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The effect of website-based digital learning media on students' cognitive learning outcomes in class x biology material

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ARTICLE INFO	ABSTRACT
	This study examines the effect of website-based learning media on students' cognitive learning outcomes in class X Biology subjects. Using a quantitative research design with the Pretest-Posttest Control Group Design model, this study involved 72 SMA Negeri 10 South Konawe, Southeast Sulawesi Indonesia students, who were divided into experimental and control groups. The experimental group used website-based learning media, while the control group used PowerPoint media. The results showed a significant increase in the average value of cognitive learning outcomes in the experimental group compared to the control group, with an average N-Gain value of 0.36 (medium criteria) and 0.20 (low criteria), respectively. The use of website-based learning media proved to be more effective in improving learning outcomes because it was able to increase learner involvement, flexibility, and learning independence.

INTRODUCTION

Education in the 21st century, which is known as a characteristic of the era of globalization or the era of openness (the era of openness), is evidenced by the development of science and technology (technology) (Hasibuan & Prastowo, 2019). The rapid development of technology is no longer a continuation of the third industrial revolution, but rather a gate for the arrival of the Industrial Revolution 4.0 (Syamsuar & Reflianto, 2019). According to research by Khusniyah & Hakim (2019), Internet technology can be used in learning activities, which can be said to be a change from conventional to modern methods (Putrianingtyas et al., 2022). In the 21st century era, education must adapt to the rapid development of information technology (Sari* et al., 2024). To create the next generation of a superior and competitive nation, the field of education is closely tied to the Industrial Revolution 4.0, which can be used to support learning and thinking patterns as well as develop creative and innovative students (Kahar et al., 2021). According to Zubaidah (2020), to compete in the twenty-first century, students need to have at least ten competencies: critical thinking, communication, leadership, teamwork, flexibility, productivity and responsibility, creativity, global citizenship, entrepreneurship, and the capacity to access, evaluate, and synthesize information (Asy'ari & Hamami, 2020). The 21st-century era of educational transformation requires educators to be more creative and innovative in maximizing learning technology (Anam et al., 2023). Education is developed by improving the technologies used in learning (Ridwan Yusup et al., 2024)

Technology-based learning, which is currently expanding quickly, is made possible by 21st-century education; 1) critical thinking, 2) creative and innovative thinking, 3) communication, and 4) collaboration are the four C's that should guide the design of learning (Rosnaeni, 2021). Enhancing students' higher-order thinking abilities, developing technological literacy, and making the learning process more effective, efficient, and appealing all depend on incorporating technology into the curriculum (Rahmatullah et al., 2022).

The needs of the 21st century as it is today indeed needing in-depth knowledge (cognitive) skills in the context of life regarding a problem, event, or event (Rahayu et al., 2022). The primary component of the three assessment domains in Indonesia's educational system is learning outcomes in the cognitive domain. Cognitive is a crucial component of the teacher's capacity to establish an educational communication environment between students and teachers that encompasses cognitive, affective, and psychomotor elements in an attempt to learn something based on planning, evaluation, and follow-up to meet learning objectives (Rahmawati, 2022). Learning outcomes are the result of students' successful completion of learning toward predefined learning objectives. To improve learning outcomes, teachers' methods of instruction have an impact on students' learning outcomes in addition to students' desire to learn well (Kristin, 2016). This is in line with what is revealed by Satriani & Prasojo (2024), stating that the achievement of satisfactory learning achievement is one indicator of the success of the learning process in schools.

Based on the results of observations made on March 16, 2024, which aim to determine the cognitive learning outcomes of students, it turns out that many students got scores below the predetermined KKM of 70, it was found that there were still many students who were in the low category. This observation was conducted indirectly by using an instrument containing several indicators of observed behavior, which was filled in by the biology subject teacher. The results of the observation also found that the teacher had not used website-based media in learning, and students were very eager and interested in using website-based learning media. Students' low learning outcomes are caused by a number of factors, including the fact that learning resources are still restricted to textbooks or texts rather than being done directly, misconceptions occur when students fail to connect new concepts with preexisting ones, resulting in incorrect concepts that contradict the actual concept, learning that is not contextualized, and poor reading comprehension and interpretation skills (Suparya et al., 2022). In line with research conducted by Wahyu et al (2014), learning media can affect the success of student learning, so it needs a learning media that can support the learning process of students (Puspita Dewi et al., 2023).

Based on this description and rationale, it is necessary to develop a learning website that is designed to actively involve students so that it can help students improve their learning outcomes. Currently, there are still not many learning websites that can facilitate student learning outcomes. So that it can help students to better understand biology subject matter and students are more excited when the learning process takes place so that learning becomes more meaningful. In line with what was

revealed by Juliyanti et al. ([2022](#)), one of the learning media that can be developed today is a website. The utilization of website media is important as a companion in the learning process because it is increasingly needed to overcome problems that arise due to limited time, place, and other facilities (Sina et al., [2023](#)). Technological advances have had a significant impact on education, leading to various innovations in the learning process, thus creating a more interesting and effective learning environment (Nurhidayah et al., [2024](#)).

According to Haniko et al., ([2023](#)), Education during the Industrial Revolution facilitated learning and enhanced student learning outcomes. 4.0 mandates that teachers be proficient in using technology in the classroom. According to Haniko ([2023](#)), the use of web-based teaching materials can greatly facilitate the teacher's task in delivering learning materials (Ningrum et al., [2024](#)). Technology that is increasingly advanced and developing will certainly affect the world of education, including in terms of learning (Ginting & Siagian, [2022](#)). According to Hamzah & Rahman ([2016](#)), one of the learning media innovations in the digital era is website-based learning media. Website-based learning media is part of the utilization of technological sophistication in the world of education, which is implemented in teaching and learning activities by utilizing website media that can be used via the Internet network (Salsabila & Aslam, [2022](#)). Google Sites is one of the applications that can be used in creating websites (Juniarti et al., [2024](#)).

Research conducted by Kuswanto, ([2018](#)). The results showed that web-based learning media on class X defense system material was feasible to implement in schools because it was interesting and fun and presented according to the characteristics of students to increase students' interest in learning. Studies conducted by Ghani & Daud ([2018](#)), state that the use of websites as learning media can increase the effectiveness of the learning process, and most students feel satisfied and play a more active and critical role in developing their skills (Suripah & Susanti, [2022](#)). The novelty of the website that is implemented to students is in terms of material, various references used in explaining the problems of the material studied, namely the material on environmental change and environmental pollution, diverse content (such as videos of each learning material, and also images presented in each problem contained in the material), so that students will be more active, and independent in learning. In line with research conducted by Wahyuni et al., ([2020](#)), it states that website-based learning media has a student-centered principle so that it can enable students to learn independently and be responsible for the learning process because students can learn anytime, anywhere, and have unlimited access. This is also expressed by Marzani et al., ([2023](#)), who state that the existence of several features, such as online discussions and time management, can increase flexibility which can allow students to have better self-regulated learning. Web-based learning multimedia is one type of media that can help with the implementation of the e-learning process. It includes a variety of applications and learning resources that are online and connected to the internet, along with other features that make it easier for students or users to communicate with teachers (Danaswari & Gafur, [2018](#)). Based on the above, a learning media is needed to overcome the problems found, namely helping students to improve their learning outcomes. This research focuses on the effect of web-based learning media to facilitate students' learning outcomes. The web-based learning media was implemented at SMA Negeri 10 Konawe Selatan in Southeast Sulawesi, Indonesia.

METHODS
Research Design

This type of research uses quantitative research. While this research design uses Pretest-Posttest Control Group Design, in this design before the sample is given treatment, the sample is given a pretest first, then after the sample is given treatment, the sample is given a posttest. This research was conducted to see the effect of website-based learning media on students' cognitive learning outcomes, so the stage carried out was the implementation of website-based learning media for students.

In this study, the experimental group used web-based learning media with a flipped classroom model (X1), while the control group used media and learning models commonly used in schools (PowerPoint media). The control group did not receive any special treatment. In the implementation of field trials, pretests and posttests were held to obtain data and information about students' cognitive learning outcomes.

Table 1.

Research Design

Group	Pretest	Treatment	posttest
Experiment	O_1	X_1	O_2
Control	O_3	-	O_4

Population and Samples

The population of this study was SMA Negeri 10 Konawe Selatan, Southeast Sulawesi, Indonesia. The sampling technique used purposive sampling in class X which amounted to 72 students. This study involved two classes, namely experimental classes using Website media with a total of 36 students and control classes using PowerPoint media with a total of 36 students

Instrument

Data collection instruments are non-test and test. Non-test instruments are interview guides to teachers, learner needs analysis questionnaires, learning material expert validation questionnaires with material and language aspects, learning media expert validation questionnaires with aspects of screen design appearance, ease of use, consistency, usefulness, and graphics, and questionnaires of learning outcomes before and after learning. Non-test instruments are arranged using a Likert scale with a category of four answer options. The test instrument is prepared with variable indicators of learning outcomes, namely aspects of knowledge, comprehension, analysis, synthesis, and evaluation consisting of fifteen multiple-choice questions.

Procedure

The procedure in conducting this research is to take care of permission to conduct research at school, then prepare learning devices in the form of lesson plans, LKPD, and others. After that, make an instrument that will be used to measure student learning outcomes in the form of questions, make an observation sheet for the implementation of learning, and discuss with the teacher about the website media that will be implemented. The implementation stage begins, the teacher gives a pretest to the experimental class and control class using Google Forms, and then the teacher opens the class with preliminary activities such as greetings, prayers, and attendance of students. In this learning activity, students study the material of environmental change and environmental pollution. At the end of the lesson, the teacher again gave posttest questions to the experimental class and control class using Google Forms.

Data Analysis Techniques

The data analysis technique uses qualitative and quantitative analysis, qualitative data analysis techniques are used to analyze responses from research subjects in the form of comments, suggestions, and information that has been presented. The quantitative data analysis technique is used to analyze the response of the research subject in the form of scoring by referring to the scale used and then processed using relevant statistics. Data analysis of student learning outcomes instrument tests in the research used is the average value (mean) and percentage of learning outcomes. The average value (Mean) is used to determine the average value of students' cognitive learning outcomes in one class and to determine the average score of learning outcomes. Then analyze the improvement that occurs before and after learning is calculated by the N-Gain formula.

RESULTS AND DISCUSSION

The implementation stage is obtained from the implementation of learning. The results of learning implementation were obtained from observations made by observers at each meeting. Observations were made in experimental and control classes, and the results can be seen in (Table 2).

Table 2.
Recapitulation of Learning Implementation in Experimental and Control Classes

Class	Meetings	Activities Implemented	Total Activity	Percentage
Experiment	1	10.00	11.00	91.00%
	2	11.00	11.00	100.00%
Control	1	9.00	11.00	82.00%
	2	10.00	11.00	91.00%

Table 2 compares the implementation of activities between two types of classes, namely experimental and control classes, based on the number of activities carried out during each meeting. In the experimental class, in the first meeting, 10 out of 11 planned activities were successfully implemented, with an implementation percentage of 91%. In the second meeting, all 11 activities were successfully implemented with a percentage of 100%. In the control class, in the first meeting, 9 out of 11 activities were successfully implemented, with a percentage of 82%. In the second meeting, the number of activities that were successfully implemented increased to 10 out of 11 activities.

The results of descriptive statistical analysis in the form of the number of samples, the number of total values, minimum values, maximum values, and standard deviation values (Table 3 and Figure 1). Furthermore, the analysis used the n-gain score to determine the improvement of students' cognitive learning outcomes in both the experimental and control classes (Table 4 and Figure 2).

Table 3.
Comparison of Data on Total Score, Minimum Score, Maximum Score, and Standard Deviation of Learning Outcome Variables in Experimental and Control Classes

Type of Analysis	Experiment Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Number of samples	36.00	36.00	36.00	36.00
Minimum values	60.00	70.00	60.00	70.00
Maximum values	90.00	95.00	90.00	95.00
Standard deviation	8.45	6.56	7.95	6.61

Table 3 shows the comparison of the total value, minimum value, maximum value, and standard deviation value in the experimental class and control class. The experimental class after the pretest gets a minimum value of 60, a maximum value of 90, and a standard deviation value of 8.45. So it was found after the post-test that the minimum value was 70, the maximum value was 95, and the standard deviation value was 6.56. After the pretest, the treatment in the control class gets a minimum value of 60, a maximum value of 90, and a standard deviation value of 7.95. So it was found that after the pretest and posttest, there was no difference in the minimum and maximum values because the average student got the lowest scores of 60 and 70 and the highest scores of 90 and 95.
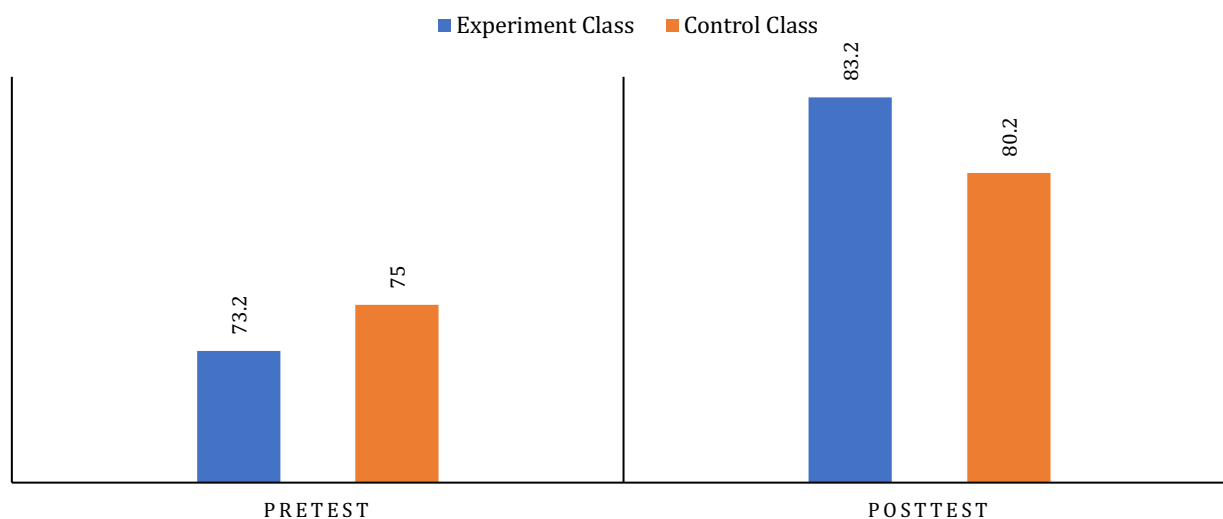

Figure 1. Comparison Chart of Average Value Data of Learning Outcome Variables in Experimental Classes and Control Classes

Figure 1 shows a comparison graph of the average value of learning outcomes data in two groups, namely the experimental class and the control class, based on the results of the pretest and posttest. From the graph after the pretest the experimental class had an average value of 73.2, and the control class had an average value of 75. Then after the learning was carried out the posttest in the experimental class increased to an average value of 83.2 and the control class also increased, but lower than the experimental class, with an average value of 80.2. So, it can be stated that the experimental class experienced a more significant increase from pretest to posttest compared to the control class, while the control class also experienced an increase in value, but not as great as the increase in the experimental class. This shows that the intervention or treatment given to the experimental class is more effective than the control class.

Table 4.
Improvement of Student Learning Outcomes Based on N-Gain Score

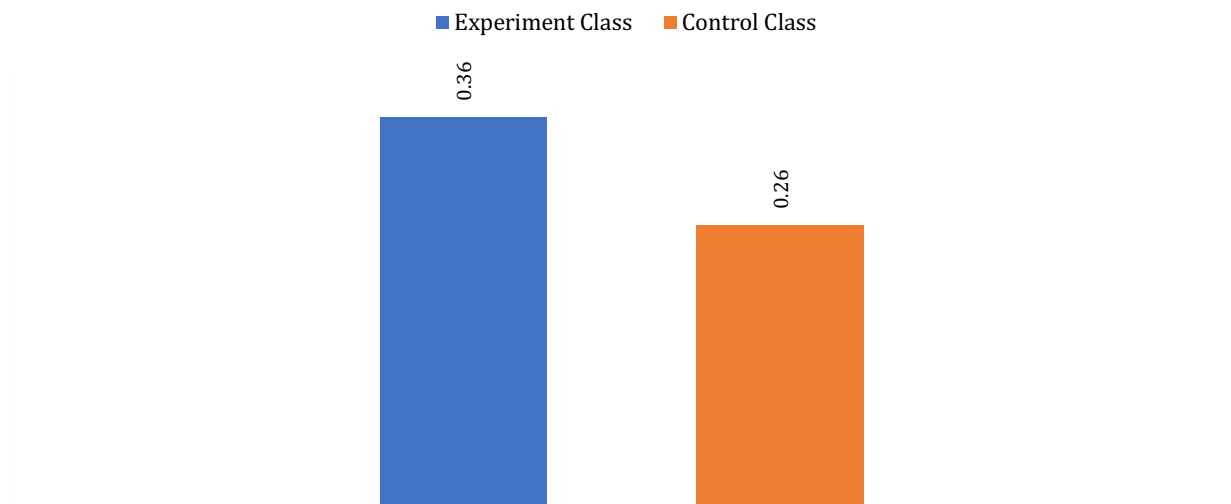| Class	Average Value		N-Gain Score	Criteria
	Pretest	Posttest		
Experiment	73.20	83.10	0.36	Medium
Control	75.00	80.20	0.20	Lower

Figure 2. Graph of Improvement in Student Learning Outcomes Based on N-Gain Score

Figure 2 shows a graph of the improvement of students' learning outcomes based on the N-Gain Score. This graph compares two groups, namely the Experiment Class and the Control Class. The experimental class (marked in blue) has an average N-Gain score of 0.36, while the control class (marked in orange) has an average N-Gain score of 0.26. The results revealed that there was an increase in student learning outcomes in both classes, with an increase in the experimental class higher (medium criteria) than the control class (low criteria), as shown in Table 5. Data analysis also shows that the total post-test score, post-test average, and n-gain score in the experimental class are higher than the control class, so it can be said that the use of website-based learning media affects improving student learning outcomes.

The difference in N-gain values between the two classes can be influenced by differences in learning techniques, such as the experimental class using website-based learning media while the control class uses PowerPoint. The N-gain test results prove that learning media affects students' cognitive learning outcomes. The increase can be seen in Table 4 and Figure 2, which shows an increase in student scores before using website-based learning media by looking at the pre-test and post-test scores of students. This is in line with the opinion of Tarigan & Siagian (2015) that using website-based learning media has a higher level of effectiveness compared to the use of PowerPoint media (Priani & Pertiwi, 2024). The same thing was said by Astuti et al. (2020), stating that if websites are often used as distance learning media, as well as affordability to access websites, and can be utilized by students

anywhere so that students can always interact with learning materials on the website (Dwi Susanti, 2021).

The use of website-based media is superior and provides positive benefits in improving learning outcomes compared to using PowerPoint (Halimatusyadiah & Disman, 2023). This is also in line with research by Persada (2017), which states that implementing website-based teaching materials reveals that the average learning outcomes using website-based teaching materials are higher than the learning outcomes of students who do not use website-based teaching materials (Samo et al., 2023). According to (Triono et al., 2024), in their research where it is known that website-based learning is proven to have a positive effect on learning outcomes in the form of increased cognitive competence of students.

The results of descriptive statistical analysis, namely the recapitulation of the total score, average score, total score, and average n-gain score, show that learning using web-based learning media affects the cognitive learning outcomes of students in the field trial subjects. After conducting inferential statistical analysis, namely MANOVA the value further strengthens that web-based learning media has a significant effect. The results of the MANOVA analysis reveal that the significant value in the Pillai's Trace, Wilks Lambda, Hotelling's Trace, and Roy's Largest Root formulas is 0.00, the value is less than 0.05 so it can be concluded that the learning outcomes of students are significantly influential for students who use website-based learning media compared to students who use PowerPoint in learning. The website is an innovation that contributes significantly to changes in the learning process (Nanda & Agustini, 2023).

Research conducted by Baisa (2019), shows that students' cognitive ability can be affected by the use of web-based media. Nonetheless, the use of web-based media is popular due to its benefits, including the fact that it encourages greater interaction during online and offline learning (Ni'matus Salihah, 2022). The implementation of this learning media provides a new experience for students in learning, which does not only use PowerPoint media in every lesson. The creativity of an educator in teaching is needed, so that students are not bored while learning. Research has been conducted by Viola et al (2021), stating that the use of website media in learning activities can improve learning outcomes and student responses to the media is very good (Thofiqo Fakhruddin et al., 2024).

CONCLUSION

This study shows that website-based learning media has a positive effect on improving students' cognitive learning outcomes in Biology subjects. The use of website-based media provides a significant increase in the average value of students' cognitive learning outcomes in the experimental class compared to the control class using PowerPoint media. Implementation of web-based learning media proved to be more effective because it can increase students' involvement in the learning process.

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