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Instructional Package Development to Improve Students Understanding about The Basic Concepts of Ecology

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Instructional Package with a Scientific Approach to Improve Student Understanding of Basic Ecology Concepts

ABSTRACT

The 2013 curriculum requires teachers to apply learning with a scientific approach to ensure that they are student-centered. It is carried out because student-centered learning has been proven to help improve student achievement. An appropriate instructional package is needed and makes it easier for teachers and students to support the implementation of learning with the scientific approach. This study determines the effect of implementing an instructional package with a scientific approach to students' understanding of ecology's basic concepts. So this research was conducted with a quasi-experimental approach following a matching only pretest-posttest control group research design. Data regarding students' understanding of the basic ecology concepts were collected through a pretest and posttest in a multiple-choice test. Researchers analyzed data from the gain score of the control group and the experimental group using the t-test. The results of the t-test show that the t score: 4.704> critical value: 1.671, at = 0.05, which implies that there is a significant difference in the level of understanding amid the experimental group and the control group. Furthermore, seen from the effect size, it is evident that the instructional package's application with the scientific approach has a large effect size with Eta squared = 0.28. In other words, the instructional package's application with the scientific approach has an effect of 28% on increasing students' understanding of basic ecological concepts.

Keywords: instructional package, basic ecological concepts, scientific approach

Introduction

With the implementation of the 2013 curriculum, all teachers are expected to create student-centered learning. It is done because student-centered learning has various advantages compared to teacher-centered learning. By making students the center of learning, they will be more actively involved in constructing knowledge on their own so that learning becomes more

effective and meaningful (Talberta & Mor-Avi, 2019). Student-centered learning provides students opportunities to play an active role as actors who determine what, when, where, and how they will learn (Judi & Sahari, 2013). The implementation of the student-centered approach will help students to make them independent learners. They can dig up information independently outside the classroom implementation in the classroom (Attard & Holmes, 2020). Besides, the application of student-centered learning, incredibly cooperative learning can make students more confident and improve students' social skills in communicating effectively (Asoodeh, Asoodeh, & Zarepou, 2012).

Student-centered learning in the 2013 curriculum is realized by applying the scientific approach. With this approach, students will learn through various activities that actively involved the learning process. The activities carried out include observing, asking questions, gathering information, associating, and communicating. Implementing learning by carrying out various activities will make students more enthusiastic about learning (Rensburg, 2018). From these stages, it can also be understood that the implementation of learning with the scientific approach makes students try to find something independently. In other words, learning is structured to help students explore something until they can deduce what they understand from the process. This approach is also known as inquiry learning, which is one approach that has been proven to make learning more effective (Suárez, Specht, Prinsen, Kalz, & Ternier, 2018).

However, even though learning is student-centered, in its implementation, teachers' support as facilitators who are always ready to help when students experience problems is also essential (Cairns, 2019). In addition to teacher support, the availability of materials or instructional tools that support the implementation of the learning approach is needed. It is because teaching material is the leading learning resource for students that will affect the achievement of learning objectives and student understanding (Adalikwu & Iorkpilgh, 2013; Nwike & Catherine, 2013). Besides, instructional tools that are made according to the needs of

students and teachers will make learning more effective because it makes it easier for teachers to deliver material and, at the same time, makes it easier for students to learn it (Yıldız, Taşkın, Köğce, & Aydın, 2011).

Seeing the excellence of student-centered learning and the importance of appropriate instructional tools to support it, this study aims to test instructional devices arranged with a scientific approach. This test aims to determine the effect of implementing these instructional tools on students' understanding of ecology's basic concepts.

Materials and Methods

This research used a quasi-experimental research approach to match only the pretest-posttest control group research design (Fraenkel, Wallen, & Hyun, 2012). The experimental group and the other class were the control group with two classes involved in this study. There were 30 students in each group so that the total sample size of this study was 60 students. The experimental group was prepared using an instructional package with a scientific approach, while the control group was taught using conventional materials or those commonly used by teachers.

Researchers used a multiple-choice test to collect data on students' understanding of ecology's basic concepts. This study used two test packages to implement the pretest and another package to implement the posttest. Both groups were given a pretest before giving treatment to the experimental group. While the posttest was given to both groups after the treatment in the experimental group was completed.

The data in the form of gain scores from the pretest and posttest results of the experimental and control groups were then used to see the effect of applying the instructional package with the scientific approach to students' understanding of the basic ecology concepts. Before the data is analyzed using a different test (t-test), the data in the form of a gain score is

tested for normality and homogeneity first. After it was stated that the data were normally distributed and homogeneous, the data were analyzed using the t-test. Statistical tests to test normality, homogeneity, and t-test were performed using the Windows ver's SPSS application. 19. After that, the effect size measurement was also carried out to see how much influence the instructional package's application with the scientific approach had on students' understanding of ecology's basic concepts. Measurement of the effect size is carried out using the Eta squared formula (Pallant, 2011), namely:

$$\text{Eta squared} = \frac{t^2}{t^2+(N1+N2-2)}$$

With the assessment criteria according to Cohen (1988), namely:

.01= minor influence
.06= moderate influence
.14= great influence

Result and Discussion

Data Description

The data described in this section are the total scores summarized from the instruments distributed to students as respondents. In processing data, the authors use the Microsoft Office Excel 2007 computer program and SPSS version 19.

a. Description of Control Group Pre-Test Data

Respondents as a sample of 30 students. The average value (mean) = 10.17; median = 10, mode = 9, standard deviation = 2.36, highest score = 16 and lowest score = 6 (see Table 1).

Table 1. Frequency Distribution of Control Group Pre-Test Data

No. Kls	Interval Class	Absolute Frequency	Cumulative Frequency	Relative Frequency (%)
1	5,5 – 7,5	4	4	13,33
2	7,5 – 9,5	9	13	30,00
3	9,5 – 11,5	8	21	26,67
4	11,5 – 13,5	7	28	23,33
5	13,5 – 15,5	1	29	3,33
6	15,5 – 17,5	1	30	3,33
	Total	30		100.00

b. Description of the Experimental Group's Pre-Test Data

Respondents as a sample of 30 students. The average value (mean) = 14.93; median = 14, mode = 13, standard deviation = 3.38, highest score = 22 and lowest score = 10 (see Table 2).

Table 2 Frequency Distribution of Experimental Group's Pre-Test Data

No. Kls	Interval Class	Absolute Frequency	Cumulative Frequency	Relative Frequency (%)
1	9,5 – 11,5	6	6	20,69
2	11,5 – 13,5	7	13	24,14
3	13,5 – 15,5	5	18	17,24
4	15,5 – 17,5	5	23	17,24
5	17,5 – 19,5	3	26	10,34
6	19,5 – 21,5	3	29	10,34
Total		29		100

c. Description of Control Group Post-Test Data

Respondents as a sample of 30 students. The average value (mean) = 12.07; median = 13, mode = 14, standard deviation = 2.24, highest score = 16 and lowest score = 7 (see Table 3).

Table 3. Frequency Distribution of Control Group Post-Test Data

No. Kls	Interval Class	Absolute Frequency	Cumulative Frequency	Relative Frequency (%)
1	6,5 – 8,5	1	1	3,33
2	8,5 – 10,5	7	8	23,33
3	10,5 – 12,5	6	14	20,00
4	12,5 – 14,5	13	27	43,33
5	14,5 – 16,5	3	30	10,00
6	16,5 – 18,5	0	30	0,00
Total		30		100

d. Description of the Experimental Group Post-Test Data

Respondents as a sample of 30 students. The average value (mean) = 18.90; median = 19, mode = 19, standard deviation = 2.56, highest score = 24 and lowest score = 14 (see Table 4).

Table 4. Frequency Distribution of Experimental Group Post-Test Data

No. Kls	Interval Class	Absolute Frequency	Cumulative Frequency	Relative Frequency (%)
1	13,5 – 15,5	4	4	13,33
2	15,5 – 17,5	3	7	10,00
3	17,5 – 19,5	13	20	43,33
4	19,5 – 21,5	5	25	16,67
5	21,5 – 23,5	3	28	10,00
6	23,5 – 25,5	2	30	6,67
Total		30		100

e. Description of Control Group's Gain Score Data

Respondents as a sample of 30 students. The average value (mean) = 1.90; median = 2, mode = 2, standard deviation = 1.52, highest score = 5 and lowest score = -1 (see Table 5).

Table 5. Frequency distribution of the control group gain score data

No. Kls	Interval Class	Absolute Frequency	Cumulative Frequency	Relative Frequency (%)
1	-0,5 - 0,5	5	5	16,67
2	0,5 – 2,5	17	22	56,67
3	2,5 – 4,5	5	27	16,67
4	4,5 – 6,5	3	30	10,00
5	6,5 – 8,5	0	30	0,00
6	8,5 – 10,5	0	30	0,00
Total		30		100,00

f. Description of the Experimental Group's Gain Score Data

Respondents as a sample of 30 students. The average value (mean) = 3.97; median = 4, mode = 3, standard deviation = 1.86, highest score = 8 and lowest score = 1.

Table 6. Frequency Distribution of the Experimental Group's Gain Score Data

No. Kls	Interval Class	Absolute Frequency	Cumulative Frequency	Relative Frequency (%)
1	0,5 – 2,5	7	7	23,33
2	2,5 – 4,5	12	19	40,00
3	4,5 – 6,5	9	28	30,00
4	6,5 – 8,5	2	30	6,67
5	8,5 – 10,5	0	30	0,00
6	10,5 – 12,5	0	30	0,00
Total		30		100,00

g. Description of the data summary for the control and experimental groups

The pretest, posttest, and gain score data for the control group and the experimental group on the instructional package's effectiveness test for students' understanding of ecology's fundamental concepts are summarized in Table 7 below.

Table 7. Summary of the Pretest, Post-Test, and Gain Scores for the Control and Experimental Groups

Score type	Descriptive Statistics	Group	
		Control	Experiment
Pre Test Score	n	30	30
	Total	305	448
	Mean	10,17	14,93
	Modus	9	13
	Median	10	14
	Score Range	6 - 16	10 - 22
	St. Deviation	2,36	3,38

	Variant	5,59	11,44
Post Test score	n	30	30
	Total	362	567
	Mean	12,07	18,90
	Modus	14	19
	Median	13	19
	Score Range	7 - 16	14 - 24
	St. Deviation	2,24	2,56
	Variant	5,03	6,58
Gain Score	n	30	30
	Total	57	119
	Mean	1,9	3,97
	Modus	2	3
	Median	2	4
	Score Range	-1 - 5	1 - 8
	St. Deviation	1,52	1,86
	Variant	2,3	3,48

From the data in Table 7 above, the control group's average pretest score is 10.17, while the experimental group is 14.93. This condition means that students who are involved in testing the instrument have an understanding of the basic concepts of ecology, which are not much different. The average posttest score of the control group was 12.07. The experimental group's average posttest score was 18.90, with an exceptionally high increase in the experimental group score. Likewise, the increase in score was relatively high, seen in the average gain score, the control group average score was 1.9, and the experimental group was 3.97.

Testing data analysis requirements

To test the difference between the pretest and posttest results in control and experimental groups was carried out using the t-test, which first carried out the normality test and the homogeneity test as a prerequisite.

a). Normality test

Normality test using the Kolmogorov-Smirnov test. The results of the normality test are summarized in the following Table 8.

Table 8. he summary of the calculation of the normality of the student's answer scores using the Kolmogorov-Smirnov test with a significance level α = 0.05

Test Group	N	D_{hit} Max	D_{tabel} at α= 0,05	Conclusion
Control Group Pre Test Score	30	0,122	0,248	Normal
Experimental Group Pre Test Score	30	0,150	0,248	Normal
Control Group Post Test Score	30	0,161	0,248	Normal
Post Test Score of Experiment Group	30	0,151	0,248	Normal

From the data summarized in Table 8, the highest D_{count} value is 0.161, while the D_{table} is at the significance level α = 0,05 with n = 30 is 0,248. It is concluded that H_0 is accepted, meaning that the sample comes from a normally distributed population, which indicates that the pre-score data test and posttest in the experimental group and the control group were generally distributed so that the homogeneity test could be continued.

b). Homogeneity Test

The pretest score homogeneity test of the control group and the experimental group used Microsoft Office Excel 2007 software through the F test rule. The two data groups' variance homogeneity test was the pretest experimental group's pretest score and the control group. The results of the pretest score homogeneity for the two groups can be seen in Table 9.

Table 9. Homogeneity Test Results with F test for pretest scores of the experimental group and the control group

Sample Group	N	dk	Test Statistics		
			Variant	F_{count}	F_{table}
Control Pre-Test Score	30	29	5,592	0,489	0,537
Experimental Pretest Score	30	29	11,444		

From the data in Table 9 above, it can be seen that $F_{count} < F_{table}$ at α = 0,05, where both data groups have F_{count} less than F_{table}, meaning that H_0 is accepted. Thus, both groups' sample population has a homogeneous variance so that it qualifies for further analysis, namely the difference test (t-test).

c). Different test (*t-test*)

The difference test or the difference between two means (t-test) on the four data groups the results can be seen in Table 10.

Table 10. Results of the Analysis of the Difference in the Two-Mean Test (t-test) of the Control and Experimental Groups

Test Group	N	dk	$\overline{X}$	$\overline{Y}$	T_{count}	T_{table} (one-tailed)	
						0,05	0,01
Pre Test - Post Test Control Group	30	29	10,17	12,07	0,280	1,699	2,462
Pre Test - Post Test Experiment Group	30	29	14,93	18,90	11,663	1,699	2,462
Post Test Experiment Control Group	60	58	18,9	12,07	11,003	1,671	2,392
Gain Score in Control Experiment Group	60	58	3,97	1,9	4,704	1,671	2,392

1) Hypothesis test of the difference of two dependent means (small sample) for the control group pretest and posttest scores

The results of the analysis of the difference between the two dependent means for the pretest and posttest scores of the control group were obtained t_{count}: 0.280 < t_{table}: 1.699 at α = 0,05, then H_0 was accepted. There was no notable difference between the pretest and posttest in the control group. Thus, the students' understanding of the basic concepts of ecology in the group of students who did not read the instructional package about the basic concepts of ecology (control group) based on the pretest and posttest scores did not significantly differ.

2) Hypothesis testing of the difference of two dependent means (small sample) for the experimental group's pretest and posttest scores.

The results of the analysis of the difference between the two dependent means for the pretest and posttest scores of the experimental group obtained t_{count}: 11,663 > t_{table}: 1,699 at α = 0,05, then H_0 is rejected, meaning that there is a significant difference between the pretest and post scores. -test in the experimental group. Thus the students' understanding of the basic concepts of ecology in the group of students who read the instructional package about the basic concepts of ecology (experimental group) based on the pretest and posttest scores showed a significant difference.

3) Hypothesis testing of the difference of two independent means (small sample) for the experimental group's posttest scores and the control group.

The results of the analysis of the difference between two independent means for the posttest numbers of the experimental group also the control group obtained t_{count}: 11,003 > t_{table}: 1,671 at α = 0,05, then H_0 is rejected. There is a significant difference separating the posttest scores in the experimental and control groups. Thus the students' understanding of the basic concepts of ecology in the group of students who read the instructional package about the basic concepts of ecology (experimental group) and the group that did not read (control group) showed a significant difference.

4) Hypothesis testing of the difference of two independent means (small sample) for the Gain Score of the experimental group and the control group

The results of the analysis of the difference between the two independent means for the gain score concerning the experimental group and the control group obtained t_{count}: 4,704 > t_{table}: 1,671 at α = 0,05, then H_0 is rejected, meaning there is a significant difference in the gain score for the experimental group and the control group. Thus the students' understanding of the basic concepts of ecology in the group of students who read the instructional package about the basic concepts of ecology (experimental group) and the group that did not read the instructional package (control group) showed a significant difference.

Furthermore, to determine the size effect level of implementing the instructional package with a scientific approach to students' understanding of the basic ecology concepts, it is calculated using the Eta square formula. From the results of the calculation of Eta squared obtained a score of 0.28 (strong influence). These prognoses' results mean that the instructional package's application with the scientific approach has an effect of 28% on students' understanding of the basic concepts of ecology. The calculation for getting the Eta squared score is as follows:

$$\text{Eta squared} = \frac{t^2}{t^2+(N1+N2-2)}$$
$$= \frac{4{,}704^2}{4{,}704^2+(30+30-2)}$$

$$= \frac{22,13}{22,13 + (58)}$$
$$= \frac{22,13}{80,13}$$
$$= 0,28$$

Discussion

Of the description above, it can be deduced that instructional devices designed with a scientific approach and tailored to students' needs are proven to improve student understanding. This study's results are supported by the results of research conducted by Aulia, Poedjiastoeti, & Agustini (2018) who found that the use of material developed according to student needs makes students help students to understand the material better. Moreover, if the material is integrated with current technology users, making the material display more attractive and interactive, it is also proven to increase student understanding and motivation (AlAmmary, 2012).

When viewed in more detail, this instructional tool's successful application cannot be separated from the scientific approach's advantages applied to the material. The steps in the scientific approach that are applied to the instructional package make students active learners. Students will better understand various learning activities that enable them to gain knowledge independently (Yenen & Dursun, 2019; Aji & Khan, 2019). Besides, the scientific approach stages that begin with observing and are continued by asking questions, gathering information, associating, and communicating can be categorized as inquiry learning. Thus, the strength of inquiry learning is also the key to successfully implementing instructional packages using the scientific approach.

Inquiry learning has been confirmed to improve student achievement because, through inquiry learning, students' curiosity can be maintained so that they have the motivation to discover new knowledge through various activities interpreted by their teachers (Velooa, Perumalb, & R.Vikneswary, 2013; Bayram, Oskay, Erdem, Özgür, & Şen, 2013; Aktamiş, Hiğde, & Özden, 2016). Furthermore, the application of inquiry learning has also been shown to

help students form critical thinking skills. When they do exploration, discuss, and arrive at the concluding stage, they must be able to process information from various points of view (Alameddinea & Ahwalb, 2016). By applying inquiry learning, the teacher can also create a fair learning atmosphere because of every child. Whenedge through learning methods that suit their learning styles (Tang, et al., 2017). Inquiry learning makes students' different learning styles accommodated with various learning activities (Tuan, Chin, Tsai, & Cheng, 2005).

In addition to activating students, the scientific approach step also makes students work cooperatively with other students. Several studies have demonstrated that the implementation of cooperative learning can help improve student learning outcomes. Such as research conducted by Hossaina & Tarmiz (2013) found that the application of cooperative learning helps students improve their learning achievement because by studying in groups when they encounter difficulties, they can directly ask friends who understand better. Besides that, students do not need to feel awkward to ask their classmates when they face difficulties and have to ask teachers (Aziza & Hossain, 2010). The advantage of implementing cooperative learning is that students can develop their social and personal skills to interact with their classmates (Altun, 2015).

This research was conducted only to test the effectiveness of implementing instructional tools with a scientific approach to students' basic understanding of ecology's basic concepts. However, it should be understood that student activity in the classroom is also influenced by the teacher's ability to maintain the class and support all students in the class (Abdullah, Bakar, & Mahbob, 2012). Besides, research conducted ecology'sTyabaev, Sedelnytovich (2015) found that the use of technology supporting the implementation of student-centered teachers' ability active in making students become active learners they can help improve their abilities. Tsay, Kofinas also conducted a similar study, & Luo (2018) found that using technology could help students learn independently and fun. The use of technology with gamification was proven to be successful in increasing student activity and student understanding of the material being studied.

Another study also found that the level of independent use of technology by students in seeking additional learning resources also showed positive results on student academic achievement (Al-Hariri & Al-Hattami, 2017).

Conclusion

From the results of the data analysis that has been carried out, it can be concluded that the application of the instructional package with the scientific approach is proven to have a significant effect on increasing students' understanding of the basic concepts of ecology. This influence is caused by the instructional package arranged to suit the needs of students and teachers. Besides, the instructional package is also adapted to the stages of the scientific approach. Thus, the learning process is truly student-centered and able to make students become active learners. The instruction package's implementation, which also provides students with opportunities to learn cooperatively, also makes students solve problems faced together with other students through discussion poses. However, even though this study's results have shown positive results, testing involving more samples with a larger population with a truly experimental approach needs to be done to ensure that this study's results can be generalized. Other factors can also influence student activeness in the teaching and learning process, so further research involving these other factors also needs to be carried out.

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