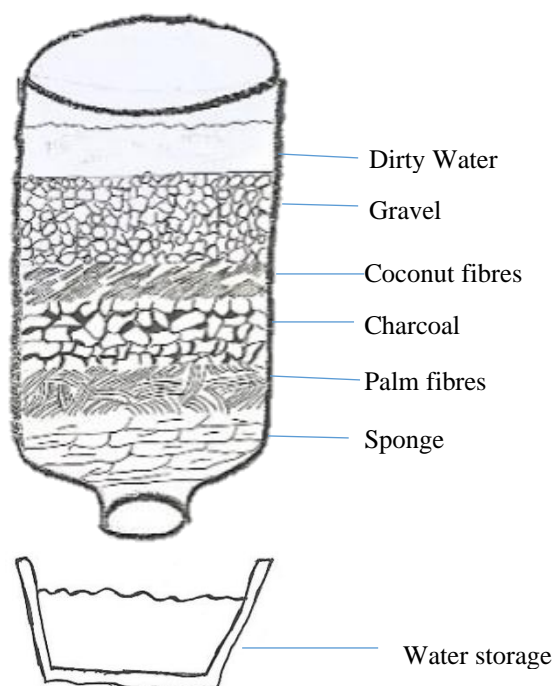


Figure 3. Initial design of the water purification device

Water purification device are designed to introduce SDGs on Clean Water and Sanitation. The initial design of the water purification device is attached in Figure 4. Water purification equipment is designed by adjusting the efficiency, the aesthetics, seeing the accuracy of the device made, and the clarity of the water. Learning innovation with water purification equipment practice also aims to provide solutions to water problems. One of the principles of learning media, namely the interactive principle and can encourage students to be active in learning (Yektyastuti & Ikhsan, 2016).

3.3. Develop Stage

At the development stage, there are two steps, specifically expert validation and trials. Validation aims to make Android-based PowerPoint learning media products and water purification tools suitable to be used in learning. In the development of Android-based learning media, validators provide media and material assessments (Table 5).

Table 5. The results of the validation of Android based learning media

No	Types of Assessment	Score	Overall Average	Percentage Result Criteria	
				Eligibility Score	Category
1	High	$\frac{4,11}{3,9}$	4	8	Good
2	Material	$\frac{4}{4,57}$	4,28	8.56	Excellent

In Table 5, the media assessment obtained an eligibility score of 8 "good categories" ($6.78 < x \leq 8.34$). Meanwhile, from the eligibility score obtained in the type of material assessment, an eligibility score is 8.56 "excellent category" ($x > 8.39$) (Elvina & Dewi, 2020). Validator suggestions are used in development in the form of replacing images as text support with a more formal and user-friendly operation of PPT by Android.

Android-based PowerPoint learning media can be developed continuously according to needs. This is also in line with technological developments that will develop continuously, especially in the field of education. Technology in the field of education is also useful in overcoming a problem (Husaini, 2014).

In the development of water purification devices, validators provide assessments based on five aspects (Table 6). The aspects assessed include tool durability, tool efficiency, aesthetics, tool accuracy, and the quality of the produced water.

Table 6. Score results of water purification equipment validation

No	Product Name	Score	Overall Average	Percentage Result Criteria	
				Eligibility Score	Category
1	Water purification	4,17	4,61	8	Good
		4,28			
		485			
		4,57			
				9,22	Excellent

The revision was done because the purified water looks the same as before it was purified. Therefore, the water purification device was revised with the addition of one layer of purifier. One purifier layer consists of cotton, aquarium filter, stone, palm fibre, charcoal, and coconut fibre. After adding one layer of purification, you can see the difference between the purified water and before it was purified. The composition of the water purification device before and after is attached in Figure 3.

From the assessment given, an eligibility score was 9.22 "very good category" ($x > 8.39$). Based on the eligibility score obtained, and the assessment stage to validators that had been carried out, the water purification tool that was developed can be implemented in a lesson. With water purification tools, students can understand the SDGs goals "clean water and sanitation" and the material of "Indonesian Ecology and Biodiversity".

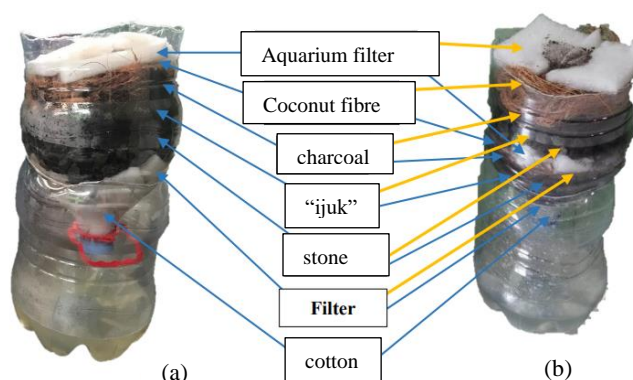


Figure 4. Water purification device before revision (a); after revision (b)

The next validation is the Student Worksheet, as a learning support that was designed to support and help in achieving learning objectives. The result of the Student Worksheet validation score is an eligibility score of 8.86 "Very Good". The water purification was equipped with

practicum guidance objectives so that the practicum can be carried out in a directed manner, with an eligibility score of 9.12 “excellent”.

Validation and revision of teaching modules that was made before carrying out learning aims to make the teaching modules according to the syllabus and development that are carried out for the next meeting. The lesson plan is a plan that contains learning procedures and structures, with the aim of achieving one basic competency or predetermined learning outcomes (Kasna, 2020). The preparation of lesson plans or teaching modules makes it easier for teachers to deliver the learning material, so that the teaching and learning process takes place in accordance with what has been prepared in the teaching module. In problem-based learning, there are five syntaxes, namely (1) Student orientation; (2) Organizing students to learn; (3) Guiding group investigations; (4) Develop and present results; (5) Analyse and evaluate the problem-solving process. The implementation of the five syntaxes was not possible if it was carried out in one meeting, because one lesson hour is only 40 minutes, and in one meeting there are two lesson hours.

Student worksheet, teaching modules, and practicum instructions was compiled and validated by validators who experts in their fields. Student Worksheet, teaching modules, and practicum instructions are not only complementary to learning, but can be used as a guide for student experience by improving science process skills, adequacy of concepts, and their application in everyday life (Asmi et al., 2023).

3.3.1. Limited Field Test

The final step at the *Design* stage is a limited field test, conducted by asking 10 students to try operating an Android-based PowerPoint. The result of student responses in the limited field test class was an excellent assessment for Android-based learning media. The result of the questionnaire that had been filled out by students was very good result, with an average score of 0.94. According to Yanto et al. (2021), the assessment given using the Guttman scale, the score is in a very eligible category (0.76 – 1.0) from the calculation that had been determined on the Guttman type scale. Based on the results of the assessment obtained, with the packaging of Indonesian Ecology and Biodiversity material in the form of an Android-based application, it is expected to make it easier for students to understand and absorb the material. There is an opinion, by utilizing ICT packaged in learning media through animation and simulation in multimedia form, it will make it easier for teachers to deliver abstract and difficult learning materials (Fadlianto et al, 2022).

3.4. Disseminate Stage

Learning process in disseminate stage was carried out in grade 7 with 30 students. At disseminate stage, the problem-based learning model was carried out with the help of Android-based PowerPoint, Student Worksheet, water purification tools and practice.

3.4.1. Power Point

The existence of learning media such as Android-based power points that have been created is in addition to following technological developments and following the percentage of *mobile phone* use among students. Innovation through Android-based learning media is done to create joyful learning. Based on Nurita’sresearch (2018), learning media will make it easier for teachers to deliver information about learning materials. With the development of Android-based learning media, it will make it easier for teachers to take advantage of technological

developments. In accordance with the demands of a teacher, where teachers are required to master technology and also have the ability to develop a learning media (Fadlianto et al, 2022).

3.4.2. Student Worksheet

Learning activities by observing river conditions in groups that were carried out on the edge of Kali Lanang and Benoyo River, Salatiga. This activity is also part of the *Problem Based Learning* model stage, namely the syntax of "guiding group investigation". The enthusiasm of students in making observations is evidenced by students who succeed in answering questions in the Student Worksheet correctly means that these students understood the purpose of the observation. The value obtained as a form of learning outcomes is an indicator of learning success (Isnanto, 2022).

Student Worksheet as a form of cognitive and affective understanding functions to support the learning process. Student Worksheet is said to be qualified when it contains elements of character education values (Pulungan et al., 2020). From the average results (94.34), the information contained in the Student Worksheet, and the value of character education that were contained with the solution provide by students. It can be said that the Student Worksheet is arranged in accordance with the material.

3.4.3. Water Purification Practicum

In the material of Indonesian Ecology and Biodiversity, learning innovations are carried out in the form of science purification practicum. In addition, aspects of "gotong royong", skills with interactive learning media, determine how students are involved in learning intensively. That way, it can also increase the motivation of students to learn (Trimansyah, 2021).

As the final form of the *Disseminate stage (dissemination)*, water purification tools are used as a form of learning innovation. The contribution of the water purification research concept that was integrated to SDGs was included in the "Karya Ilmiah Remaja" (KIR) competition at the Junior High School (SMP) level in Central Java in 2023. With the theme "Accelerating Change" to overcome water and sanitation crises and in the framework of the 2023 Global World Water Day Campaign. Youth Scientific paper SMPN 9 Salatiga won First Place at the Central Java Province level.



Figure 5. Documentation of research contribution with includ student in the "Karya Ilmiah Remaja" (KIR) competition

3.4.4. Pre-Test and Post-test

Pre-test and post-test were also carried out at the beginning of the Indonesian Ecology and Biodiversity material studied and also at the end of learning on the Indonesian Ecology and Biodiversity material. The other purpose was aiming to see the understanding of students in learning and the level of effectiveness of Android-based learning media used in Indonesian Ecology and Biodiversity learning with Water Purification sub-material and learning innovations with water purification practice. The average pretest and posttest scores are presented in Figure 6.

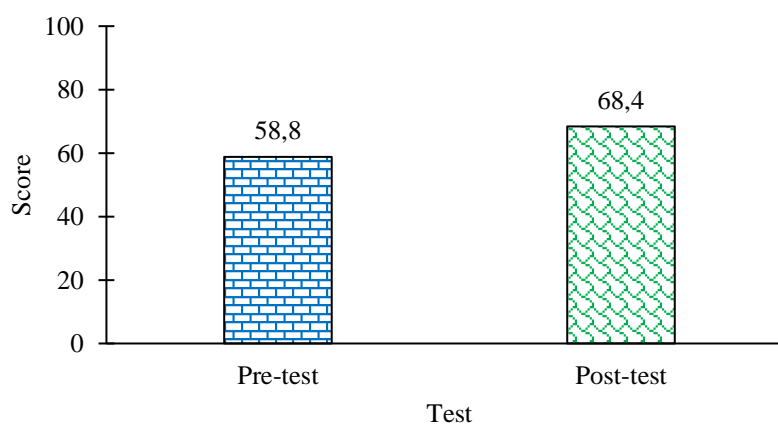


Figure 6. The Score of Pre-Test and Post-Test

Effendy (2016) states that the benefits of conducting tests, and their role in teaching. With tests, student success can be measured and assessed. The test aims to help students make conclusions from the material that has been learned, it is useful so that the material that students have learned can be remembered for a long time. The result of the N-Gain calculation was obtained at 0.23, the result obtained the low category. The low N-Gain score is influenced by the enthusiasm of students in learning and the mood of students when doing test questions. The intensity of student learning will affect the achievement of student learning achievement. The boredom felt by students in the learning process will also affect student learning outcomes. Students who experience boredom in learning will not gain progress in their learning outcomes (Rahman, 2021).

The low N-Gain score obtained is not the main standard to conclude the success of student learning. In the Student Worksheet which was done by observing the condition of 2 rivers in Salatiga, students managed to answer the questions listed correctly. Then in the water purification practice, students succeeded in compiling the provided materials to purify polluted water, in accordance with the instructions enclosed in the practicum instructions and on the shown video. Students are also able to answer the questions enclosed in the practicum instructions and were able to conclude the practicum activities that have been carried out.

Another factor of the success of a learning can be seen from the presented learning process. A learning can be presented effectively, efficiently, and qualified by seeing the learning strategy used (Apriani et al., 2020). What is meant by the learning strategy can be in the form of the use of learning media. Learning using learning media can help students to explore their knowledge and their thinking skills to solve a problem at hand (Apriani et al., 2020). This opinion is in line with the results of the Student Worksheet scores and water purification practice that the students have successfully obtained. This is inseparable from the effectiveness of learning media made in the form of Android-based PowerPoint, learning innovations with water purification tool practicum, and complements in the form of Student Worksheets and practicum instruction.

According to Sugiyono (2015), the effectiveness is concluded based on the effective category range (3.40 – 4.19).

Dd

Based on the result, the combination between learning media and practicum gained the effectiveness of science learning innovation. This is in line with Tapilouw (2023) that innovation in learning can be done in form of practicum which were strengthen the concept. As mention in Fajri & Taufiqurrahman (2017), the learning must be well prepared in order to gain learning's effectiveness. In order to sustain the learning media, we must develop the learning media and practicum continuously so that we can solve the environmental problem through science learning.

4. CONCLUSION

In this study there are three conclusions. First, Android-based Powerpoint and purification practicum have been designed and declared valid with “good category” results. Android-based PowerPoint and water purification practicum were then developed as a form of learning innovation on the material "Indonesian Ecology and Biodiversity" to introduce SDGs. Second, learning innovation on the material "Indonesian Ecology and Biodiversity" to introduce SDGs in the form of android-based PowerPoint media and purification practicum to obtain student learning outcomes in the form of N-gain at a low level. However, student activeness was also assessed through psychomotor assessment and obtained a score of > 75. Finally, learning media in the form of Android-based power points, learning innovations in the form of water purification practicum, student worksheets and practicum instructions are said to be effective (> 3.40).

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