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The impacts of instructional media on the concept mastery of Merapi ecosystem succession

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ABSTRACT

This research is focused on the use of different instructional media in learning activities. The aims of this research were to determine the impacts of different instructional media on students' learning achievements, to investigate the values of significant difference among the used instructional media, and to investigate the equity distribution of learning outcomes in each class, with experimental research class design. The data collected from class with photographs and with videos as the instructional media, each class consists of 30 students. Then, the data were compared with three classes that used real objects as the instructional media. These classes consist of 29, 39, and 46 students. The research instruments to measure students' learning achievements were tested for their validity and reliability with Quest Program. Normality test was carried out using Shapiro-Wilk, and homogeneity test used ANOVA. Then the analysis data of learning outcomes was administered using Kruskal-Wallis. The results show that the three classes which used real objects lead to better learning outcomes and smaller standard deviation value which shows the evenness of students learning achievements. Therefore, real objects have positive effects on student learning achievements in the ecosystem succession learning materials. The implication of this research is biology learning outcomes will be better if you use biology objects directly.

Introduction

In the learning process, instructional media and teaching methods aim to facilitate the learning process (Anggraini et al., 2021). These media and methods are expected to improve student achievement. However, the impact of the use of instructional media and methods varies greatly. Thus, teachers need to increase their creativity in teaching, so students have better learning achievement. One of the strategies taken by teachers to improve student achievement is to develop

instructional media for teaching. Concretely, instructional media will help students to understand the concept of the material and improve learning achievement. Teachers need to make sure that all students are capable of understanding all materials. Their understanding is shown by their ability to answer questions related to the learning material. This study tries to determine the best instructional media among those commonly used in the Biology Education Study Program, Universitas Negeri Yogyakarta.

The subjects of this study are students of Biology Education. Compare their achievements in learning with different media, namely photos, videos, and real objects. Fägerstam and Blom (2013) point out that learning Biology outdoors might have positive effects on both knowledge and attitudes toward Biology. It underlies the principle that real objects are the most effective media in learning Biology. With outdoor learning, we can observe and experiencing inside the real life. outdoor environments and its studies have a big potential for all learner (Yokuş, 2020). Aladağ et al. (2021) stated according to they did research that the outdoor learning has good effect to learning result, therefore they gave recommend to teacher for devote more time to nature education and curricula promote nature education. Beside of the impacts are good, outdoor learning also can enhance the learning process by providing relief from stress (El-Darwish, 2021).

Outdoor learning which uses real objects is not commonly conducted in universities in Indonesia. Orion et al. (1997) suggest that the neglected state of outdoor education may reflect our limited knowledge and understanding of the outdoors as an effective learning environment. They claim that one of the reasons for this limited knowledge and understanding is the lack of unique and adequate assessment and evaluation techniques. Fido and Gayford (1982); Zaragoza and Fraser (2017) point out that teachers often avoid the outdoor learning environment because they are not comfortable with the field trip experiences. van Dijk-Wesselius et al. (2020) states, one of barrier to go to outdoor learning is teachers have a low confidence in their outdoor teaching due to a lack of experience and knowledge.

Outdoor learning is not common anymore because it is difficult to carry out. Therefore, an alternative solution is to develop instructional media which are based on technology. Technology-based media used in this study are photographs and videos. The materials presented during this study are about ecosystem succession that occurs on the slopes of Mount Merapi. According to Li et al. (2020), there are seven barriers that had been identified in his research, (1) institutional system, (2) academics, (3) organization, (4) accident, (5) site, (6) students, and (7) social environment.

Real objects are believed to have more significant impacts on students' achievements than other media. As mentioned by Almeida-Gomes et al. (2016) "Field-oriented labs allow students to experience common situations faced by landscape Ecology researchers on real landscapes. As it is going to be shown, such labs have the potential to help students develop the necessary skills to do research, and not only to learn landscape ecology theory". It indicates that Biology outdoor learning is quite promising because by doing so students will get real experiences that may help them in understanding materials. Moreover, Glackin (2016) argues that it is imperative not only that pre-service science teachers are exposed to outdoor pedagogical practice, but also that the practice is underpinned by social constructivist theory and that the outdoor learning is presented as offering 'authentic' learning experiences rather than a novel teaching strategy. Zaragoza and Fraser (2017) suggest that hands-on science field- study classrooms were especially effective in promoting the learning environment and students' positive attitudes towards science among students with limited English proficiency.

Outdoor learning allows students to interact directly with learning objects to develop students' character and potential optimally. According to Reiss (2006), Biology teachers have inaccurate understanding on the field since Biology teaching is generally better introduced through contexts than through fundamentals, and Biology teaching sometimes needs to result in more than understanding. Thus, by conducting adventure learning, Biology course might be taught through contexts which may help learners in understanding a problem and

finding the solution to the problem. Hamilton-Ekeke (2007) assumes that field trips can be highly effective in developing a mutual understanding between teachers and students, so that it enhances the effectiveness of learning and can provide motivation, which transfers or remains after the field trip experience. It indicates that teaching with real objects positively affects the learning processes. Topic for learning in this research is about Merapi volcano with ecosystem succession process on the south slope.

Merapi is a volcano located in Java, in the border between Central Java and Yogyakarta. Repeated eruptions occur every three or five years. Gertisser et al. (2012) mention that Merapi is one of Indonesia's most active and dangerous volcanoes, and it is best known for its small-volume pyroclastic flows from gravitational lava dome which collapse. It is commonly referred to as Merapi-type nuéesardentes.

Merapi eruptions are commonly effusive, but the prior eruption happened in 2010 was a double eruption type. The effusive eruption is characterized with the steadily flowing lava on the slopes and explosively thrown erupted material from the lava dome. This type of eruption has occurred since the periods of Old Merapi and Holocene. Gertisser et al. (2012) mention that the Holocene stratigraphic record reveals that fountain collapse pyroclastic flows are a common phenomenon at Merapi. As far as the theory I understand, effusive mount will be indicates with Earthquakes, lava flows, tephra fall, ballistics and gas emissions affected the volcano's west and south flanks (Wantim et al., 2018).

This effusive eruption that descends into the mountain valley is often referred to by Yogyakarta people as Wedhus Gembel. They are pyroclastic materials which melt out of the lava dome in the mountain peak and flow through the mountain slopes. High temperatures Wedhus Gembel burns all vegetation in its path. Steam mixed with hot dust from the molten lava is then known as ash clouds. As Gertisser et al. (2012) explain, ash cloud includes widespread pumiceous fall deposits alternating with finer grained ash deposits of plume fall or ash cloud origin and locally with coarser grained overbank pyroclastic flow, surge and reworked deposits. The damage to the vegetation caused by the erupted materials is called Nudation. Damaged ecosystems will gradually recover and lead to a balanced condition known as ecosystem succession.

The process of complete ecosystem succession requires a relatively long time. Succession ecosystem process are including the growth and development stages as a dynamics of the ecosystem, and followed by the collapse and subsequent reorganization and launching to a new growth and development cycle (Nielsen et al., 2020). It may take hundreds of years to reach the climax point and balance situation. The special thing about the succession on the slopes of Merapi is the incomplete succession due to repeated eruptions that occur in a relatively short time. Therefore, the ecosystem in Merapi slopes grows in a unique condition. Any two kind succession types in southern slope of Merapi. It was primary succession, at the area that was covering by pyroclastic and secondary succession at the area that has effect removed a large portion of vegetation by fire (Shao et al., 2019).

Successional change in the succession ecosystem is not random but orderly and even predictable patterns (Nielsen et al., 2020). Video of the succession (site series) in Merapi slopes and the estimate of the ecosystem recovery towards its climax has been developed as instructional media. The practicum process using videos is better in capturing the phenomenon of Merapi ecosystem succession process than the class using photographs. Both classes show a significant difference between the concept mastery indicated and the students' learning achievements. One of the benefits of using videos for the practicum is that it can reduce the time needed to show the evidence of succession.

Thus, in the following years, the Ecology Practicum is conducted on the slopes of Merapi, so students can see ecosystems and interact with real objects. The expected result is that students are able to master the concept of ecosystems which are one part of the Ecology Practicum material presented in outdoor learning. Outdoor learning is commonly called as adventure learning. According to Moos and Honkomp (2011), an adventure learning environment appropriately matches the knowledge and skills needs of the students. This integration can facilitate student competency because learning is in an authentic environment. One of the

benefits of adventure learning is that it can facilitate learners' needs for an authentic learning environment with constructivist, inquiry-based and has work value (Ruhanen et al., 2021).

Mastery of concepts discussed in this study is the concept of Biology that must be achieved by students to master the competencies needed in Ecology practicum. A mastery concept can be indicating from the score of exams. A concept is a construction of ideas about learning materials which need to be mastered by students to have an understanding about a specific field. In the learning materials of Merapi ecosystem succession, the concepts that should be mastered by students are: nudation and succession processes, changes occurring in succession processes, factors affecting the processes of succession, the characteristics of climax and developing ecosystems, the climax ecosystem of Merapi, the types of succession, and the rate of succession in the southern slopes of Merapi. In outdoor learning, students are divided into some groups. Each group visits one succession location, and then in the last meeting it presents the succession steps of each area that is investigated. This process is called debriefing which is conducted by the course lecturers by conducting discussions about the succession locations. Debriefing can help students to mastering the concepts. Alvarez and Welsh (1990) state that each group activity is followed by a group debriefing. During this time, the preceding activity is discussed, and group members are encouraged to process their own feelings about the activity and personal gain derived from the activity.

In this study, three media were used in five different classes, and then students' scores from the five classes were compared. The first class used photographs taken about ecosystem succession in Merapi's slope. The second class used videos Merapi succession, because video in the last decade has been expansion as an instructional media both formal and informal educational context (Bétrancourt & Benetos, 2018). Then, there were three classes used real objects in the Ecology Practicum. The objectives of this research were: (1) to determine the effects of instructional media on students learning achievements, (2) to investigate the impacts of different media on students learning achievements, and (3) to investigate the evenness of students learning achievements in three different classes.

Method

This study uses an experimental research design. Classes are compared using different instructional media. In the classes which used photographs and videos as the instructional media, the data being compared were from the preliminary study conducted by Handziko and Suyanto (2015). The data is the score of the final exam and were collected from the students of Biology Education Department and related to the mastery of ecosystem succession concepts which were collected from class A and class B, 30 students in each class. Both classes were then compared with classes which used real objects as the instructional media and were conducted in adventure learning. The classes used the media were class C, class D, and class E, with 29 students in class C, 39 students in class D and 46 students in class E. Total data were compared in each class are 174 data students.

The instrument used in this study was developed by Handziko and Suyanto (2015) and was validated with the Quest program in the range of 0.7-1.33. The normality test with Shapiro-Wilk and homogeneity test in ANOVA were done, and nonparametric test with Kruskal-Wallis's test was conducted because the data were not homogenous. Through a series of tests, it was found that there were significant differences between the classes compared as shown by students' mastery of concepts. It is assumed that the wider the range of the values of significant difference, the lower students' mastery. The significant difference is from the values of standard deviation.

The subjects of this study were the students who took the Ecology Practicum. According to the data from Handziko and Suyanto (2015). There were 2 classes which consisted of 30 students. From both classes, one class (class A) used the photographs of Merapi ecosystem succession, and the other class (class B) used videos which were developed to present the development of Merapi succession. The other subjects were three classes namely Class C, D, and E. Those classes consisted of 29, 39, and 46 students, respectively. Data taken from

classes C, D, and E went through normality and homogeneity tests. Then, the classes with photographs (class A) and with videos (class B) were compared with the classes which used real objects as the instructional media. Kruskal-Wallis's test was used to find out the significant difference among the classes with different instructional media. Besides, the test was used to produce the standard deviation of the data. Comparison of each classis are A-B-C, A-B-D, A-B-E.

All instruments used in this study were the same with those used in the study conducted by Handziko and Suyanto (2015). By using the instruments, the researchers prevented the bias in comparing all the classes. Questions about concept mastery were validated by Expert Judgement and within Quest with 0.7-1.33 infit value.

Results and Discussion

The data of this study were collected from two different classes using two instructional media, namely photos and videos. Both classes consist of 30 students. The secondary data of this study are in the form of students' final scores which are compared with the scores of the students from three classes which used real object as the instructional media. The test results of three other classes are presented in the following.

Normality test. The data of C class, D class, and E class (Table 1) students are processed to check the normality with SPSS 17. It is shown that all the classes have significant values higher that 0.05, so they are in normal distribution.

Homogeneity test. This test is carried out with ANOVA test. It is found that the data from three classes are not homogenous since the significance values are lower than 0.05 (Table 2). The test shows that all the classes are in normal distribution, but the data from one class are not homogenous. Thus, nonparametric test is conducted.

Test of difference. In order to fulfill the objectives of the study, a test of difference was conducted. The test was carried out for the data of the three classes which used three different media. The test was conducted three times since there are three classes using real objects as the instructional media.

Class A (Photographs), Class B (Videos), and Class C (Real Objects)

The first comparative analysis was conducted in class A, class B, and class C. Because the previous data were not homogenous, the parametric test was carried out by using Kruskal-Wallis's test. The results of the test are presented in the following Table 3.

The mean values. Mean Rank for the Class A with 30 students is 25.05, Class B with 30 students is 50.23 and Class C with 29 students is 60.22. That mean results shows that class C which employs adventure learning with real objects as the instructional media has mean value higher than the other two classes. The mean value is the indicator that adventure learning has significant impacts on students' mastery of the taught concepts.

The test of difference. In order to find out whether the mean value has significant difference based on the used media, further test with Kruskal-Wallis is carried out. The test of difference shows that the Asymp sig 0.000 is lower than the specified significance value (0.05). It can be indicated that the different media used in each class have significant difference to the mastery of concept which is shown in student learning achievements.

The test of comparison. The comparison among the three classes is aimed at investigating the significant difference of the effects of three different media in three different classes. The results of Tukey and Bonferroni tests are presented in the following Table 3.

Table 1. Tests of Normality for Class C, D and E

	Kolmogorov–Smirnov			Shapiro–Wilk		
Class	Statistic	df	Sig.	Statistic	df	Sig.
C	.157	29	.064	.930	29	.056
D	.135	39	.069	.949	39	.076
E	.090	46	.200	.976	46	.444

Table 2. Test of Homogeneity of Variance Between All Class

	Levene Statistic	df1	df2	Sig.
Based on Mean	12.669	2	111	.000
Based on Median	10.228	2	111	.000
Based on Median and with adjusted df	10.228	2	93.366	.000
Based on trimmed mean	12.068	2	111	.000

The results of both tests (Tukey and Bonferroni) show similar results (Table 3). The data of comparison between class A and B and between class A and C have significant value of 0.000. It means that class A is significantly different from class C and class B. A unique result comes from the comparison of classes B and C. The comparison values between those classes are 0.200 (Tukey test) and 0.261 (Bonferroni test). The significance values are higher than the significance limit (0.05). It means that classes B and C are not significantly different.

Class A (photographs), Class B (video), and Class D (Real objects)

Comparative analysis is then conducted in classes A, B, and D. Because the previous data is not homogeneous, the test is continued with the Kruskal-Wallis non-parametric test. The result of the test is shown in the following Table 4.

The mean values. Mean Rank for the Class A with 30 students is 25.05, Class B with 30 students is 50.23 and Class D with 39 students is 68.38. That result shows (Table 4) that class D (Real Objects) has the higher mean value than other classes. This is in line with the comparison with the C class.

The test of difference. To find out whether the mean values have significance difference based on the used media, further test needs to be conducted to check the hypothesis testing with Kruskal-Wallis.

The comparative analysis shows that Asymp sig 0.000 is lower than the specified significance value of 0.05. These results mean that the different instructional media significantly affect the mastery of concepts which are related to students' learning achievements.

The test of comparison. The results of Tukey and Bonferroni tests are similar (Table 4). The results of the tests in class A and class B show a significance value of 0.000, and so does the class which uses photographs as the instructional media and class D. It indicates that class A is significantly different from class B and class D. A unique result is shown in the comparative analysis of class B and class D. The value resulted from Tukey test is 0.072, and the Bonferroni test value is 0.086. The significance value is higher than the lowest value of 0.05. It means that class B and class D do not show a significant difference. The results are similar to that of class C.

Class A (Photographs), Class B (Video), and Class E (Real Objects)

The third comparative analysis is conducted in the scores of class A, class B, and class E. Because the previous data from those classes were not homogenous, a comparative analysis using nonparametric test with Kruskal-Wallis is conducted. The results are shown as follows Table 5.

Table 3. Multiple Comparisons for Class A, B and C (significancy at the 0.05 level)

	(I) media	(J) media	Std. Error	Sig.
Tukey HSD	photographs	videos	2.45775	.000
		real objects	2.47885	.000
	videos	photographs	2.45775	.000
		real objects	2.47885	.200
	real objects	photographs	2.47885	.000
		videos	2.47885	.200
Bonferroni	photographs	videos	2.45775	.000
		real objects	2.47885	.000
	videos	photographs	2.45775	.000
		real objects	2.47885	.261
	real objects	photographs	2.47885	.000
		videos	2.47885	.261

Table 4. Multiple Comparisons for Class A, B and D (significancy at the 0.05 level)

	(I) media	(J) media	Std. Error	Sig.
Tukey HSD	photographs	videos	2.12954	.000
		real objects	2.00291	.000
	videos	photographs	2.12954	.000
		real objects	2.00291	.072
	real objects	photographs	2.00291	.000
		videos	2.00291	.072
Bonferroni	photographs	videos	2.12954	.000
		real objects	2.00291	.000
	videos	photographs	2.12954	.000
		real objects	2.00291	.086
	real objects	photographs	2.00291	.000
		videos	2.00291	.086

The mean values. Mean Rank for the Class A with 30 students is 25.05, Class B with 30 students is 50.23 and Class E with 46 students is 69.65. The result shows that the class with adventure learning has the higher mean value than other classes. There is a similar result in the classes with adventure learning in the C and D classes.

The test of difference. To check whether the mean values are significantly different based on the instructional media used, further analysis needs to be conducted by using Kruskal-Wallis hypothesis testing. The value of Asymp sig 0.000 which is lower than the specified significance value of 0.05 means that instructional media have significant effects on the concept mastery which is indicated from students' learning achievements.

The test of comparison. The results of the two tests (Tukey and Bonferroni) of class A and class B show significance value of 0.000, and so does the comparison of class A and class E. It means that class A is significantly different from class B and class E. A unique result is shown in the comparison of class B and class E (Table 5).

The results of comparison analysis involving class B and class E are 0.252 for the Tukey test and 0.341 for the Bonferroni test. Those significance values are higher than the lowest significance value of 0.05, and it means that class B and class E do not show a significance difference. The similar results are obtained in the comparison of class C and class D.

In general, the results of data analysis show that students' concept mastery in outdoor learning class is higher than other classes which use photographs and videos as the instructional media. The differences among the data of student concept mastery are significant. It indicates that instructional media have real impacts on students' mastery of the ecosystem succession concept.

The results of the comparative analysis of two different media show that the comparison in three groups namely photographs, videos, and adventure learning has a significant difference. Like the stated results, the class with photographs is different from the class with real objects although class with videos is relatively the same with the class with adventure learning.

The value resulted from Tukey test and Bonferroni test show that both classes with videos and real objects are different although the difference does not significantly affect students' mastery of the ecosystem succession concept. This most likely due to the almost identical visual effects that the videos display. Videos show objects and record them directly from the field. The most obvious difference among the classes is made by the class using photographs it displays static images.

Learning Evenness

The learning evenness is indicated from the students' learning achievements evenness. The evenness of the students' learning achievements can be seen from the lists of standard deviation values from the statistical test using ANOVA.

The Table 6 shows that the standard deviation value of student achievement of three classes (C, D, and E) is lower than class A and class B. It indicates that the learning achievements of students who learn with real objects is more even than that of the students who learnt with photographs and videos. Evenness is an important thing that needs attention. The better learning process is the more even the student's learning achievement.

Table 5. Multiple Comparisons for Class A, B and E (significancy at the 0.05 level)

	(I) Media	(J) Media	Std. Error	Sig.
Tukey HSD	Photographs	Videos	2.09855	.000
		Real objects	1.90736	.000
	Videos	Photographs	2.09855	.000
		Real objects	1.90736	.252
	Real objects	Photographs	1.90736	.000
		Videos	1.90736	.252
Bonferroni	Photographs	Videos	2.09855	.000
		Real objects	1.90736	.000
	Videos	Photographs	2.09855	.000
		Real objects	1.90736	.341
	real objects	photographs	1.90736	.000
		videos	1.90736	.341

The high mean values and the low standard deviation values, suggest that real objects are the best among other learning media. All students understand that the materials presented using the real objects because the classes allow students to use their senses in learning, and as a result the materials being learnt stay longer in their memories. The finding is supported by D'Amato and Krasny (2011) who state that transformative learning theories provide insight into how Outdoor Adventure Education (OAE) might further contribute to the instrumental goals of environmental education while retaining its personal growth outcomes, through connecting on-course experiences to learning, action, and community post-course. The theory is the basis that learning experiences, actions, and adventure may lead to holistic comprehension.

Nurhikmah H et al. (2018) state that the result of the need assessment shows that the need to develop blended based instructional media for Biology subject to improve students' self- learning skill and explore their skill personally. In addition, it is expected that the students can learn Biology every time and everywhere. In accordance with Almeida-Gomes et al. (2016) who point out that the case study developed in Brazil showed that field labs allowed students to develop important skills, including the ability to design field studies, choose appropriate scales of analysis, detect ecological patterns, and judge multiple hypotheses. By mastering the analysis of Ecology pattern detection, students will have better understanding on Ecology materials. Zaragoza and Fraser (2017) suggest that field-study classrooms provided a positive and enjoyable learning environment. The more frequent use of field-study classrooms is recommended. When students show positive attitudes and enjoy the learning process, they will master the materials better.

The concepts of Ecology can be more easily mastered with real objects as the instructional media. As Auer (2008) explained, when students are conscious and deliberate about what they are seeing, hearing, smelling, tasting and touching, boundaries between the observer and the observed begin to break down. The learning processes which include more senses have positive impacts on students learning achievements. The retention of learning with real objects is the highest of all. As Fägerstam and Blom (2013) states, the adventure learning students remembered both activities and contents better than the pupils in the indoor classes, because adventure learning certainly uses real objects to learn a learning material. This results are in line with Hamidah and Suryadarma (2021), the outward learning application makes it possible to improve between science process skills and aspects of awareness in biology learning, so that material concepts will be easier to master. With ecology mastered well, student can construct sense of belonging to the nature ecosystem (Torkar & Krašovec, 2019).

Table 6. Learning Evenness Comparison Class

	N	Mean	Std. Deviation	Std. Error
Photographs	30	60.5000	9.65794	1.76329
Videos	30	71.9167	10.18542	1.85960
Real objects class C	29	76.2069	8.61634	1.60001
Real objects class D	39	76.3692	4.63608	.74237
Real objects class E	46	74.9609	4.92280	.72583

Conclusion

The comparative analysis of the learning processes shows that instructional media in the forms of photographs, videos, and real objects have significant impacts on students' understanding on ecosystem succession (the ecosystem succession in Merapi slopes, Yogyakarta). Real objects as the instructional media lead to the best concept mastery and the most evenness. The learning achievements of students who learn using adventure learning show the highest value and the good evenness. The implications of this research are studying biological phenomena directly in learning biology has a good impact on learning, and as recommendation, to learn biology would be better if using biological phenomenon (real objects) directly as instructional media.

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