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Research Article

Ecolabel with Augmented Reality on the Website to Enhance Student Environmental Awareness

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Industrial Revolution 4.0, accompanied by an environmental crisis, shows that modernization and technological sophistication do not make harmonization between nature and humans more closely intertwined. This harmony needs ecological consciousness nurtured from an early age which is a challenge for the Industrial Revolution 4.0. Using technology in this research aimed to examine enhancing student environmental awareness affected by ecolabel with web-based augmented reality at elementary schools in Setia Budi subdistrict in South Jakarta in Indonesia. Environmental awareness of the students was indicated by student environmental action related to solving the environmental problems, environmental manner of doing environmental activities, and noble values of sustainability to have conservation. This research population is elementary school students in Setia Budi subdistrict in South Jakarta in Indonesia with simple random sampling utilizing the Slovin Formula sampling technique. Data analysis procedure executed independent samples *t*-test. The decisions reveal that the average value for environmental awareness for the experimental class arrives at 56.406, significantly larger than that for the control group of 55.063 at a 0.05 significance level. The investigation found that ecolabel using augmented reality attached on the website can raise student environmental awareness.

1. Introduction

The Industrial Revolution 4.0 produced many advanced technological inventions having the impact of rapid changes altering human civilization. This advancement can assist daily human activities more effectively and efficiently. However, these advantages also have negative influences and threaten the ecological domain, including environmental destruction. The ability of the environment to support the lives of humans and other living creatures mostly depends on commitment and adherence to regulations in accordance with the design of the Industrial Revolution 4.0. In fact, it is not certain that industry players can do this. This is what makes Industry 4.0 a separate hope and challenge for all nations in the world. The causes of environmental damage can be the result of natural events and human activities. However, if examined further, disasters involving floods, abrasion, forest fires, and landslides could have occurred due to human intervention as well. Generally, the damage caused by humans is even greater than the damage caused by natural disasters. This is because the damage done can happen continuously and tends to increase. This damage is generally caused by human activities being not environmentally friendly, including forest destruction and forest conversion, mining, and air, water, and soil pollution.

1.1. Environmental Awareness. Detrimental effects of human activities can be restrained by the improvement of a thorough understanding of surroundings. There are many studies related to awareness of nature. Implementing effective environmental education can increase the cultivation

of ecological consciousness by implementing effective environmental education. Interactive environmental education improved engagement level with sustainability and supported ecological knowledge, manner, and readiness to practice [1]. The benefit of ecological education is related to environmental responsibility in solving ecological problems [2, 3]. The target of the living world pedagogy is environmental literacy growth [4, 5]. Ecological learning can improve sustainability awareness [6, 7]. Another study found that environmental learning supports preservation activities [8]. Environmental conservation can be done through ecolabel showing goods labeled with environmentally friendly to build environment [9, 10]. Environmental education can promote student attitude, knowledge, and skill [11]. The students are already aware of proenvironmental activities done to achieve nationwide sustainability [12]. There are significantly positive associations between environmental knowledge and values as well as between environmental knowledge and behavior [13]. Environmental awareness of primary education students is higher than that of secondary students [14]. This study presents that environmental consciousness can be improved through extracurricular environment intervention. Environmental education plays an important role in solving environmental issues [15]. However, these prior studies only focused on environmental education implemented with the conventional method.

Another study argues that environmental education can explain the variety of environmental literacy. The empirical result of this study only provides weak evidence that environmental awareness level can be predicted by environmental education [9]. Nowadays, it has become a trend that technology can integrate the teaching-learning process with technology to motivate the students to demonstrate the world outside the classroom. There are many studies relevant to the benefits of using technology. A recent investigation indicates that a newly discovered Arabic script technique accomplishment developed in order to help students learn and practice with sight being impaired to comprehend the meaning of written Arabic so smoothly [16]. It is emphasized that implementation of learning material development using augmented reality improved student achievement, motivation, and positive attitude about the course [17, 18]. Such investigations are important because they give helpful insight that technology function is not purely intellectual but also comes about in an affective context. The positive results reported by these studies can indeed pave the way for higher academic achievement and development of a good perspective.

1.2. Augmented Reality on the Website. As today's students are very much exposed to technology, increasing efforts have been created to develop technology-related tools assisting students in order to diminish their difficulties in learning. This also implies that educators are motivated to focus more on creating enjoyment in learning, and the use of technology is considered to be helpful. Technology appears to stimulate student learning. Research applying augmented reality and its impact on the students has confirmed that augmented reality can effectively enhance learning permanency [19]. Environmental education based on virtual reality technology can improve environmental ethics and literacy [20]. This study is supportive to foster the quality and level of environmental moral. This condition stimulates the agreement between man and environment to construct a good practice of environmental preservation. Recently, there has been an attempt to promote student engagement with the learning process through website-enhanced approaches. Another study examined that a website's application can increase student learning outcomes through website application [21–24]. Recent research on applying a website in the classroom has focused on raising the student's character. Results suggest that the implementation of website can also improve student positive behavior. These outcomes present that the use of technology may directly provide knowledge achievements and positive practices.

However, the utilization of this technology is not related to environmental awareness. Consequently, this study examines technology, specifically web-based augmented reality, in which ecolabel is presented to improve ecological awareness. The primary research question was "Did ecolabel with augmented reality on the website significantly influence student environmental awareness at elementary schools in South Jakarta in Indonesia?" This study is to respond to the next research queries:

(a) How is ecolabel with web-based augmented reality?

(b) Was there any difference between the posttest of mean grades of student environmental awareness through implementing ecolabel with web-based augmented reality and with conventional method?

2. Materials and Method

This research was done at elementary schools in the Setia Budi subdistrict in South Jakarta in Indonesia.

2.1. Design of Research. This study used an experimental design with a posttest-only control design. There were two groups consisting of control and experimental groups chosen randomly. The experimental group was given the treatment of using ecolabel with web-based augmented reality and the control group without using treatment. After treatment was completed, measurement with the same instrument was carried out on both groups. Posttest was placed to the experimental group and the control group. In the final step, the posttest of the experimental group is compared with one of the control groups. Instrument applied to environmental awareness consisted of providing adequate information for environmental action, environmental manner, and noble values of sustainability. The comparability of both group results displayed the effect of treatment done. The control group functioned as a comparison with the experimental group given treatment over a period of time. The experimental design model used in this study is shown in Table 1.

2.2. Population and Sample. This study comprises 7956 fifth-grade students at an elementary school in the subdistrict of

Table 1: Model of posttest-only control design.

Group	Treatment	Posttest
Experiment	X	O_1
Control	—	O_2

Notes: O1: posttest conducted in the experimental group. X: treatment using ecolabel with web-based augmented reality. O2: posttest conducted in the control group.

Setia Budi in South Jakarta, pinpointed in Indonesia. This study applied simple random sampling using the Slovin Formula sampling technique composed of 143 students for the experimental and control group.

2.3. Research Instruments. Instrument for posttest in this research is about student environmental awareness related to the environmental activity of the students to solve environmental issues, student behavior in the surroundings regarding environment, and students having worthy values to act leading to sustainable conservation. The posttest was offered after applying the treatment to the experimental group. Further, the posttest of the experimental group was compared with the control group to find out whether there was an effect of the treatment given.

The supplementary data provide raw data of student environmental awareness in the control and experimental groups related to indicators of environmental practices, environmental attitudes, and noble values of sustainability. The data on environmental practices are related to student comprehension of environmental issues, student responsibility for environmental problems, student discussion about environmental issues, and student participation in environmental activities. The data on environmental attitudes are connected with student disappointment with air and river pollution, student appreciation of biodiversity, and student awareness of environmental responsibility. The data of noble values of sustainability are associated with student effort to diminish the amount of waste, student not familiar with plastic bag, student effort in electric energy and water conservation, and student effort to create fertilizer.

2.4. Data Analysis. A normality test finding a use for the Kolmogorov–Smirnov two-sample test was required for comparing observation distributions from the two datasets, the experimental and control groups. The null hypothesis suggests that the two dataset values of experimental and control groups are from the same continuous distribution. Alternative hypothesis shows that the two datasets of experimental and control groups are from different continuous distributions. Hypothesis test was carried out at a 0.05 statistical significance level. If the asymptotic distribution coefficient of the Kolmogorov–Smirnov test output is more significant than the 0.05 prespecified alpha value, data is normally distributed. This performs that the Kolmogorov–Smirnov test shows that the two data sets of the experimental and control groups at a 0.05 significance level guided to the conclusion of the null hypothesis are not being rejected, indicating that the two samples are drawn from the same continuous distribution. This study did a homogeneity test applying Levene's test to conclude if the data groups had equal variances. These equal variances across samples reveal homogeneity of variance. If the resulting p value of Levene's test is smaller than a 0.05 significance level, differences got in sample variances are improbable to have happened based on random sampling from an equal variance population. It can be stated that the null hypothesis indicating equal variances is rejected, and it can be concluded that there is a difference between population variances. This study applied independent sample t-test criteria as an inferential statistical test with the value set at 0.05 to evaluate whether the means of student environmental awareness differ significantly across two groups, the experimental and control groups. If the means of the experimental group do not differ from the means of the control group significantly, this indicates that there is no treatment effect of using ecolabel with web-based augmented reality. Rejection of null hypothesis with p larger than 0.05 was selected if t is larger than critical values taken from distribution of t using $(n_1 + n_{2-2})$ df with $\alpha = 0.05$, two-tailed. It can be said that it is found a statistically significant difference between the sample means of student environmental awareness in the experimental and control groups.

3. Results

3.1. Augmented Reality on the Website. Characterization of ecolabel with web-based augmented reality developed as follows. The product designed in this research is termed ecolabel with web-based augmented reality for student environmental awareness. The formation process of web-based augmented reality in this study applied wix.com as a website builder created explicitly for beginners to develop and design a web without the hassle. The augmented reality attached on the website was developed using Vuforia software to combine real-time digital content with the natural world related to the environment. The home page of web-based augmented reality emerges with an arrangement presented in Figure 1. The second page seen in Figure 2 is about the ecolabel augmented reality marker menu bar presenting nine markers that a scanner can use to display augmented reality. When the user directs the camera at the augmented reality application at each marker, a description will appear on the smartphone screen. It means that anyone can access this web-based augmented reality anywhere and anytime.

3.2. The Effect of Augmented Reality on the Website on Student Environmental Awareness. In accordance with examining the effectiveness of ecolabel with web-based augmented reality to improve student environmental awareness, normality and homogeneity test should be done. It can be traced from normality check outcomes manifested in Table 2, and it can be seen that there are 143 student participants in the control and experimental group. Table 2 also presents that normal parameters were estimated by mean as the central tendency of distribution reaching 56.41 for the experimental group and 55.06 for the control group. In Table 2, it is displayed that the standard deviation as variability measurement

Figure 1: Homepage of web-based augmented reality.

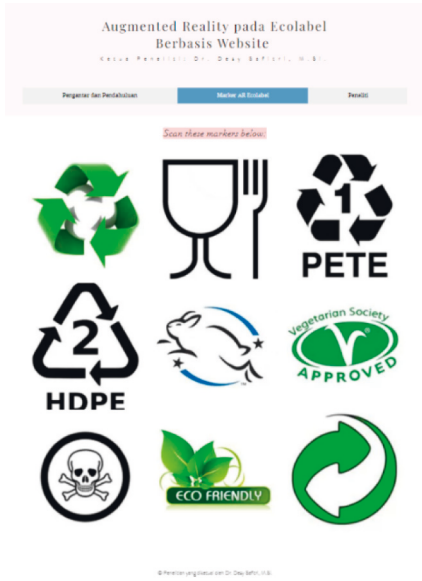

Figure 2: Menu marker page.

reached 2.98 for the experimental group and 3.01 for the control group. Table 2 reveals that, in the experimental group, the Asymp. Sig. (2-tailed) Kolmogorov–Smirnov value acquired is 0.16 larger than 0.05. In the control group, the Asymp. Sig. (2-tailed) Kolmogorov–Smirnov value gained is 0.09, greater than 0.05. Kolmogorov–Smirnov calculated value manifested by the absolute value in the most extreme differences for the experimental group reached 0.09, and the control group attained 0.10 less than 0.12 as the Kolmogorov–Smirnov table value. These ends assume that data in experimental and control groups are normally distributed as a precondition for statistical examination. It indicates that it can upgrade the neutrality and keep away from partiality in this exploration.

Table 3 presents that Levene's Sig test based on mean for environmental awareness with degrees of freedom (df1) = 1 and df2 = 284 is 0.56 larger than 0.05. This outcome of the variance homogeneity test reveals that variances of experimental and control group data are homogeneous, indicating that the variance level in these groups is constant across the sample, so that value of probability value is reliable.

Table 4 shows that the experimental and control group sample is as many as 143 students each. The mean of student environmental awareness for the experimental group reached 56.41, larger than the control group of 55.06. Statistically descriptive, the results recommended a difference in the average of student environmental awareness between the experimental and control groups. Furthermore, to prove whether the difference is significant or not, it is needed to look at the output of the independent samples test in Table 5.

Table 5 launches that the value of sig. Levene's test for equality of variances is 0.56 larger than 0.05, indicating that variance is homogeneous or the same between the experimental and control group. The interpretation table of the independent samples test is guided by the values in the equal variances taken for granted. Based on the equal variances presumed, the sig. (2-tailed) is 0.00 less than 0.05 as the basis for decision-making in the independent sample t-test. In addition to this, the calculated t-value achieved 3.84, bigger than the critical t-value of 1.96. On the report of these results, it can be said that the null hypothesis is rejected, showing that there is a significant difference between the average environmental awareness in the experimental and the control groups.

4. Discussion

It can be highlighted that the ecolabel with web-based augmented reality positively affects environmental awareness for the fifth-grade elementary school students in the subdistrict of Setia Budi in South Jakarta in Indonesia. This result indicates that effective environmental education is necessary to have positive attitudes and behaviors towards the environment. This fact-finding is in agreement with the verdict presenting that environmental education can enhance ecological literacy, environmental awareness, environmental knowledge, and environmental attitude [25, 26]. Another investigation shows evidence that environmental education can develop environmental knowledge leading to eco-behavior [27]. In this context, environmental education can develop environmental knowledge leading to eco-behavior. It can be underlined that these results show that the need for effective environmental education becomes more essential to develop environmental sensitiveness and consciousness, enabling individuals to have a positive frame of mind, habits, and contributions to the sustainability of a more livable environment. These pieces of evidence present that an increase in environmental responsibilities, knowledge, skill, and attitude due to the implementation of environmental education can contribute to solving environmental problems leading to sustainability development. In our study, it is emphasized that environmental literacy provided by ecolabel combined with augmented reality attached on the website improves responsibility to the environment. Therefore, it can grow the awareness of the students towards the environment.

Moreover, the advancement of technology has made it possible for teachers and educators to perform and reconstruct their teaching strategies to make the students get involved intensively in the class practice. As claimed by the literature, it is also noticed that applying technology can raise student knowledge. Environmental education programs combined with relevant web tools can be more attractive for

Table 2: Normality test.

One-sample Kolmogorov–Smirnov test		Experimental group	Control group
N		143	143
Normal parameters	Mean	56.41	55.06
	Std. deviation	2.89	3.01
Most extreme differences	Absolute	0.09	0.10
	Positive	0.07	0.08
	Negative	−0.09	−0.10
Kolmogorov–Smirnov Z		1.12	1.24
Asymp. Sig. (2-tailed)		0.16	0.09

Test distribution is normal.

Table 3: Homogeneity of variances test.

Levene's statistic	df1	df2	Sig.
0.34	1	284	0.56

Table 4: Results of *t*-test in posttest of the experimental and control groups.

Group	N	Mean	Std. deviation	Std. error mean
Experiment	143	56.41	2.89	0.24
Control	143	55.06	3.01	0.25

the students to improve environmental knowledge [28]. These studies delivered a comprehensive explanation of education that leads to scientific proficiency, including conception, methods, and tools near the students' daily lives, and creates meaning for them. Furthermore, the students develop their critical thinking skills and get greater apprehension about environmental problems and solutions through technological accomplishment. The intervention of technologies helps the students achieve bigger comprehension of genuine concern. These studies offer the arrangement and classroom practice of up-to-date pedagogical intercession in which the learners are provided convenience to explore flora and fauna issues and to a greater extent get involved in the teaching-learning process effectively.

There is a strengthening of information provided from ecolabel through web-based augmented reality in our study. It is more effective when learning occurs with increasing knowledge of the environment for the students. Environmental education encloses approaches and tools for developing and supporting environmentally related attitudes. Thus, augmented reality drives student engagement and satisfaction towards the course by improving student experiences and enhancing student imagination. Modernizing environmental education makes learning more attractive for the students to be a primary tool in dealing with ecological problems. In our study, through web-based augmented reality, environmental education is considered adequate to improve student involvement and interests in learning to raise students' environmental literacy and attitude related to solving ecological issues. It can be highlighted that this tool can enhance student knowledge and behavior concerning the environment. Environmental education through ecolabel with web-based augmented reality explores to inseminate affirmative approach, disseminate enthusiast, and motivate responsibility in student interaction with the environment. In this context, ecolabel with web-based augmented reality can promote the necessary skills to designate environmental trouble and cultivate approaches, encouragement, and obligation to take important actions towards the environment. Furthermore, ecolabel with web-based augmented reality ensures that the students perceive the usefulness of the environmental challenges and what can be completed to preserve them. It is also meant for students to alter environmental actions and prepare a positive code of conduct and attitude in such a manner that they associate with nature in a supportable procedure.

Furthermore, the study investigated that environmental learning can raise awareness of sustainability and contribute to conservation and environmental quality outcomes [29, 30]. These findings reveal that acknowledging and reviewing the success of environmental education often require measuring the intended outcomes, including environmental concern, consciousness, perspective, skills, and behaviors. Besides, it can be highlighted that continuous and sustainable environmental education brings about tangible rises in ecological quality, assisting in attaining preservation and driving commitment to support the sustainability of a livable environment. These findings also recommend that the success of indoctrination of nature can upgrade environmental literacy and susceptible behaviors towards the environment for the students. It can be highlighted that continuous and sustainable environmental education can drive commitment to support the sustainability of a livable environment. These findings also recommend that the success of environmental education can upgrade the Earth schooling and susceptible behaviors towards the environment for the students. In this context, student possession of knowledge, awareness, and positive attitude proneness is urgent in terms of improving environmentally alert generations. Our study suggests that ecolabel giving much information through augmented reality on the website can positively increase student apprehension about environmental issues and its explanation to foster ecological appreciation. This study reveals that environmental guidance through augmented reality influenced student consciousness likelihood towards the environment definitely.

In conformity with the byproduct of academic works in the published works, ecolabel manifested into positive manners to environmental quality [9, 31]. Researchers have investigated the upshot of biosphere guidance in diversification of conditions. It is determined that environmental education is frequently planned to influence capacity, outlook, and manners. Necessarily, researchers estimate

Table 5: Independent samples test.

Levene's test for equality of variances			*t*-test for equality of means						
	F	Sig.	*t*	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
								Lower	Upper
Equal variances assumed	0.34	0.56	3.84	284	0.000	1.34	0.35	0.66	2.03
Equal variances not assumed			3.84	283.54	0.000	1.34	0.35	0.66	2.03

adjustment in those territories. These findings emphasized that education in the living world can be a determinant of the world quality, consciousness, attitudes, skills, and behaviors. According to these results, it can be stated that environmental education influenced student emotional likelihood consisting of point of view, perception, worthiness, and also empathy towards the environment positively. It can be expressed that the positive enlargement of the student perspective propensity towards the environment can be described by the growth of knowledge about the environment after joining environmental education.

Our study presents that ecolabel's enactment with web-based augmented reality can make the students more engaged with the learning to enlarge their environmental literacies. These support the student's appearance to answer environmental mess and heighten their awareness of the environment. This notion implies for sustainability development, and environmental learning should be constant and supportable. Furthermore, ecolabel with web-based augmented reality allows a unique configuration of student creativity that is different from the earlier model of creativity through its relationship with student engagement. Specifically, implementing ecolabel with web-based augmented reality is a continuous process of creative student engagement. This tool empowering student creativity originates from strengthened student engagement and, in turn, provides higher environmental awareness for students. Through this lens, ecolabel with web-based augmented reality allows a different form of service visualization that lessens invisibility, strengthens inspiration, and guarantees creativity in student decisions towards the environment. In this framework, it is underlined that ecolabel with web-based augmented reality makes student creativity that has been considered in a context where the students explore to maximize the fulfillment of raising their environmental awareness. In this study, student interaction with ecolabel with web-based augmented reality applied in the teaching-learning process has been exhibited to be a positive experience that might engage the students to acquire benefits such as bigger interests and motivations for the students with related environmental decisions from the creative activity itself.

In a study concerning environmental education's benefit, emphasis created on ecological responsibility to solve ecological problems catches the attention [3]. It is highlighted that researchers have reflected the demand to evaluate the relatedness joining habitat edification implementation and student natural awareness of a kind that the increasing number of students volunteering to participate in environmental activities related to solving problems in their environment. Simultaneously, researchers have called for more understanding of environmental education involving approaches and tools to contribute to environmentally related perspective, utility, appreciation, proficiency, and skill arranging individuals to clasp knowledgeable effort in place of the ecosystem. Besides, these tools can develop the student skill for identifying and solving environmental problems as well as bring out active student participation in the natural development.

In our study, the ecolabel attached on the website providing the students with much information about the environment enables them to raise environmentally literate and conscious students. In this context, students can extend their competencies in terms of knowledge, attitudes, and skills in solving environmental problems through gaining environmental literacy in contributing to sustainable development. Interaction with ecolabel applied by web-based augmented reality has been displayed to be a positive experience. It should be noted that ecolabel with augmented reality attached on the website strengthens the advancement of nature-based pedagogy to heighten student environmental attitude and viewpoint concerning environmental stability converted to responsible and activity-oriented environmental maintenance. It is examined that ecolabel with web-based augmented reality shapes personal commitment to stewardship and movement that promotes reform in values and conducts to stimulate environmental sustainability.

However, the solution of this probing is not compatible with some studies arguing that environmental education supports environmental responsibility. When the literature is examined, it is seen that, according to some literature, ecological education can be acknowledged to be a significant factor decisively affecting higher environmental literacy, notwithstanding not up to the present time explicit. One study shows that environmental information transparency has a weak association with environmental responsibility [32]. It was found that the increase in student environmental behavior due to environmental education was not significant. This study presented that environmental education failed to change student perception and attitude towards responsible ecological conduct. Further, another study confirmed that the effect of environmental education provided on student environmental care attitude was only moderate [33]. In this context, the findings of this study express that circumstances enlightenment had better not be examined as a predominant component in pushing student ecological competences. There is little evidence suggesting that environmental education upgrades proenvironmental behaviors

[34]. It is demonstrated in this research that it is difficult to raise climate change consciousness through environmental education to build long-lasting changes in proenvironmental manners effectively.

We believe that our study clarifies that environmental education through ecolabel with web-based augmented reality can enhance student environmental awareness and student comprehension ability. Additionally, our research proves that environmental education using ecolabel combined with web-based augmented reality has significant improvement on student learning environmental problems and finding the best solution alternatives and interests so that it can improve student learning effectiveness. Moreover, our findings show that ecolabel with augmented reality-assisted technology attached to the website can give the students perceptual feedback and communication, allowing them to recognize environmental content better and reach the learning goals more simply. It should be noted that ecolabel with web-based augmented reality gives a correct insight of perception and provides uniqueness of education application model. The students can interact freely with virtual objects in authentic nature to help them visualize abstract concepts. Additionally, this condition makes the students acquire new knowledge which is not simply replicated in real nature and helps the students to provide correct scientific concepts. We consider that ecolabel with web-based augmented reality is a new pattern implemented in environmental education and has enormous potential for prospective progress in encouraging student learning motivation and eagerness. It is trusted that this advanced and particular instructional method and strategy in environmental education can assist the students with the specialized experience, interact easily with the environment, and allow them to alter their native knowledge independently. Our study found that ecolabel with web-based augmented reality is an instructional model that can lead the students directly precisely to the substance of learning content related to environmental issues and better demonstrate knowledge leading to developing student learning effectiveness.

5. Conclusion

The culmination of this research is that there is an encouraging concomitant of ecolabel with web-based augmented reality on ecological awareness for elementary school students in the subdistrict of Setia Budi in South Jakarta in Indonesia. More importantly, augmented reality attached to the website can enrich the student's knowledge about the environment to positively increase student environmental literacy about solving environmental problems leading to ecological awareness. The contribution of this research is through executing ecolabel with augmented reality tied on the website, which can lift student sensibility to the environment leading to higher student responsibility to appreciate, take care of, and look after the environment. Recommendation for further research is developing ecolabel on the basis of virtual reality in order to enhance student sensitivity to the environment.

Data Availability

All the data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest related to the research content and publication of this paper.

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Supplementary Materials

The supplementary data provide raw data of student environmental awareness in control and experimental group related to indicators of environmental practices, environmental attitudes, and noble values of sustainability. The data of environmental practices are related to student comprehension of environmental issues, student responsibility of environmental problems, student discussion about environmental issues, and student participation in environmental activities. The data of environmental attitudes are connected with student disappointment with air and river pollution, student appreciation of biodiversity, and student awareness of environmental responsibility. The data of noble values of sustainability are associated with student effort to diminish amount of waste, student not familiar with plastic bag, student effort in electric energy and water conservation, student effort to create fertilizer. (*Supplementary Materials*)

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