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ArcGIS StoryMaps as Geography Teaching Materials for the Distribution of Indonesian Flora and Fauna at Senior High School

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ABSTRACT

The diversity of teaching materials in the current era is experiencing very rapid development, so that the selection of appropriate teaching materials will have an impact on student learning outcomes. The purpose of this study was to analyze the results of the application and determine the improvement in student learning outcomes in the implementation of teaching materials based on ArcGIS StoryMaps. The results of initial observations conducted at SMA Negeri 12 Makassar showed that teachers still use teaching materials in the form of books, power points and websites that are less interactive so that this has an impact on student learning outcomes that are lacking. The method in this study uses N-Gain analysis to measure student learning outcomes. The data collection technique in this study was divided into two classes, namely the experimental class and the control class with 20 samples each through pre-test and post-test. The results of this study are 1. based on the results of the average pre-test, the experimental class score was 52 and the control class 34 while the average post-test score in the experimental class was 73 and the control class 35. 2. Based on the results of the normality test (N-Gain) showed that the experimental class was 0.56 and the control class was 0.8. This shows that there has been an increase in students' understanding in the use of teaching materials based on ArcGIS StoryMaps, especially in the material on the Distribution of Flora and Fauna in Indonesia.

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1. Introduction

The current learning process is experiencing significant development and challenges. This is related to the era of globalization and rapid innovations in science and technology. This rapid technological development has had an indirect impact, particularly on the learning process, which has become more varied and diverse (Yan et al., 2024). For example, there are many technological options available for teachers to use when conveying information about a subject (Meduri et al., 2022). Implementing a learning system using technology is one of the preferred media in the learning process. Analysis and readiness are the initial steps taken by teachers and educators. The availability of an internet network is one of the most vital requirements for supporting the development of technology-based teaching materials (Maphosa, 2021). Therefore, the Internet can be used as a learning resource for all components, both students and teachers, and can provide a more interactive learning process.

Teaching materials are inseparable for both teachers and students in the classroom. Overall, the use of teaching materials in a medium ultimately increases the effectiveness and efficiency of the learning process (Alzubaidi et al., 2023). Considering that each subject has its own characteristics, teachers should choose teaching materials to be implemented (Hutauruk et al., 2022). As explained above, the involvement of teaching materials in learning has a significant impact. This is also supported by the increasing interest and learning experiences of students in the classroom (Alzubaidi et al., 2023). Furthermore, teachers are required to optimize the use of increasingly complex teaching materials to optimize their use. Therefore, it is hoped that the development of ideas about teaching materials will continue according to what students need (Yuliarni et al., 2023).

Technological advances in the current era have had numerous positive effects on education. Teachers no longer need to use conventional teaching materials, and can guide students to learn independently (Indariani et al., 2019). Students are also usually able to grasp new technologies more quickly, especially in the subject matter (Juwanti et al., 2020). The diversity of teaching materials available in today's educational technology can facilitate teachers' learning process. The development of information technology is currently changing the perspective of 21st-century learning, allowing learning to utilize information technology and digital platforms (Cendikia et al., 2024). Selecting the right media for teaching materials will also maximize the quality of the learning process and maximize the results in a quality classroom (Kandia et al., 2023). However, this is not

always the case in all schools; sometimes, teachers still use conventional learning media, which affects student learning outcomes.

Seeking knowledge is one way to transform human attitudes from ignorance to knowledge. Learning cannot be carried out optimally without the interconnectedness of components; therefore, these components must be involved and collaborate in the learning process (Romadhani and Harahap, 2022). These components included educators, students, objectives, media, materials, and evaluations. In classroom learning, the inclusion of media in teaching materials facilitates information delivery to students. Success in learning is certainly influenced by factors such as the model used, teaching materials used, learning strategies, and environmental conditions (Zaifullah et al., 2021). When educators develop teaching materials, they adhere to principles of relevance and consistency. Therefore, selecting and compiling appropriate teaching materials will enable students to develop their reasoning skills. To determine the scope of learning materials, attention must be paid to the types of materials that can be delivered, such as cognitive aspects (facts, concepts, principles, and methods), psychomotor aspects, and affective (Putra et al., 2024).

Education is the most important factor shaping a person's character, traits, and personality. Through education, teachers as conveyors of information strive to train, guide, and teach students. Essentially, the quality of learning is not solely determined by the educator but is also influenced by the students themselves, available facilities, and other factors (Novalita, 2019). However, the core issue is that the quality of teaching depends more on the delivery of information by teachers who must be more professional. During the learning process, all educators are required to be more active in communicating with students. Teaching materials can be used as tools for both in-class (online) and out-of-class (offline) learning. Aspects used to improve the quality of the teaching process include a more controlled learning environment, the use of appropriate learning models and methods, and the use of more interactive and varied teaching materials (Hayani and Sutama, 2022). Therefore, prioritizing and achieving these goals can create a more memorable learning experience, especially for students. Therefore, an instrument that can support and strengthen students, especially in terms of human resources, is needed to improve their cognitive, affective, and psychomotor abilities (Sudihartono, 2020). Thus, educators are indirectly required to create a variety of teaching materials to assist in delivering materials in the learning process.

The role of technology in geography learning is crucial in creating a fun learning environment. Geography learning technology also plays a significant role in facilitating the exchange of scientific information between teachers and students (Widjaja and Aslan, 2022). Teachers can utilize various technologies, such as Google Sites, ArcGIS StoryMaps, and Assemblers. This will undoubtedly encourage students to avoid boredom or fatigue during the classroom learning process (Juwanti et al., 2020). The wide selection of teaching materials requires teachers to keep up with the current technological developments. Failure to do so will indirectly lead to a lack of variety in the classroom learning process (Putri, 2023). Therefore, incorporating technology into learning enhances and strengthens the unique characteristics of a subject (Ika et al., 2017).

Each subject in a field has its own unique characteristics, which make science diverse. Both in terms of the approach and focus of learning materials, science develops (Khasanah, 2016). Geography learning has the same characteristics as other subjects (Nasution and Lubis, 2018). The involvement of technology in geography learning is certainly inseparable from the unique characteristics of the study in the subject matter of geography. A distinctive characteristic of geographical studies is the use of three approaches (spatial, environmental, and regional) (Aksa, 2019). These three approaches are often incorporated into Geographic Information Systems (GIS) to convey information to students (Pratama et al., 2024). However, there are still educators who have not optimized the interaction between technology, GIS, and the three spatial approaches of geography (Y. K. S. Dewi et al., 2021).

Geographic Information Systems (GIS) are a crucial component of geography, particularly when the topic addresses the distribution. Therefore, teaching materials that integrate GIS should form the foundation of the learning process. However, many geography teaching materials have been developed without spatial or GIS components (Ridha et al., 2020). The inclusion of GIS in teaching materials is crucial for the development of geographical materials (Rianto et al., 2024). An example of a platform that incorporates GIS into geography learning is ArcGIS StoryMaps. The ArcGIS StoryMaps platform is a tool for displaying information in the form of text and images at specific locations (Vojteková et al., 2022). This web-based platform was developed by the ESRI (Suni and Suni, 2023). Storytelling is a key feature of ArcGIS StoryMaps software. This technique is often used in webGIS software. The storytelling map technique, which is the main content of the ArcGIS StoryMaps platform, is a method for conveying information. Storytelling maps contain information and are integrated into maps or geospatial data. These narratives were created to convey and disseminate information (Bowden et al., 2016). Therefore, storytelling maps are a method for conveying geospatial-based information (Farida et al., 2019).

Nowadays, geography learning places more emphasis on 4C competency objectives, namely critical thinking and problem solving, collaboration, communication, and creative thinking (Azizah et al., 2023). The problem-solving process involves collecting data and facts, compiling solution abstracts, analyzing information, and selecting the appropriate solution. Indicators that can be identified in solving a problem include: a. identifying or recognizing a problem, b. formulating a problem, c. finding alternative solutions, d. sorting solutions, and e. drawing a conclusion (Ariani, 2020). Instilling problem-solving skills is considered an effort to solve a problem based on the information and data available through the characteristics of the geography material itself, which discusses problems in the student's contextual environment (Mukhid, 2023).

Many educational institutions still use conventional teaching materials, such as textbooks, PowerPoint presentations, and assignments, making learning less engaging. The content presented to students is often non-interactive, which impacts their learning outcomes (Sibley et al., 2024). Therefore, there is a need for teaching materials that encourage students to improve their learning outcomes (Hasanah Lubis et al., 2023). One example is a case from initial observations regarding the lack of technology involvement in learning at SMA Negeri 12 Makassar. Observations showed that teachers still relied on teaching materials, such as textbooks, PowerPoint presentations, and websites of questionable origin, specifically regarding the distribution of flora and fauna in Indonesia for grade XI (phase f). Consequently, teachers felt that the teaching materials used in class were still inadequate, leading to students becoming less bored and experiencing poor learning outcomes, particularly in geography (Opoku et al., 2021). Therefore, the more engaging the teaching material is, the higher the student learning outcomes it will achieve. Initial observations also demonstrated the importance of technology in learning, particularly in geography lessons, which often involve visual content to reinforce material (Jong et al., 2020). Therefore, using conventional geography teaching materials will result in students seeing only a limited amount of content (Opoku et al., 2021). Therefore, choosing appropriate teaching materials will indirectly impact the learning process and student learning outcomes (Dewi and Lestari, 2020). Given the development of information technology related to geography, today's learning process should integrate media into more advanced teaching materials, particularly for the distribution of flora and fauna in Indonesia.

ArcGIS StoryMaps software, as geography teaching material, has several prominent advantages and strengthens its quality. ArcGIS StoryMaps contains a user-friendly interface. Using ArcGIS StoryMaps for geographical learning, particularly in the distribution of flora and fauna in Indonesia, can create a more varied learning process, especially content that displays interactive maps. Furthermore, the features implemented in ArcGIS StoryMaps can also help simplify any shortcomings in flora and fauna material in Indonesia. The application of this teaching material can improve learning outcomes, and students can access it anytime and anywhere. The presence of a technological approach in the learning process used by teachers and students can support the achievement of effectiveness, because students are presented with interactive media. ArcGIS StoryMap-based teaching materials include several types of media, especially interactive map media. Therefore, this media can be an alternative for educators to convey location-based information through maps. The goal is to achieve maximum learning outcomes (Wulandari and Zuhroh, 2023).

This study differs from other studies, such as the results of the Fadlan (2023) study, where the material is presented through Google Site and ArcGIS StoryMaps as the map provider, whereas in this study, both the material and maps are presented directly through ArcGIS StoryMaps. McDaniel and Ingram (2024) examined spatial thinking outcomes using project-based learning. Al-Bukhori and Purwanto (2024) also examined spatial thinking measurement outcomes by focusing on remote sensing. Malone et al. (2024) research explored broader topics, including disaster management and cultural geography.This teaching material is also flexible and can be accessed repeatedly so that it helps improve students' understanding of the distribution of flora and fauna in Indonesia (Husain et al., 2024).

2. Method

This research is quantitative and experimental, testing previously developed teaching materials using a pretest and posttest design. Experimental research was also conducted to determine the impact and effectiveness of ArcGIS StoryMap-based teaching materials on the Distribution of Flora and Fauna in Indonesia on student learning outcomes.

2.1. Time and location of the research

The location of this research was carried out at SMA Negeri 12 Makassar, Antang Village, Manggala District, Makassar City with the research time being carried out from March 12 to April 12, 2025 (Figure 1). This school was chosen as the research location because it was in accordance with the results of initial observations on the distribution of flora and fauna in Indonesia. According to the results of the interviews, geography teachers still use teaching materials that make students bored and have poor learning outcomes.

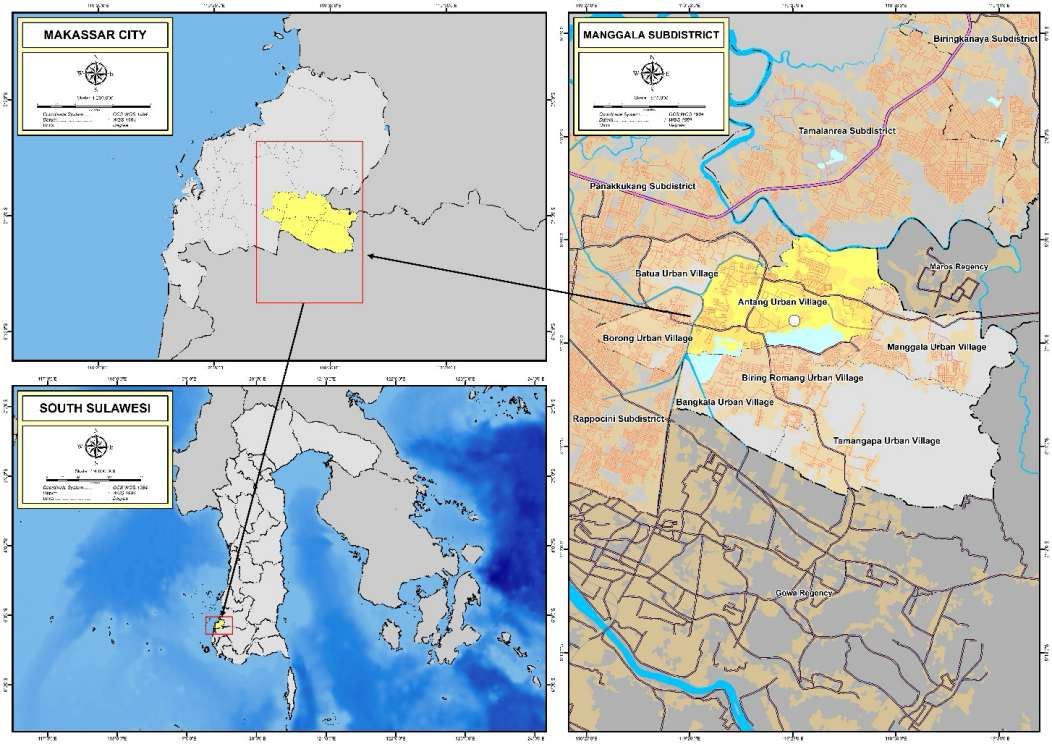


Figure 1. Map of research location

2.2. Population and sample

The population and sample are two different aspects of the research. A population is the entirety of the research subjects, whereas a sample is a subset of those subjects (Hasanah Lubis et al., 2023). The population in this study was in an experimental class with 32 students and a control class with 29 students. Twenty samples were collected from the two classes was 20 samples.

2.3. Research instruments

Research instruments will be used to examine the results of the measuring variables (Duckett, 2021). The instrument used in this study was in the form of 12 multiple-choice questions, and this assignment was distributed using GForm.

2.4. Data collection techniques

The data collection technique from the two classes is random sampling, in which the researcher randomly takes samples from both classes randomly (Ahmed, 2024). In addition, the implementation of this teaching material also included tests: a pre-test conducted at the beginning of implementation and a post-test conducted after implementation. This was done to determine the effectiveness and appropriateness of the product when implemented in the learning process.

2.5. Research procedures

Research procedures are the steps taken in a study, the purpose of which is to serve as the basis for the study (Opie, 2019). This research certainly has stages in implementing the teaching materials. 1) Preparation, The researcher prepared the instruments that would be used to measure student learning outcomes, which were divided into two aspects (pre-test and post-test). In addition, the researcher prepared a teaching module to serve as a guideline for the implementation of this teaching material. 2) Implementation**,** ArcGIS StoryMap-based teaching materials will be used in the experimental class, while conventional teaching materials are used in the control class. The implementation of these materials was divided into three meetings. The first meeting is an introduction to the teaching materials that will be used in the experimental class, while the control class only

has an introduction regarding the beginning of the material and conducting pre-test data collection. The second meeting presents the material as usual, and the third meeting is the final presentation of the material and post-test data collection. 3) Closing, is where the researcher obtains the desired data during the implementation process. After obtaining the data, a data processing stage was performed.

2.6. Data analysis techniques

After obtaining the pre- and post-test results, the researchers analyzed the scores. Furthermore, prerequisite and hypothesis tests were conducted in this study. The prerequisite tests were divided into two categories (normality and homogeneity). The hypothesis test was used for hypothesis testing. The following formula was used for the N-gain test: The following formula was used to calculate the normality gain according to Islami and Soekamto (2022):

$$N\ Gain\ = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}$$

N Gain : Gain normality test value
Spost : *pretest* score
Spre : *posttest* score
Smax : Maximum score

The effectiveness criteria that are the source of the gain normality value according to Islami and Soekamto (2022) are listed in Table 1:

Table 1. Classification of gain normality values

Gain normality value	Criteria
0,70 ≤ n ≤ 1,00	High
0,30 ≤ n ≤ 0,70	Medium
0,00 ≤ n ≤ 0,30	Low

Source: Islami and Soekamto, (2022)

3. Results and discussion

The implementation of teaching materials using websites during the learning process can encourage collaborative learning among students. Moreover, many students are able to recognize and operate technology, especially in education. (Aziz et al., 2021). Therefore, the Geography learning process should be more optimal and enjoyable if combined with technology, so that the characteristics of the material discussed can be clearer and more revealed (Haryoko et al., 2019). The ArcGIS StoryMaps software for flora and fauna material in Indonesia will be applied to students at SMA Negeri 12 Makassar. The application of this teaching material involves the use of ArcGIS StoryMaps to improve the level of student learning outcomes regarding the distribution of endemic flora and fauna, particularly in Indonesia. The mechanism of this teaching material is that students will access it based on the website, and the teacher becomes the presenter of the material in the learning process.

The application of teaching materials in the experimental class will certainly produce more effective learning. This is because conventional teaching materials are no longer used for the distribution of flora and fauna in Indonesia, which involves interactive maps with storytelling methods. Thus, it can maximize the function of teaching materials, namely, improving learning outcomes, overcoming limitations in delivering material, and providing stimulation that can make students' learning experiences more comfortable. After conducting the learning process in the classroom, the evaluation or assessment stage is carried out to determine the level of student knowledge, and the evaluation is carried out to provide considerations based on certain standards to obtain objective and convincing information. Two types of evaluations were carried out: pretest and posttest. The pre-test stage was carried out before the application of teaching materials, and the post-test stage was carried out after the application of teaching materials. The following are tables and graphs of the results of the application of ArcGIS StoryMaps teaching materials (Table 2 and Figure 2).

Table 2. Results of the evaluation of ArcGIS StoryMaps teaching materials

Class	Pre-Test	Post-Test
Experiment	35	73
Control	34	52

Source: 2025 research results

ArcGIS StoryMap-based teaching materials have special advantages for classroom implementation. Students can access the content of the material anywhere and anytime as long as the device used is connected to the network and does not require storage to access it. Thus, students can learn independently and can operate with many types of devices, such as tablets, laptops, and cellphones. Based on the analysis of the learning outcome data in Table 2 and Figure 2, the average value for the control class was 52 and the experimental class was 73. Thus, it can be seen that the learning outcomes of the experimental class that applies new teaching materials are higher than those of the control class that still uses conventional teaching materials. The results of this study are also the same as Fadlan (2023), revealing that the use of ArcGIS StoryMap-based teaching materials in the classroom provides quite a different difference from classes that do not apply teaching materials based on ArcGIS StoryMaps. The same thing was obtained by (Saputra et al., 2024), the results of learning using ArcGIS StoryMap-based teaching materials by taking values from the pre-test and post-test showed effective results. Thus, the application of this teaching material has a significant impact, especially in recognizing information-based information.

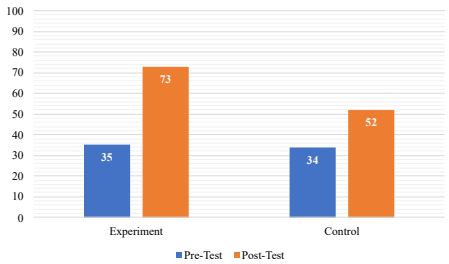


Figure 2. Graph of ArcGIS StoryMap teaching material test results

ArcGIS StoryMap-based teaching materials for flora and fauna in Indonesia certainly have an influence compared to the control class, especially in the use of teaching materials and learning outcomes. However, if observed again, the difference in learning outcomes between the two classes is not too far, which shows that it is not only teaching materials that are the benchmark, but other obstacles that inhibit and influence student learning outcomes. Analysis of the evaluation data from the two test processes provides an explanation of the level of effectiveness of this teaching material when applied in the classroom, which shows an increase in student learning outcomes. The pre-test and post-test results regarding the average of the experimental and control classes were analyzed. Then the gain normality analysis was carried out to determine how much influence the ArcGIS StoryMaps-based teaching materials implemented in the control class and the experimental class have, here are the results of the N-Gain analysis (Table 3):

Table 3. Results of the N-Gain Test analysis of the experimental class and control class

No.	Control Class (Initial)	*N-Gain* Scor	Experiment Class (Initial)	*N-Gain* Scor
1	S R	-1,00	R I	0,73
2	M	0,50	A C F	0,67
3	M P P P	-0,75	M F	0,43
4	S M D	0,09	M A F	0,45
5	A W	0,60	S F S A	0,20
6	M R	0,80	M P	0,60
7	F A	0,67	F R A M	0,90
8	R A M	-0,50	N A A Y	0,83
9	A A B	0,82	M F N H	0,70
10	F A	0,20	M A Z S	0,56
11	R P A	-0,50	E S	0,75
12	Z M U	0,33	A K M	0,70
13	M F H	-0,25	W J A	0,00
14	A W I	-1,00	M A A	0,50
15	S A N A	0,29	A R	0,83
16	R M	0,18	M A A	0,40
17	R R	-0,14	F Q A	0,56
18	Z E R	0,25	A D	0,29
19	N N N	0,60	F Z P	0,73
20	A K	0,50	I K	0,43
	Mean	**0,08**	**Mean**	**0,56**

Source: 2025 research results

Learning using ArcGIS StoryMaps in the experimental class can be operated with each student's gadget. Almost all students have good discussions and improved grades, especially in the material on flora and fauna in Indonesia. Based on the results of the implementation of teaching materials carried out at SMA Negeri 12 Makassar, it can be seen in Table 3 that the level of understanding of students in the experimental class increased, with the pre-test results showing an average score of 35 to 73 after the post-test, in contrast to the control class, where the average pre-test result was 34 and the post-test was 52. Thus, the results conclude that the availability of the right teaching materials can optimize student learning outcomes (Idayanti and Suleman, 2024). This is the same as the results of research by Saputra et al. (2024), which examined the material on regional development, where the total pre-test score was 667 and the total post-test score was 847. Thus, the implementation of teaching materials based on ArcGIS StoryMaps provides information that is more memorable and improves learning outcomes.

The results of the normality test of the control and experimental class data showed a value of 0.200. This indicates that the value was normal. The homogeneity test showed a value of 0.000 or <0.05, indicating that the data obtained were not homogeneous. The following is a table of the results of the normality and homogeneity tests (Tables 4, 5, 6):

Table 4. Results of normality test

Class	Kolmogrov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig	Statistic	df	Sig
Experiment	0,122	20	0,200	0,955	20	0,443
Control	0,173	20	0,121	0,915	20	0,081

Source: 2025 research results

Table 5. Results of homogeneity test

Levene Statistic	df1	df2	sig
15,572	1	38	0,000

Source: 2025 research results

The results of the hypothesis test value (Sig 2-tailed) were <0.05, indicating that the implementation of teaching materials has an influence on student learning outcomes in the experimental class. The results of the hypothesis test are as follows:

Table 6. Mann-Whitney U test results

Mann-Whitney U	92,500
Wilcoxon W	302,500
Z	-2.909
Asymp. Sig. (2-tailed)	0,004
Exact Sig. [2*(1-tailed Sig.)]	0,003b

Source: 2025 research results

In accordance with the N-Gain classification, the results of the analysis conducted in the experimental and control classes showed significant differences. In the control class, the normality test results were 0.08, and the experimental class was 0.56. Referring to the classification, the use of the influence of teaching materials based on ArcGIS StoryMaps is in the moderate classification, which shows a difference from the control class that still uses conventional teaching materials. This is also the same as the results of research conducted by Saputra et al. (2024), which discusses regional development material assisted by ArcGIS StoryMap. The study revealed that the results of the N-gain normality test were 98%, and the study combined a problem-based learning model to increase learning outcomes. Furthermore, teaching materials assisted by ArcGIS StoryMaps can also increase student enthusiasm and encourage discussion. The following is a display of the teaching materials used to implement the learning process in the experimental class (Figure 3):



Figure 3. Documentation and QR-Code of teaching materials

Learning in the experimental class using ArcGIS StoryMaps went well and effectively, with the advantage that students could explore the content that was highlighted, namely interactive maps filled with pictures and descriptions of the locations of the flora and fauna discussed. Therefore, indirectly, the use of teaching materials based on websites and interactive content can create enjoyable learning for students (Aminoto and Pathoni, 2015). However, in connection with these results, teachers should not ignore something important regarding other factors that influence the process and learning outcomes of students, such as intrinsic and extrinsic factors. The difference in learning outcomes between students who used teaching materials based on ArcGIS StoryMaps and those who did not was also influenced by factors related to each student's characteristics. These factors are divided into intrinsic and extrinsic factors (Asri et al., 2024). Extrinsic factors include elements that come from the students themselves, such as physical, talent, motivation, and circumstances (Kutip). Meanwhile, extrinsic factors are the opposite of intrinsic factors that are influenced by the environmental conditions of students, such as teacher teaching ability, material delivery, support from people around them, and learning facilities (Joen et al., 2023). Both factors influence one another 's level of success in understanding the material they receive.

Education plays a very important role in shaping a person's good or bad, as well as teaching materials, where if you choose the right teaching materials, learning in the classroom will be better, and vice versa. The application of teaching materials that require a network in the school environment is certainly not free of many challenges (Abidin et al., 2024). These challenges are not far from the availability of facilities or location conditions of schools. The presence and efforts of the government certainly provide substantial support for the development of technology in education (Singh et al., 2021). Website-based teaching materials must, of course, consider their content, such as media in the form of images, videos, and simulations that aim to improve students' memory in learning, so that it will indirectly create more comfortable learning for students (Asri et al., 2024).

4. Conclusion

Teaching materials can not only provide information clearly, but also capture students' attention. Of course, the material of flora and fauna in Indonesia requires media in the form of pictures, videos, or interactive media. Based on the results and discussion discussed above, the conclusions that can be drawn from this study are the pre-test and post-test results implemented in experimental and control classes with each sample of 20 students. It can be seen that the mean pre-test results of the experimental and control grade 2 examinations in 5th grade 4, the post-test results of the average score in the experimental class was 73 and the control class was 35. Second, the testing results using the N-Gain test of 20 students in both the experimental and control classes, in which the experimental class had a higher learning outcome score of 0.56 while the control class had a score of 0.08. Third, the results of both tests and N-Gain testing showed significant differences in that the classes that did not use teaching materials had lower learning outcomes than the experimental classes that used ArcGIS StoryMap-based teaching materials.

Using effective and appropriate teaching materials, students are more likely to understand a taught concept in developing the analytical potential of students. Thus, the use of ArcGIS StoryMaps has shown its advantages as a useful and effective information source instrument, as it plays an important role in the learning process, particularly in geography subjects that strongly require map media. Therefore, educators and learners can maximize the currently available educational potential gaps with their planned goals..

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