

# Mabar geo learning tool for advancing sustainable education: enhancing student learning outcomes

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**Abstract.** Teachers still rarely use ICT-based learning media in the learning process. This research aims to examine the current state of learning outcomes and preparedness in SMA schools in Merauke, Papua with utilize a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis framework and develop the MaBar Geo application for advance sustainable education and analyze its effect on student learning outcomes. This research uses a quasi-experiment method with a one-group pre-test and post-test design. The research results show that 1)The development of the MaBar Geo application received an average score with the category very suitable for use in the learning process after receiving validation from media experts, material experts, and students. 2)Learning outcomes in the experimental class consist of cognitive, affective, and psychomotor aspects, with the highest score in the affective aspect. The results of learning completion were 27 students (75%) classified as complete and 9 students (25%) classified as incomplete. 3) The use of the MaBar Geo application has a positive effect in improving learning outcomes in the experimental class, which is based on the results of the linear regression test with Sig 0.000 < 0.05 and  $t_{count}$  (8.504) >  $t_{table}$  (1.668).

## 1. Introduction

Education has an essential role in educating nations and states [1]. Through education development, knowledge and technology will quickly be absorbed so that a nation and country can move forward [2]. However, in reality, education in Indonesia still faces various problems and challenges; one issue many experience in education in Indonesia is that many teachers still use conventional methods in the learning process and rarely use ICT-based media [3, 4]. Hence, the teacher's knowledge is profoundly developing interactive learning media to help convey material lessons that are still limited [5].

Problems can be found almost everywhere in schools in Indonesia, especially in education in eastern Indonesia, namely in Papua Island [6]. This matters to the interest and motivation of participants, and low education influences the learning process, which in turn influences the study's results. When the study's results are low, the quality of schools is still low, impacting school accreditation [7]. Based on research data carried out in 2023 by the BAPPEDA of South Papua Province with Musamus University in the frame study strategic

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and policy development education, the source mentions that the level of education in South Papua is still classified as low.

**Table 1.** Level accreditation school case: south papua province

No	Accreditation Level	School Amount	Percentage (%)
1	A ( Excellent )	15	14.01%
2	B ( Good )	35	32.72%
3	C ( Enough )	26	24.30%
4	TT ( No Accredited )	31	28.97%
<b>TOTAL</b>		<b>107</b>	<b>100%</b>

Table 1. shows level data accreditation schools case in South Papua Province. The data is the observation results of 107 sample schools in South Papua, which show that 15 schools (14.01%) have reached the bear predicate school with *excellent* accreditation, 35 schools (32.72%) hold accreditation *good*, 26 schools (24.30%) have accreditation *enough*, and 31 schools (28.97%) are still *not accredited*.

Based on the data, there are several reasons why the level of education in South Papua Province is still classified as low: (1) low accessibility, (2) Lack of power educators, (3) Facilities and facilities infrastructure schools that don't support, (4) Interest participant education is deficient for leave school, this caused by the teacher's role not being optimal use current curriculum left behind, even schools in the interior still use 2006 KTSP curriculum.

Along with the development of technology, information, and communication in the era of modernization, technology holds a role in every aspect of life in education [8]. Progress technology at the moment is something we can't avoid in life [9, 10]. In education, technology has a role in knowledge, where the participants are taught about symptoms and facts and naturally use technology to learn and apply knowledge [11]. One of the application technologies in the world of education can applied to learning media [12].

In general, Instructional Media is a tool to help the learning process teaching [13, 14]. Besides that, learning media can stimulate thoughts, feelings, attention, and abilities or skills. Participants are educated to push the learning process to occur [15]. In general, the benefit of media in the learning process is to expedite interaction between teacher and student so that learning will be more effective and efficient [16]. In geography, many fields of abstract study are a must-study in a way that is directly in the field. However, because of limited class hours, the required tools help in the form of image media or videos to make it easier for participants to understand the material presented [17]. In the learning process, these media can integrated into a component called multimedia [18].

Multimedia refers to various types of media, including text, sound, graphics, animation, video, and interactive aspects, along with where the implementation is on the storyboard. Users can choose the material they desire in an active way [19]. One of the interactive multimedia tools that can be used in learning is the application [20]. Use an application in learning by the instruction of the Minister of Education No. 22 of 2016 concerning process standards in principle teaching. One of them is using information from technology for increased efficiency and effectiveness in learning [21].

Increasing technology has advanced the creation of a process for creating more accessible learning media, one of them with the manufacturer's website application named Andromo [22]. Andromo is a website maker application that makes it easy to create and customize applications without coding. Andromo has a lot of excess: high performance, enhanced security, easy operation experience, and fast integration of new features. Andromo is specially designed and has mature features, so it can directly run on the device and access component devices such as GPS, camera, screen touch, audio, and others [23].

The teacher's knowledge is still limited in creating and using learning media-based technology, making learning using conventional media a choice for internal teachers' implementation learning. This research aims to give an outlook on making applications

simple without coding, with the hope of being practiced by teachers in creating learning media-based applications using the andromo website. By far away, an expected application impacted the improvement of students' learning outcomes in the geography subject at SMA Negeri 3 Merauke.

## **2. Method**

### **2.1 Methodology Study**

We combined research utilized a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis framework to examine learning outcomes and preparedness in SMA schools case in Merauke, Papua. The development application uses research and development methods with ADDIE design (Analysis Phase development application uses research and development methods with ADDIE design (Analysis, Design, Development, Implementation, and Evaluation). In the context of educational data from SMA schools: this contextualizes the research within the framework of educational data gathered from SMA schools in Merauke, providing a basis for the analysis. Besides, researchers also used type study experiments (quasi-experiments) to analyze the students' learning outcomes in the learning process using the one-group pretest-posttest design. In this design, there is only one group without an existing comparison. Researchers give the measurements to the class experiment with the pre-test to know the circumstances of the beginning group before providing treatment. After the pre-test, the class experiment was given appropriate treatment with those already planned. After that, the group experiment given measurement uses the post-test to know the circumstances group after treatment.

### **2.2 Population**

This research was conducted on the participant to educate class 10 at SMA Negeri 3 Merauke, located on Jl. Kamizaun , Rimba Jaya Village , Merauke District , Merauke Regency, South Papua (99615). The school has stood since 05 October 1994 and is one of the superior schools in Merauke Regency with accreditation A (Very Good). The astronomical school is at 08° 31' 53" South Latitude and 140° 25' 07" East Longitude. The school is located in front of Musamus University and 3.4 km from the Regent's Office Merauke Regency. The population of this research is all students in 10th grade at SMA Negeri 3 Merauke, with 324 participants distributed education into nine classes, starting from 10.1 to 10.9. The retrieval technique sample in this research is non-probability sampling and implemented with a purposive sampling technique, so the obtained sample study is class 10.7 with 36 participants.

### **2.3 Instrument Study**

The SWOT analysis approach, indicating an examination of the strengths, weaknesses, opportunities, and threats related to learning outcomes and preparedness in Merauke. This analysis will utilize research findings, as well as data from other sources, such as government reports and NGO publications. The development of MaBar Geo application uses instrument guidelines interviews to identify problems at school. Furthermore, researchers also use sheet validation to see the feasibility of the application before using it in the learning process. Besides, the researcher used a sheet evaluation application to know the evaluation from user applications after use in the learning process. In the variable of learning outcomes, the researcher used test instruments to measure the results in the cognitive aspect, a self-

assessment questionnaire to measure the results in the affective aspect, and a sheet of evaluation observation to measure results in the psychomotor aspect.

## 2.4 Data analysis

In the Analysis data, we incorporated additional elements such as MaBar Geo: a tool for advancing sustainable education in Merauke, we test effectiveness to convey the comprehensive nature of the research, encompassing the use of MaBar Geo, the SWOT analysis methodology, and the context of educational data from SMA schools. It suggests that the study will provide valuable insights into the potential of MaBar Geo to enhance sustainable education in Merauke, while also identifying areas for improvement and leveraging the available educational data to inform strategies. Data analysis for application development uses descriptive statistics, a method of analyzing data through a Likert scale that has already been determined. This is done to assess user eligibility and level evaluation related to the application through interpreted data. In a variable of learning outcomes, the researcher used the normality test and linear regression test to analyze the influence of using the application MaBar Geo against the students' learning outcomes results.

## 3. Results and Discussion

Case in Merauke, a regency in Papua, Indonesia, holds significant potential for developing sustainable education. Sustainable education, focusing on development and disaster risk reduction, is crucial for regions vulnerable to social conflicts. MaBar Geo, an initiative designed to advance integrated geography education, aims to enhance student learning outcomes and support sustainable development in Merauke. Here's a breakdown of each element SWOT Analysis of Education in Merauke:

### *Strengths:*

- **Cultural Diversity:** Merauke's rich cultural diversity can be integrated into the curriculum to instill values of tolerance and cooperation [24].
- **Local Wisdom:** Strong local wisdom can be leveraged in education to teach values of peace and sustainability [24].
- **Government Commitment:** The Indonesian government has demonstrated a commitment to improving education quality in Papua, including Merauke. This is evident through programs like the Affirmative Action for Education program and Special Autonomy Funds (Otonomi Khusus) [24].
- **Dedicated Teachers:** Despite limitations in numbers, some teachers in Merauke possess strong qualifications and competencies [25].
- **Student Enthusiasm:** Many Merauke students exhibit high levels of enthusiasm for learning, despite facing challenges [25].
- **Natural Resources Potential:** Merauke boasts a wealth of natural resources, which could be utilized to support educational initiatives [25].

### *Weaknesses:*

- **Security Concerns:** Security instability in Merauke disrupts learning and teaching processes [25].
- **Infrastructure Deficiencies:** Educational infrastructure in Merauke suffers limitations, including inadequate school buildings, teaching facilities, and internet access [25].
- **Teacher Qualification Issues:** Many teachers in Merauke lack the necessary qualifications and competencies to deliver optimal education [25].

- **Limited Learning Materials:** A lack of culturally and socially relevant learning materials hinders student engagement and understanding [25].

*Opportunities:*

- **International Support:** Merauke can benefit significantly from international support aimed at improving educational quality in conflict-affected areas. Various international organizations, including UNESCO, have programs specifically designed to support education in regions experiencing conflict [27]. These programs can provide financial resources, training for teachers, and educational materials tailored to the unique challenges faced by schools in Merauke. Such support can help address the infrastructural and educational deficits that currently exist in the region .
- **Curriculum Development:** There is a substantial opportunity to develop and implement curricula that integrate peace education and disaster risk reduction. By incorporating these elements into the geography curriculum, students can learn valuable skills and knowledge that are directly relevant to their lives in Merauke. This approach not only makes education more practical and engaging for students but also helps build a more resilient community that is better prepared to handle conflicts and disasters [28].
- **Technology Integration:** Information and communication technologies (ICT) offer the potential to enhance learning quality through e-learning platforms and online resources [26].
- **Collaboration with NGOs:** Non-governmental organizations (NGOs) can offer support by providing additional educational programs and services in Merauke [29].

*Threats:*

- **Ongoing Conflict:** Persistent social conflicts in Merauke pose a significant threat to the educational environment. These conflicts can lead to disruptions in the learning process, making it difficult for students to attend school regularly and for teachers to deliver consistent instruction. The instability caused by these conflicts undermines the effectiveness of educational programs and can have long-term negative impacts on the educational outcomes of students in the region [29].
- **Social Stigma:** In Merauke, social stigma against certain groups can exacerbate social instability and increase the vulnerability of these groups to social disasters. This stigma can manifest in various forms, including discrimination in schools and exclusion from educational opportunities [29]. Addressing this issue is critical to ensuring that all students have equal access to quality education and that schools can serve as inclusive environments that promote social cohesion and resilience .

With the targeted support and development of appropriate curricula, Merauke has the potential to transform its educational landscape, making it more resilient and better prepared to address and mitigate the impacts of social conflicts and disasters. So we chose technology integration for real experiments and produced an application android based learning media called MaBar Geo. The development of the MaBar Geo application is done in several ways. The first thing to do is analyze problems in the field, as explained in the introduction. Then, make a design and develop the application with the Andromo website. After the application created, take the validation of the application from media to expert material, media experts, and students in a small group of as many as 10 participants use the evaluation scale Likert already determined that is :

**Table 2.** Interval categorization of learning media validation

<b>Intervals</b>	<b>Category</b>
4.21 – 5.00	Very Worthy

3.41 – 4.20	Worthy
2.61 – 3.40	Enough
1.81 – 2.60	No Worthy
1.00 – 1.80	Very not Worthy

Table 2. Showing the Likert scale, which contains the interval to be used in application validation tests divided into five categories with an interval of 0.80. The media expert validation test was carried out by the learning media lecturer in the geography education study program. The results of validation from media expert are as follows:

**Table 3.** Validation test result indicator of learning media by expert

No	Indicator	Average <sup>2</sup>
1	Additional Information	4.80
2	Interface	4.37
3	Navigation	4.50
4	Knowledge	3.66
5	Durability	4.33
<b>Overall Average</b>		<b>4.33</b>

Table 3. Showing validation test results from media expert. Based on the data, if categorized on the Likert scale, the validation results are classified as *very worthy* of use in the learning process, with an average score of 4.33. The subsequent validation was carried out by the material expert from the geography teacher at SMA Negeri 3 Merauke. The results are as follows:

**Table 4.** Validation result indicator of learning media by teacher

No	Indicator	Average <sup>2</sup>
1	Material Suitability	5.00
2	Additional Information	4.50
3	Interface	5.00
4	Navigation	5.00
5	Knowledge	4.33
6	Durability	4.00
<b>Overall Average</b>		<b>4.63</b>

Table 4. Showing the validation test results from expert material. Based on the data, if categorized according to the Likert scale already determined, the classified category is *very worthy* using in the learning process. The last validation test was carried out by a small group of 10 students at SMA Negeri 3 Merauke. The results are as follows:

**Table 5.** Validation result indicator of learning media by student

Indicator	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Q
Student Motivation	4.50	5.00	5.00	4.50	4.50	4.50	5.00	5.00	5.00	5.00	<b>4.80</b>
Interface	5.00	4.62	4.62	4.75	4.50	4.75	4.50	4.75	4.75	4.87	<b>4.71</b>
Additional Info	4.75	4.75	4.75	4.50	4.50	4.50	4.50	4.50	4.50	5.00	<b>4.62</b>
Navigation	4.75	4.25	4.75	4.50	4.75	4.75	4.25	4.25	4.75	5.00	<b>4.65</b>
Durability	4.66	4.33	4.33	5.00	4.66	5.00	4.33	4.66	4.66	5.00	<b>4.66</b>
<b>Average</b>											<b>4.68</b>

Table 5. Showing the small group's validation test results. Based on the data, there is a validation test assessment of 10 students in a small group with existing indicators determined. Based on the data, it is known that the average value of the validation test for the small group is 4.68, a category that is *very worth* using in the learning process.

After carrying out learning media validation tests to 3 validators, namely media expert, expert material, and participants educated in group small, these are the average validation results in a whole application validator:

**Table 6.** Validation final result of learning media

No	Respondent	Amount	Average
1	Media Expert	1	4.33
2	Material Expert	1	4.52
3	Students	10	4.68
<b>Amount Whole</b>		<b>12</b>	<b>4.51</b>

Table 6. Showing average results of learning media validation tests, based on validation test results above, the application MaBar Geo earned the average result of 4.51 on a 5.00 scale. If categorized in the Likert scale already set, the app is classified into a category that is *very worthy* of use in the learning process.

Further evaluation is needed to use the application MaBar Geo. The evaluation step is held after the application is used in the learning process. In this matter, this evaluation was carried out by a media expert (geography teacher) and users (participants educated), the respondents who used the application in the learning process in the class experiment with 36 students. The results of this assessment are as follows:

**Table 7.** Evaluation application mabar geo as media assesment learning

No	Respondent	Amount	Average
1	Geography Teacher	1	4.70
2	Participant Educate	36	4.24
<b>Amount Whole</b>		<b>37</b>	<b>4.51</b>

Table 7. Showing results of media assessment learning. Based on the data, it is known that the mark results from the evaluation of learning media is 4.51, so it can be concluded that the application MaBar Geo earns the category *Very good* for use in the learning process. Although applications are classified as very good when used in the learning process, there are still several evaluations of the application that is:

**Table 8.** Feedback of mabar geo application

No	Problem	Recommendation
1	The size of the application is too big	Size application reduced
2	There is not have a guide intrsuction	Add on instruction guides
3	Not have a task of skill assesment	Add on task skills
4	Application can't used on iOS	Making supporting applications iOS
5	No exists internet network	Providing wifi by School

Table 8. A number of the problems faced in implementing the learning use application MaBar Geo show that 4 out of 5 issues were sourced from the learning media used, and one was sourced from facility schools that don't support it. Besides that, the researcher gives recommendations for problems faced In improving media in research next.

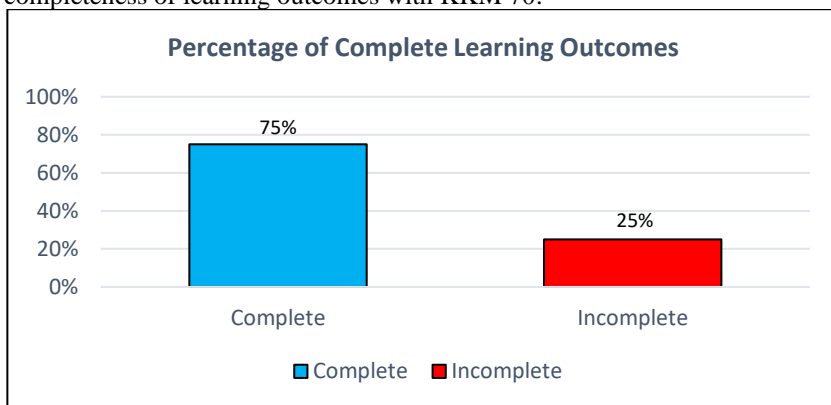
The aim of implementing media in the class is to know the students' learning outcomes after being given treatment. As for the results, the study is based on Bloom's opinion that three aspects can be used in the learning outcomes: cognitive, affective, and psychomotor. Based on students' learning outcomes at the first and second meetings, the results obtained average value whole. That value is categorized by The KKM value set at SMA Negeri 3 Merauke, which is 70. The following are the results of the average score obtained in the class experiment:

**Table 9.** Categorization of the class experiment learning outcomes

Criteria	Intervals	Qty	Percent
Very high	95 – 100	0	0%
High	88 – 94	3	8.33%
Enough	82 – 87	5	13.89%
Low	76 – 81	9	25%
Very low	70 – 75	10	27.78%
Less	< 70	9	25%

<b>TOTAL</b>	<b>36</b>	<b>100%</b>
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Table 9. Showing average categorization of the class experiment learning outcomes, based on the data, it is known that there are no participant students who achieve average learning outcomes with *very high* category, three students with average learning outcomes results with *high* category, five students with average learning outcomes results with *enough* category, nine students with average learning outcomes results with *low* category, ten students with average learning outcomes results with *very low* category, and nine students with average learning outcomes results with *less* category. Following is the percentage average completeness of learning outcomes with KKM 70:



**Figure 1.** Percentage completeness results of the learning outcomes class experiment.

Based on the above data, it can be known that of 36 participants educated, 25% or 9 participants got an average score below 70 (incomplete), and 75% or 27 students got a mark more than 70 (complete). Following is a categorization of the completeness of the learning outcomes in the class experiment.

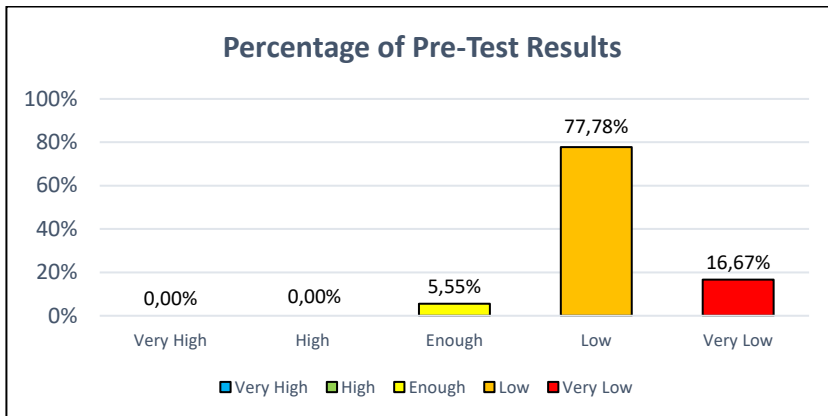
**Table 10.** Criteria of learning outcome from class experiment result

Criteria	Intervals
Very high	81% – 100%
<b>High</b>	<b>61% – 80%</b>
Enough	41% – 60%
Low	21% – 40%
Very low	0% – 20%

Table 10. Showing category completeness results of learning outcomes to the Likert scale already determined, the table above shows that as many as 75% of completeness students are classified as category high in criteria completeness learning outcomes.

Besides analyzing the study results, researchers also examine the influence caused by using the learning media-based application MaBar Geo. The analysis process uses giving the pre-test and post-test on the experiment class. The results from the experiment class’s pre-test are as follows:



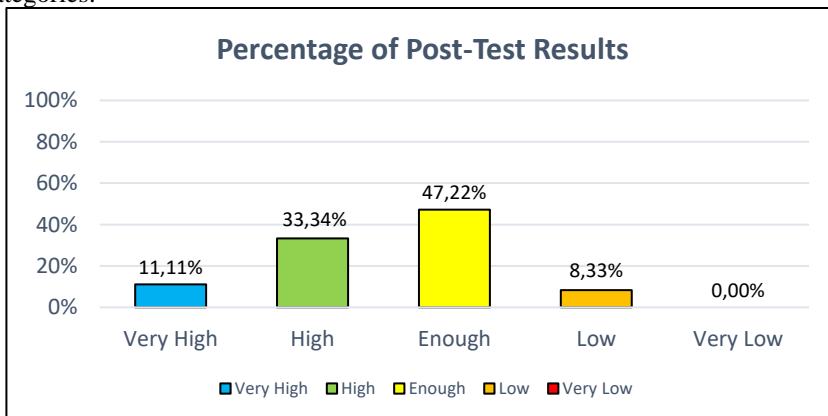


**Figure 2.** The Results of the pretest in the experiment class.

Based on the picture, the results of the pre-test are classified into three categories: 5.55% (2 students) with enough category, 77.78% (28 students) with low category, which is the most dominant category, and 16.67% (6 students) belong to the very low category. Based on this data, the class experiment got an average pre-test score of 30.41 on a 100 scale.

Experiment class owns the average value of results test early yet satisfactory, where matter the can caused by several constraints among them media use is not optimal, due to facilities and infrastructure not capable of supporting the learning process, no existing internet network (wifi ), no exists projector, and lack of source study. Besides that, based on the results of the interview with the geography teacher at SMA Negeri 3 Merauke, the learning process of geography is still conventional, which is listening to the teacher explain material without learning media assistance-based technology.

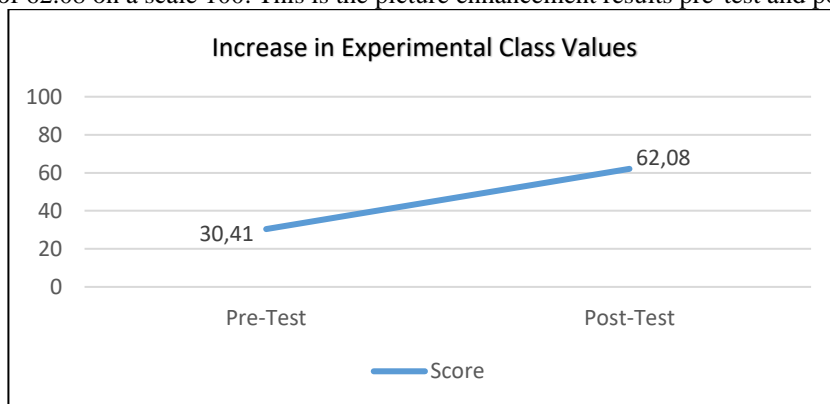
After getting the pre-test result, the experiment class is treated using the learning media-based application MaBar Geo. Furthermore, it is to carry out the post-test. The post-test aims to know the different results after the given treatment, where the post-test is followed by the students in the experiment class with a total of 36 participants. The questions included 20 multiple-choice questions, the same as those in the pre-test. There are the recapitulation results of the post-test in the experiment class using the Likert scale already determined with five categories:



**Figure 3.** The percentage of post-test results of the experiment class.

Based on the picture, it is known that the post-test results of the experiment class fall into four categories, namely 11.11% (4 students) with very high category, 33.34% (12 students)

with high category, 47.22% (17 students) with enough category which is the most dominant category, 8.33% (3 students) with low category. There are no participants classified students into the very low category. Based on this data, the experiment class got an average post-test score of 62.08 on a scale 100. This is the picture enhancement results pre-test and post-test:



**Figure 4.** Showing enhancement average test results pre-test and post-test.

Based on the picture above, enhancement is sufficient for a significant difference between the pre-test and post-test, with an average value of 31.67, indicating that the average post-test score is 2x bigger than the pre-test.

After getting the pre-test and post-test data, the next step is to analyze the data obtained using the normality test. Following are the results from the normality test using the SPSS test Kolmogorov - Smirnov Test on SPSS application version 26:

**Table 11.** Normality test data

Criteria	Value
N	36
Std. Deviation	5.322
Asymp.Sig. (2-tailed)	0.200 <sup>c,d</sup>

Table 11. Showing normality test results, testing using the Kolmogorov - Smirnov test is carried out in the experiment class through the difference between pre-test and post-test scores and gets the mark of  $0.200 < 0.05$ . So, it can concluded that the result data study in the class experiment was distributed normally.

Next is a linear regression test for the influence of using the learning media-based application MaBar Geo against the students' learning outcomes at SMA Negeri 3 Merauke. The following are the results of testing using the SPSS 26.0 application:

**Table 12.** ANOVA test result

Model	Sum of Squares	F	Sig.
<b>Regression</b>	2189.476	72.325	.000
<b>Residual</b>	1029.274		
<b>Total</b>	3218.750		

Table 12 showing ANOVA test results. Based on the data, it can be known that there is a calculated F value amounting to 72.325 with a value significance that is equal to  $0.000 < 0.05$ . It can be concluded that the regression model can used to predict an independent variable in the MaBar Geo application against a dependent variable, namely learning outcomes. The next step is to see the effect variable X has on variable Y with the method. Look at the model summary table of simple linear regression test results. The results are as follows:

**Table 13.** Magnitude mark correlation

<b>R</b>	<b>R Square</b>	<b>Adjusted R Square</b>	<b>Std. Error</b>
.825	.680	.671	5.502

In Table 13 based on the data, the summary model test results show that the magnitude mark correlation (R Square) is 0.680 or 68%. So, that can concluded that variable free ( app MaBar Geo) can be influenced by the dependent variable (learning outcomes), which amounted to 68%, while other variables caused the other 32%. The next step is to analyze the influence of variable X against variable Y through a comparison  $t_{count}$  and  $t_{table}$ , with results as follows:

**Table 14.** Regression linier model

<b>Model</b>	<b>Unstandardized B</b>	<b>Beta</b>	<b>t</b>	<b>Sig</b>
<i>Constant</i>	-1.058		-277	.783
<i>Pre-Post- Experiment</i>	.507	.825	8.504	.000

Based on the data in table 14, the coefficients test results show that the constant (a) value is -1.058, while the trust value (b) is 0.507. So that equality, the regression can written as follows:

$$Y = a + bX \quad (1)$$

$$Y = -1.058 + 0.507X$$

Equality can translated as follows:

- 1) A constant of -1.058, which means that mark consistency variable participation is amounting to -1.058
- 2) A coefficient X regression of 0.507 states that every additional 1% trust value marks a participation increase 0.507. The coefficient is positive, so the direction of influence of variable X against variable Y is positive.

In taking simple linear regression test decisions, carried out with notice provision as follows:

- 1) If the sig value is  $> 0.05$ , there is no significant influence between the independent and dependent variables;  $H_0$  is accepted, and  $H_1$  is rejected.
- 2) If the sig value is  $< 0.05$ , there is a significant influence between the independent and dependent variables;  $H_1$  is accepted, and  $H_0$  is rejected.

Based on table coefficients, it is known that the sig value is equal to  $0.000 < 0.050$ , so it can be concluded that variable X influences variable Y. Apart from that, the determination results end can be seen based on mark  $t_{count}$  that amounting to 8.504 where the value more significant than  $t_{table}$  that is amounting to 1.668. Hence, it can be decided that  $H_1$  is accepted and  $H_0$  is rejected, meaning that variable X (MaBar Geo application) influences variable Y (learning outcomes).

## 4. Conclusion

The theoretical implications for education based on the results of this study are multifaceted. First, the findings suggest that integrating technology, such as the MaBar Geo application, into the geography curriculum can significantly enhance learning outcomes across cognitive, affective, and psychomotor domains. This aligns with educational theories that emphasize the importance of interactive and engaging learning materials in improving student understanding and retention of information [30-31]. Additionally, the use of validated learning media supports the theory that well-designed educational tools can cater to diverse learning styles and needs, thereby fostering a more inclusive and effective learning environment [32]. The improvement in learning outcomes, as indicated by the substantial increase in pre-test and post-test scores, reinforces the theoretical perspective that active learning strategies, supported by technology, can lead to better educational achievements

[33]. Based on the results, despite some weaknesses and threats, the SWOT analysis indicates that there are significant opportunities to improve learning outcomes and preparedness in SMA Merauke. Collaborative efforts from the government, schools, NGOs, and the community are needed to address the weaknesses and capitalize on the available opportunities. Utilizing technology, developing relevant learning materials, and enhancing teacher qualifications are key to achieving quality and sustainable education in Merauke. Others concluded that the development of the MaBar Geo application earned very feasible criteria used in the learning process based on the results of learning media validation tests from media experts, material experts, and students with an average value of 4.51 (Very Worthy) and results of the evaluation with very good category used in the learning process by the geography teacher and 36 students as application's user with the average value is 4.51 (Very Good). Learning outcomes in the realm aspect cognitive got an average result of 73.26, the affective aspect got an average value of 82.10, and the psychomotor aspect got an average of 72.91. Hence, it is known that the highest aspect is in the affective aspect, with an average value of 82.10; meanwhile, the lowest mark is found in the psychomotor aspect, with an average value of 72.91. Based on the results of the learning outcomes completeness, as many as 27 students (75%) achieved the category completed and 9 students (25%) with the category uncompleted. The results of the pre-test and post-test of the experiment class were enhanced, which increased the average value from 30.41 to 62.08. Normality test results were proven to have normal data with sig value  $0.200 > 0.05$ . Then, based on linear regression test results, the sig result is  $0.000 < 0.050$  and value  $t_{\text{count}} (8.504) > t_{\text{table}} (1.668)$ . So, it can be decided that  $H_1$  is accepted and  $H_0$  is rejected, meaning there is an influence on the use of the learning media-based MaBar Geo application against students' learning outcomes at SMA Negeri 3 Merauke.

Limitations of the study despite the positive findings, several limitations must be acknowledged: sample size and generalizability of the study were conducted with a relatively small sample size of students from SMA Negeri 3 Merauke. This limits the generalizability of the findings to other schools and regions. Future studies should include larger and more diverse populations to validate the results. The study's duration was limited, focusing on short-term impacts. Long-term studies are necessary to understand the sustained effects of the MaBar Geo application on learning outcomes. While the study provides valuable quantitative data on learning outcomes, it lacks qualitative insights into students' and teachers' experiences and perceptions. Incorporating qualitative methods could provide a more comprehensive understanding of the application's impact. Technical and Infrastructural Constraints: The effectiveness of technology-based learning tools is often contingent on the availability of reliable technological infrastructure, which can vary significantly across different regions. This study does not address potential technical and infrastructural challenges that might affect the implementation of such tools.

Future Study research should focus on addressing these limitations and exploring new avenues such as longitudinal studies its mean conducting longitudinal studies to assess the long-term impact of integrating technology into the geography curriculum would provide more robust data on the sustainability of learning outcomes. Comparing the effectiveness of different technological tools and traditional teaching methods across various educational settings can help identify best practices and optimize learning strategies. Using mixed methods, combining quantitative and qualitative approaches, can offer deeper insights into the educational process and outcomes. And evaluating the technological infrastructure in different regions to identify potential barriers and develop solutions to ensure equitable access to educational technologies.

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