



## The influence of waterwheel open diorama media on students' concept understanding of ecosystem component materials

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### ABSTRACT

The use of learning media by teachers that is not optimal results in students who do not pay attention to the teacher in delivering material during the learning process in the classroom. To overcome these problems, the researcher provided a watermill-based diorama media to evaluate whether its use had an impact or not. This study is aimed at determining the influence of the use of diorama media on students' concept understanding in grade V of SDN 1 Panggungrejo and SDN 3 Mojosari. The method used in this study is quantitative with a *quasi-experimental research model*. Instruments in the form of *pretest* and *posttest* were given in the control class and the experimental class to test students' comprehension, and analysis was carried out to calculate the t-test. The results obtained showed that the experimental class using waterwheel-based diorama media had an influence on students' understanding of concepts in the science subject of ecosystem material. In addition, there was a significant influence on the concept comprehension test between students who participated in learning using watermill-based diorama media and students who did not use watermill-based diorama media. In conclusion, the application of waterwheel-based diorama learning media has a significant influence on students' understanding of ecosystem materials in grade V elementary school.



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## INTRODUCTION

Learning is the relationship between teacher and student. Learning is more than just sitting in class and listening to the teacher explain things. Learning leads to changes in an individual's abilities, behaviors, and knowledge (Tomprowski et al., 2017). Learning is a process that helps humans gain competence in the field of knowledge, attitudes, and abilities. The learning process is very important because it involves the exchange of information between teachers and students to enable successful learning in a learning environment (Zhou, 2025). Learning as a teacher-led activity that influences student behavior in a positive direction (Martinez & Wighting, 2023). Thus, learning is a process of teaching and learning activities that involve teachers and students. Both carry out learning activities for each other to achieve learning goals.

However, in the context of learning, teachers and students have different responsibilities and are not only limited by the fact that teachers are the ones who teach or transfer knowledge to students, while students are only recipients of knowledge from teachers. However, teachers and students work together to ensure that the learning process runs smoothly (Jacobs & Renandya, 2021). This shows that teachers are not the only providers of learning activities. Students can also act as knowledge givers for teachers and other students (Sukamto et al., 2024).

Students can also get information from books, the internet, magazines, newspapers, and so on. Therefore, the government developed and implemented a new curriculum, the Independent Curriculum, which incorporated science and technology learning into educational activities. So, with this curriculum, it is easier for teachers to assign problem-based assignments to students, and students are expected to actively solve these problems using their own skills (Weng et al., 2021).

To present learning materials, teachers can use learning media in science classes. Learning activities may be considered less effective without learning media, and students will

not understand the subject matter in its entirety, so it can have an impact on achieving learning goals. Learning media is a tool or gadget that can help students understand the content of the lessons presented by the teacher (Arief et al., 2022). Learning media needs to refer to individuals, objects, or events that can create the conditions that students need to obtain information, attitudes, and abilities (Salsabila & Khairudin, 2021).

One of the media that is considered appropriate for learning science material is the open diorama media. Open diorama learning media is a miniature teaching aid that depicts a certain environment or scenario in three dimensions without glass covers or boundary walls. This media is designed so that students can see and interact directly with the elements in it, such as animals, plants, water, or other ecosystem elements, according to the learning theme to be conveyed. In the context of science learning in elementary school, open dioramas are used to visualize scientific concepts, such as ecosystems, food chains, and interactions between biotic and abiotic components. Thus, this media can make it easier for students to understand abstract material by presenting a concrete and interactive learning environment, so that they can learn through direct observation and exploration (Sari & Qohar, 2023). The advantage of open dioramas is that they provide a more real learning experience and allow students to be directly involved in the learning process (Melinda & Ariyani, 2024). In addition, diorama media is also effective in fostering students' interest in learning (Alfhandy et al., 2024). Students are triggered to actively participate in learning activities. This considers that students not only passively listen to the teacher's explanations, but also engage in observing, practicing, and analyzing. In addition, diorama media helps students to understand the material more easily because the material that is considered abstract becomes more concrete for students to digest.

Considering the usefulness of diorama media, the researcher conducted a study to determine the influence of open diorama media on students' understanding of concepts in ecosystem materials in elementary schools. The findings of this study provide an innovative learning reference that can be applied by teachers in science learning.

## **RESEARCH METHODS**

### **Research Design**

This study uses a quantitative approach with a quasi-experimental research design of the nonequivalent pretest-posttest control group design. This design is aimed at determining the influence of watermill-based dioramas in increasing students' understanding of concepts in ecosystem component materials. Effectiveness is seen from the comparison between the experimental class and the control class, where the experimental class uses a watermill-based diorama learning media and the control class does not use the learning medium.

### **Research Sample**

This study involved 38 elementary school students in class V divided into 2 classes, class A and class B, where each amounted to 19 people. Class A comes from SDN 3 Mojosari, which was later designated as the control class. Class B comes from SDN 1 Panggungrejo, which is an experimental class. The determination of the two classes is based on voluntariness in participating in this study.

### **Collecting Data**

The instrument used in this study is an objective assessment instrument in the form of multiple choice. An instrument is said to be reliable if the observation score has a high correlation with the actual score. Reliability is defined as a correlation coefficient that measures the compatibility between the scores of two parallel tests. Thus, the understanding that can be obtained from the statement is that a test is reliable if the measurement results are close to the actual state of the test participant (Retnawati, 2016).

Instruments related to these variables were tested on 38 students. Reliability using *the Factor: Reliability Analysis test* in the JAMOVI 2.3.2 application. Determination of the classification level of *Cronbach's Alpha coefficient* presented in accordance with Table 1 (Guilford, 1942).

**Table 1. Cronbach's Alpha Coefficient Classification**

<i>Cronbach's Alpha coefficient</i>	<i>Interpretation of Cronbach's Alpha Coefficient</i>
0,40 – 0,69	Realibilitas sedang
0,70 – 0,89	Realibilitas tinggi
0,90 – 1,00	Realibilitas sangat tinggi

The reliability of a test is generally expressed numerically in the form of a coefficient of -1.00 to +1.00. High coefficients indicate high reliability. Conversely, the lower the test score coefficient, the lower the reliability. Optimal reliability is achieved when the reliability coefficient is close to +1.00 and then shows perfect. The hope is that the reliability coefficient is positive. Reliability is also related to measurement errors. A high reliability coefficient indicates the consistency and accuracy of the measurement results. The greater the reliability of an instrument, the smaller the measurement error, and vice versa, the lower the reliability of the score, the greater the measurement result (Retnawati, 2016).

This study uses construct validity is a validity that shows the extent to which the instrument reveals a certain ability or theoretical construct that it wants to measure. The construct validation process begins with identifying and limiting the variables to be measured, then defined specifically based on relevant theories. This allows the development of hypotheses about the results of measurements under certain conditions. If the results are in accordance with expectations, the instrument is considered to have good construct validity (Retnawati, 2016). In research that measures the understanding of concepts which consists of recognizing and understanding the definitions, characteristics and examples of a concept. In this study, the validity determination was used using EFA. EFA is used when the measurement model of the instrument construct is still being sought or explored. Next, the computer compiles the variance-covariance matik, then calculates the eigenvalue. This eigen value is then used to calculate the percentage of variance described, as well as draw the screeplot. Determination of construct validity using the JAMOMI 2.3.2 application.

### Data Analysis

There are two prerequisite tests that must be carried out before the analysis is carried out, namely the normality test is carried out with the aim of finding out whether the data used from each variable has been distributed normally or not. The normality test was carried out using a data program on students' concept understanding (*pretest and posttest*), which was treated to 2 classes, namely the control class (CC) and the experimental class (EC) and then statistically tested using the Jamovi 2.3.28 *Shapiro-Wilk Multivariate Normality Test* to see the prerequisites for normality. According to Sugiyono (2007:173), if  $p > 0.05$ , then the data is distributed normally and vice versa if  $p < 0.05$ , then the data is not distributed normally. Testing the normality of data distribution is an important prerequisite in statistical analysis, so it is carried out on *students' pretest and posttest data*. The criterion is that if the sig value  $> 0.05$ ,  $H_0$  is accepted and  $H_1$  is rejected, while if the sig value is  $< 0.05$ ,  $H_0$  is rejected and  $H_1$  is accepted at a significance level of 0.05. The criteria for the null hypothesis and its alternatives are as follows:

- $H_0$  : Normally distributed data
- $H_1$  : Data is not normally distributed

The homogeneity test was carried out to find out whether the sample used in the study came from the same variance or not. The homogeneity test was carried out using the Jamovi 2.3.28 program. The homogeneity test is determined by the level of significance (sig.), if the value (sig.)  $> 0.05$ , then the data is declared homogeneous, and if the value (sig.) is  $< 0.05$ , then the data is declared inhomogeneous. The homogeneity test was carried out on *students' pretest and posttest data*. The criteria are that if the sig value  $> 0.05$ ,  $H_0$  is accepted and  $H_1$  is rejected, while if the sig value  $< 0.05$ ,  $H_0$  is rejected and  $H_1$  is accepted at a significance level of 0.05. The criteria for the null hypothesis and its alternatives are as follows:

- $H_0$  : Homogeneous group variants
- $H_1$  : Variants of the group are not homogeneous

The t-test was chosen because it was to find out the difference in the average value of the control class compared to the value in the experimental class using the t-test. The hypothesis test carried out was the t-test, and the test of the influence of the free variable on the bound variable. The Independent Sample T-Test is performed to find out the difference between the control class and the experiment. The t-test in this study uses the Jamovi 2.3.28 program. The criteria for acceptance or rejection of H0 at the significance level of 5% using significance, i.e. if the significance is  $> 0.05$ , then H0 is accepted, and vice versa if the significance is  $< 0.05$ , then H0 is rejected. The research hypotheses are as follows:

- H<sub>0</sub> : There was no significant effect on students' understanding of concepts who participated in learning using watermill-based dioramas on ecosystem materials with students who participated in learning not using watermill-based dioramas on ecosystem materials. With:  $\mu_1 = \mu_2$ .
- H<sub>1</sub> : There was a significant influence on students' understanding of concepts who participated in learning using watermill-based dioramas on ecosystem materials with students who participated in learning not using watermill-based diorama media on ecosystem materials. H<sub>1</sub> :  $\mu_1 \neq \mu_2$ .

Based on the hypothesis that has been made, the criteria used in the test can be explained as follows:

- H0 is accepted if p-value (sig)  $> 0.05$  ( $\alpha$ ) or H0 is rejected if p-value (sig)  $< 0.05$  ( $\alpha$ )  
 H1 is accepted if p-value (sig)  $< 0.05$  ( $\alpha$ ) or H1 is rejected if p-value (sig)  $> 0.05$  ( $\alpha$ )

## RESULTS

### Validity and Reliability of Research Instruments

The instrument used in this study is an instrument for understanding students' concepts in the form of multiple-choice questions totaling 20 items. Multiple-choice questions were tested on 38 elementary school grade V students to determine the reliability and validity of the research instruments used. Based on the results of the test data of the student concept understanding instrument in the JAMOVI application, the results were obtained as presented in Table 2.

**Table 2. Scale Reliability Statistics of Instrument for Students' Understanding of Concepts**

	<i>Mean</i>	<i>Cronbach's Alpha</i>
Scale	4,26	0,826

The student concept comprehension test instrument has a realism of 0.826 which is indicated by the *Cronbach's Alpha* coefficient in the JAMOVI application which indicates the level of reliability of the measured data. Based on the determination of the classification level of *Cronbach's Alpha* coefficient presented on Table 2, it shows that 0.826 is in the high reliability range. Thus, a high coefficient indicates high reliability.

Based on Table 3, *item-rest correlation* obtains correlation results that (positive) indicate that the item can be used to reflect the concept measured by the instrument, while low (negative) correlation can indicate a problem in the construction or formulation of the question so that it must be discarded or replaced.

**Table 3. Item Reliability Statistics of Instrument for Students' Understanding of Concepts**

<i>Item</i>	<i>Mean</i>	<i>Item-rest correlation</i>
S1	4.59	0.378
S2	4.43	0.474
S3	4.28	0.519
S4	4.18	0.603
S5	4.11	0.503
S6	4.13	0.237
S7	4.49	0.200
S8	4.29	0.609
S9	4.47	0.346

S10	4.38	0.446
S11	4.63	0.330
S12	3.89	0.414
S13	3.72	0.478
S14	4.42	0.413
S15	4.51	0.306
S16	4.38	0.448
S17	3.72	0.409
S18	4.38	0.587
S19	3.88	0.322
S20	4.20	0.344

The item-rest correlation shows all positive values. The item-test correlation on 20 question items, all of which have positive values, can provide a strong picture related to the quality of the measurement instrument (Figure 2). A positive correlation between each item and the total test score indicates that all questions or statements consistently support the concept or ability measured by the test. A positive result like this can be considered an indication that the test instrument has been well designed and capable of accurately measuring the desired construction. This provides confidence that each item effectively assesses the desired aspect, and that the total test score reflects well the level of students' understanding of concepts being measured. Thus, the results of the statistical test show that the reliability of the concept understanding test instrument shows the reliability category.

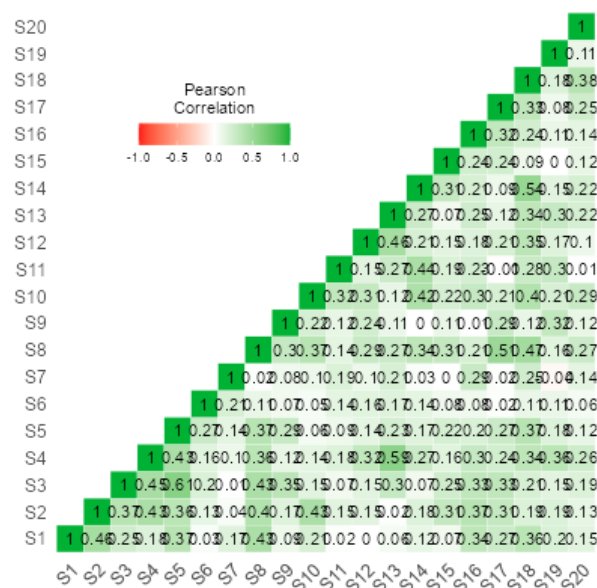


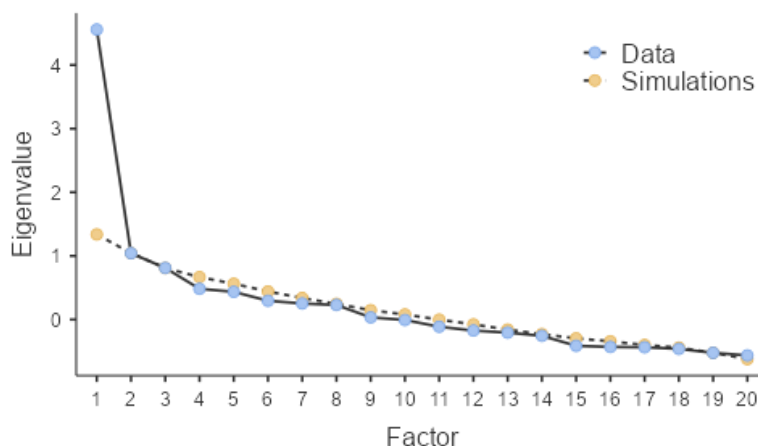
Figure 2. Headmap Correlations of Reliability of Instrument for Students' Understanding of Concepts

In this study, the determination of validity uses EFA because it is still vague whether the understanding of concepts consisting of recognizing and understanding the definitions, characteristics and examples of a concept has the same factors. The results of the analysis showed that the Bartlett's Test of Sphericity value was <.001 (Table 4). Retnawati (2016) explained that a p-value of less than 0.01 indicates that the sample size used in the analysis of this factor is sufficient.

Table 4. Bartlett Test of Sphericity of Instrument for Students' Understanding of Concepts

$\chi^2$	df	p
479	190	< .001

The many factors contained in the instrument can be known from *the scree-plot* and the Eigen's value, so that a graph is obtained that shows steep and sloping. Figure 3 presents the analysis of *the Scree Plot* of the Student Concept Understanding Instrument.



**Figure 3. Scree Plot Results of Exploratory Factor Analysis of Instrument for Students' Understanding of Concepts**

Observing the results of the scree plot that there are 1 steep and the blue dot is below the yellow dot, so this test instrument is correct only to measure students' understanding of concepts. This is also corroborated by *Eigen Values*, which is only 1 factor that stands out in value over the others, which is presented in Table 5.

**Table 5. Initial Eigenvalues Analysis of Exploratory Factors Instruments for Understanding Students' Concepts**

<i>Initial Eigenvalues</i>	
<i>Factor</i>	<i>Eigenvalue</i>
1	4.55760
2	1.04184
3	0.81056
4	0.48345
5	0.43565
6	0.29478
7	0.25253
8	0.22900
9	0.03380
10	-0.00698
11	-0.11272
12	-0.17332
13	-0.20568
14	-0.25587
15	-0.41286
16	-0.43043
17	-0.43594
18	-0.46102
19	-0.52300
20	-0.56381

Based on the analysis of these exploratory factors, it can be concluded that the instrument is valid for measuring students' understanding of concepts in general and is empirically proven.

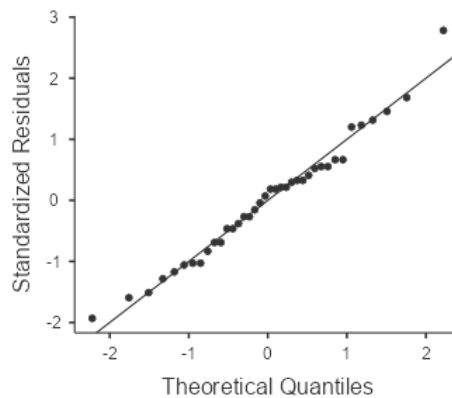
### Hypothesis Testing

One of the formulations of this research problem is to examine the influence of water wheel-based diorama media on students' understanding of elementary school class V ecosystem material. To answer the formulation of the problem, *quasi-experimental* research with a *pretest-posttest design* is needed. Therefore, it is necessary to calculate *the pretest* results and calculate the *posttest results*. The test was given to 38 elementary school students with the participation of 19 students in the control class (learning not to use water wheel-based diorama media) and 19 students in the experimental class (learning to use water wheel-based diorama media). The control class was carried out at SDN 3 Mojosari, while the experimental class was held at SDN 1 Panggungrejo.

**Table 6. Normality Test (Shapiro-Wilk)**

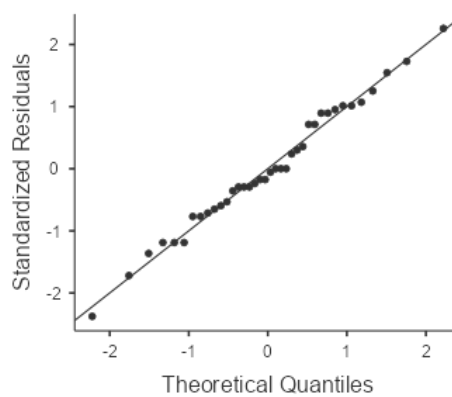
	<i>W</i>	<i>p</i>
Pretest	0.981	0.746
Posttest	0.989	0.963

The questionnaire given was 20 questions on understanding concepts that were valid and reliable. This research is a *pretest-posttest design*, so measurements are needed for *pretest* data and *posttest data*. Data on students' concept understanding (*pretest and posttest*) were treated to 2 classes, namely the control class (CC) and the experimental class (EC) and then statistically tested using JAMOVI 2.3.28 to see the prerequisites for normality and homogeneity.



**Figure 4. Q-Q Plot Assessing Multivariate Normality (Pretest)**

Table 6 presents a p-value of 0.746 in the pretest and 0.963 in the posttest, greater than 0.05. This indicates that the data is normally distributed, and  $H_0$  is accepted. The *Q-Q Plot Assessing Multivariate Normality* shown in Figures 4 and 5 shows the distribution of normality points related to the presented data.



**Gambar 5. Q-Q Plot Assessing Multivariate Normality (Posttest)**

From Figures 4 and 5, these points are close to the parallel line so that it can be concluded that the error is normally distributed. Next, a homogeneity test was carried out.

**Table 7. Homogeneity of Variances Test (Levene's)**

	<i>F</i>	<i>df</i>	<i>df2</i>	<i>p</i>
Pretest	0.236	1	36	0.630
Posttest	0.159	1	36	0.693

Table 7 presents a p-value of 0.630 in the *pretest* and 0.693 in the *posttest*, greater than 0.05. This indicates that the data is homogeneous, and  $H_0$  is accepted. The prerequisite test to be able to use *the independent sample t-test* is met, namely normal and homogeneous distributed data, so that it is forwarded for further testing. Next, *an independent sample t-test* was carried out.

$H_0$  : There was no significant effect on the concept comprehension test between students who participated in learning using watermill-based diorama media of ecosystem material and students who participated in learning not using watermill-based diorama media of ecosystem material. With:  $\mu_1 = \mu_2$ .

$H_1$  : There was a significant influence on the concept comprehension test between students who participated in learning using watermill-based diorama media of ecosystem material and students who took part in learning not using watermill-based diorama media of ecosystem material.  $H_a: \mu_1 \neq \mu_2$ .

Based on the hypothesis that has been made, the criteria used in the test can be explained as follows:

$H_0$  is accepted if p-value (sig) > 0.05 ( $\alpha$ ) or  $H_0$  is rejected if p-value (sig) < 0.05 ( $\alpha$ )  
 $H_1$  is accepted if p-value (sig) < 0.05 ( $\alpha$ ) or  $H_1$  is rejected if p-value (sig) > 0.05 ( $\alpha$ )

From the table 7, a P value of 0.667 was obtained. Because the p value > 0.05,  $H_0$  was accepted so that it can be concluded that there was no influence on the concept of elementary school students in the experimental class with the control class at the time of the pretest. Meanwhile, when the posttest was carried out in the control and experimental class based on Table 7, a p-value of < 0.001 was obtained, which means it has less/lower than (< 0.05). The value of p < 0.05 then  $H_0$  is rejected so that it can be concluded that  $H_a$  is accepted. Thus, there was a significant influence on the concept comprehension test between students who participated in learning using watermill-based diorama media and students who did not use watermill-based diorama media.  $H_a: \mu_1 \neq \mu_2$ .

## DISCUSSION

The use of diorama media in science learning not only aims to attract students' attention, but also substantially supports the implementation of the four principles of science as stated by Carin (1970), namely science as a process, science as an attitude, science as a product, and science as an application. In this study, these four aspects are integratively realized through the application of waterwheel diorama media.

As an attitude, science is reflected in the development of scientific attitudes in students, such as curiosity, thoroughness, discipline, and an attitude of never giving up (Redjeki, 2024). These positive attitudes grow when students actively observe and observe various elements displayed in the diorama media. Thus, this media can stimulate students' interest in the scientific investigation process in a more real and in-depth way.

The aspect of science as a process is illustrated through observation activities and grouping of biotic and abiotic objects presented in dioramas. This process helps students develop classification skills as well as analytical thinking skills, so that knowledge of ecosystem concepts can be built in a systematic and structured manner. This activity is in line with the view that the scientific process directly carried out by students will strengthen their understanding of the material being taught (Aji & Khan, 2013).

Furthermore, science as a product is realized through students' understanding of facts, concepts, and theories about ecosystems. Dioramic media concretely present facts about the diversity of living

things and the non-living environment (abiotic), which are important elements in an ecosystem. Thus, students are able to understand basic concepts more effectively compared to abstract or verbal learning only (Jordan et al., 2014).

Science as an application in the context of this research emphasizes the importance of students' awareness of environmental and ecosystem conservation. Direct observation through diorama media encourages students to understand the importance of maintaining ecosystem balance to avoid increasing environmental damage, especially due to global warming. This learning instills students' awareness of real actions such as reforestation and maintaining environmental cleanliness, which are real forms of application of science knowledge in daily life (Yücel & Özkan, 2015).

Empirically, the effectiveness of 3-dimensional diorama media in improving students' concept understanding is proven through statistical analysis using a t-test that shows a significant improvement in students' concept understanding after learning. This finding is in line with Edgar Dale's Cone of Experience theory (Dale, 1969), which emphasizes that direct experience helps students understand the material more meaningfully because they experience real learning. Direct experience through ecosystem observation in diorama media helps students build a deep conceptual understanding, in accordance with the stages of cognitive development of elementary school students described by Piaget, namely at the concrete operational stage. Thus, students are able to understand ecosystem material better, which is reflected in the increased understanding of students' concepts after participating in learning with this media.

## CONCLUSION

The results of the *pretest* and *posttest* contain multiple-choice questions with a total of 20 questions. The results were obtained that the Experimental Class at SDN 1 Panggunrejo got a higher score compared to the Control Class at SDN 3 Mojosari. This is in accordance with the calculations made using JAMOWI 2.3.28. A P value of 0.463 was obtained. Because the p value > 0.05, H<sub>0</sub> is accepted so that it can be said that there is no influence on the understanding of the concept of elementary school students in the experimental class with the control class at the time of the *pretest*. Meanwhile, when the *posttest* was carried out in the control and experimental classes, a p-value of < 0.001 was obtained, which means that it had less or lower than (< 0.05). The value of p < 0.05 then H<sub>0</sub> is rejected so that it can be concluded that H<sub>a</sub> is accepted. Thus, there was a significant influence on the concept comprehension test between students who participated in learning using watermill-based diorama media and students who participated in learning not using watermill media. H<sub>1</sub> :  $\mu_1 \neq \mu_2$ . In conclusion, the application of water wheel-based learning media has a significant influence on students' understanding of elementary school class V ecosystem materials. The findings of this study provide an innovative learning reference that can be applied by teachers in science learning.

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