

Evaluating Sustainable Education Using Eco-Literacy

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ABSTRACT

Environmental issues are important to be solved because it would threaten both of the current and future life. It can be done through implementing sustainable education as a process of humanization that produced changes in knowledge-understanding, awareness, and sustainable practices. This study aims to evaluate the implementation of sustainable education by examining the differences in ecological literacy among students of the Faculty of Agriculture, the University of Brawijaya based on their year of submission, study program, place of origin, and sex. Several 419 students participated in this online survey. Ecological literacy was measured using an instrument developed by McGinn (2014). Chi-square and t-test were applied to test the differences. Results show that the majority of students are classified to have basic ecological literacy. There is no statistical difference in student's ecological literacy based on their year of enrollment, study program, and place of origin. Only based on sex, the difference exists, where female students have a higher level. Although there are no differences in the implementation of sustainable education on the two study programs, the improvement is still needed to raise the level of students' ecological literacy.

Keywords: ecological literacy; student; chi-square; t-test

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1. Introduction

Environmental problems have become an important issue that must be addressed immediately. Orr (1992) states that a person needs an understanding of ecology and sustainability to solve environmental problems. Ecological literacy requires extensive familiarity with the development of ecological concern. Ecological literacy implies a broad understanding of how people and society relate to one another with natural systems and how they can sustainably. Of course, having ecological literacy will be able to increase one's concern for the environment.

Research on ecological literacy has been carried out by McGinn (2014) and Muliana, Maryani and Somantri (2018). According to McGinn (2014), to know ecological literacy in students, knowledge is not enough to form a sustainable environment, so in this study, McGinn used three ecological literacy sections from Orr (1992), namely knowledge, care, and practice. This study illustrates the mindset of students to have consumer care, especially in creating

sustainable consumption practices. Research conducted by Muliana, Maryani, and Somantri (2018) was at the Syiah Kuala University in Banda Aceh, which had not been studied in the environment, while research conducted by McGinn (2014) was located in Pennsylvania. Based on the analysis that has been done, there has been no research on ecological literacy in Indonesia found in tertiary institutions that have implemented continuing education in their curriculum. This research was conducted at the Faculty of Agriculture, Universitas Brawijaya, to see the extent to which the implementation of sustainable education contributed to the internalization process of ecological literacy. The education process as a process of humanization shows an ongoing action (Tilaar, 2002).

According to (Riyanto, 2009) learning is a mental or psychological activity that takes place in active interaction with the environment, which results in changes in knowledge-understanding, skills, and values-attitudes. This opinion illustrates someone who has received education about the environment and sustainability is expected to have ecological literacy. Therefore, researchers researched the level of ecological literacy in students. Researchers used three parts

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of ecological literacy from Orr (1992), namely knowledge, care, and practice. It will also be seen as the extent to which the choice of study programs and student enrollment year contributes to ecological literacy. This research is essential to do so that it can be used as necessary information in the preparation of tertiary education policies. This study aims to examine differences in the level of ecological literacy of the students of the Faculty of Agriculture, the University of Brawijaya based on year of enrollment, study program, place of origin, and sex.

1.1. Literature Review

a. Overview of Ecological Literacy

Orr (1992), states that ecological literacy is the ability to ask, "What then?" ("What is next?"). The question is the right question to ask before a problem occurs. This statement implies that the concept of thinking and reflection on one's actions can have a major impact on society today and in the future. Ecological literacy can also be interpreted as the ability to use numbers and know what is counted and not (the limit in the number of digits).

Ecological literacy implies understanding how people can relate to one another and also relate to nature and how they carry out a sustainability. Orr (1992) states that a person needs an understanding of ecology and sustainability as a basis for solving environmental problems. Sustainability directs a person to look for other alternatives to the activities he is currently doing with the aim of reducing the negative impact on the environment and other people. The concept of sustainability discussed by Orr is the way a person can understand ecological sustainability with the competence of knowing where they live, understanding nature as a model for how humans can reduce waste, and understanding that there are limits to growth, not development.

Someone who has ecological literacy certainly needs knowledge about relationships (cause and effect relationships), and a caring attitude. Besides, it also has the practical competencies needed to act based on the knowledge and attitudes possessed. Practical competence can be obtained from direct experience in doing something. The statement shows that there are several parts in ecological literacy theory, including knowledge, care, and practice. The concern relates to how a person can think about his actions by paying attention to environmental protection and social justice. The

intended knowledge is related to understanding the principles of ecology and human interaction with what they build and nature. The practice has meaning as an action taken by someone to build sustainability (Orr, 1992).

b. Overview of Education

Education, according to Galperin's theory (Utomo and Ruijter, 1985) the learning process can be described as a series of four stages namely educators oriented toward important elements of science, including ways of reasoning that are specific to the field, educators practice doing these reasoning activities through its relation to one another, and the educator gets awareness about the learning outcomes he has achieved, and the educator continues the learning process by means of examination practice orientation. Thus, according to Galperin's theory, a learning goal will only be achieved if educators are oriented, practicing, and continuing the learning process based on the results of feedback (Utomo and Ruijter, 1985).

According to Winkel (in Riyanto, 2009) learning is a mental or psychological activity that takes place in active interactions with the environment, which results in changes in knowledge, understanding, and value-attitude. Dedeng (in Riyanto, 2009) states that learning is the association of new knowledge to the knowledge that has been stored in his memory. The principles of learning, according to Riyanto (2009) are the basis of thinking, foundation, and source of motivation, with the hope that learning objectives are achieved, and the growth of learning processes between educators and educators is dynamic and directed.

Tilaar (2002) states that education is the transmission of knowledge from someone who knows to someone who does not know. The education process is a process of liberation and, at the same time, a method of recognizing human limitations. Human freedom and limitations are transformative pedagogies. Pedagogic is a science-based on the concept of thinking about education and is a guide to the actions of the educational process itself, which is linked to two things. First, education is not isolated from community life, in the presence of the state, and so on in global life. Second, the individual is the main supporter of society in the sense of being a creative and participatory member of the community. The world of education cannot be separated from curriculum problems. A curriculum is a number of information and

experiences that want to be conveyed to students. The curriculum can as question bank, data, and experience. The education process or learning process as a process of humanization shows an ongoing action.

Kallas, Solovjeva, and Minakova (2015) say that ecological education has a goal as the formation of an ecological culture that is achieved by creating a new value system, by developing the ability of humans to compare public needs with inherent capabilities, with the reorganization of the whole world view. Higher education institutions are oriented, practicing, and continuing the learning process based on feedback (Utomo and Ruijter, 1985).

c. **Prior Research Review**

Research on ecological literacy abroad has been done by several researchers, but in Indonesia found a study of universities that have not implemented education about the environment. This makes researchers interested in researching ecological literacy, which is measured using three parts proposed by Orr (1992), namely knowledge, care, and practice. Researchers have a research objective analyzing the level of ecological literacy by describing the level of expertise, care, and training regarding the environment and sustainability. Research with that objective was conducted by McGinn researchers (2014) in Pennsylvania using Excel statistical analysis and Minitab regression. McGinn (2014) research results obtained indicate that the majority of students do not have a high level of ecological literacy.

The next study was carried out by Schimek (2016), aiming to measure the level of ecological literacy of adults in South Australia. Measurement of the level of ecological literacy is done through knowledge and understanding of ecology alone through online media. Schimek said that ecological knowledge and understanding could be obtained through formal and informal activities. Schimek's (2016) research results indicate differences in a person's knowledge and understanding scores but illustrate that at the same ecological literacy level that is high.

Subsequent research was conducted by Muliana, Maryani, and Somantri (2018), aiming to determine the level of ecological literacy in students at Syiah Kuala University, Banda Aceh. In this study, the level of ecological literacy is measured based on the parts of knowledge, attitudes, skills, and participation. The results of Muliana, Maryani and Somantri's research (2018)

obtained the majority of 51.66%, showing that students had moderate ecological literacy levels, 24.5% at low ecological literacy levels, and 23.75% high ecological literacy levels. Muliana, Maryani, and Somantri (2018) state that this occurs because knowledge of the environment is not included in the learning competency plan, so there is no optimal and comprehensive effort to create students at high levels of ecological literacy.

The results of these studies can be used as a reference in research to measure student ecological literacy and differences in knowledge and understanding of ecology. McGin (2014) research results can be used as a reference for researchers who use three parts, namely knowledge, care, and practice have the potential to measure the ecological literacy of students and those around them. Furthermore, the research of Muliana, Maryani and Somantri (2018) recommends that higher education institutions as a place to change knowledge, culture, and norms that are expected to be the basis for fostering caring attitudes towards students. Higher education needs to make strategic policies in an effort to create a green and environmentally friendly campus. Schimek's research (2016) contributes to deep understanding of ecological knowledge and understanding in a community.

2. Research Methods

2.1. Research Data

Faculty of Agriculture, University of Brawijaya chosen because it has implemented sustainability education in its curriculum. The research was conducted during July - September 2019. In this study, respondents were active students of the Faculty of Agriculture, Brawijaya University from three enrollment year, namely 2018, 2017, and 2016. Online survey was used using google form which consist of questionnaire to measure ecological literacy that was developed by McGin (2014) and student's characteristics such as: year of enrollment, place of origin and sex. The invitation to participate on this survey was announced through social media and announcement board. To attract student's participation on this survey ruffle tickets for 10 lucky respondents were offered. A number of 419 students finally participated on this survey.

2.2. Data Analysis Technique

a. Chi-Square

Before being analyzed, the questionnaire will be checked first. After that, the respondent's answer will be tabulated. The tabulated results will then be processed using descriptive and inferential statistics. Descriptive statistical analysis is used to describe the level of ecology literacy of students as a whole. Statistical analysis of inference in the form of Crosstabs Test analysis with chi-square test to determine the presence or absence of differences in the level of ecological literacy based on the status and choice of the study program of respondents.

The chi-square method (χ^2) is used to approach (estimate) several factors or evaluate the frequency investigated or the frequency of observations (f_o) with the expected frequency (f_e) of the sample, whether there is a significant relationship or difference. To solve this problem, a testing technique called χ^2 testing is needed.

Method χ^2 uses nominal (discrete) data, the data is obtained from the calculation results. While the value of χ^2 is not a measure of the degree of relationship or difference.

How to test χ^2 first make a hypothesis in the form of sentences, set the level of significance, calculate the value of χ^2 , make a decision rule that is if $\chi^2_{count} \geq \chi^2_{table}$, then reject H_o is significant, look for χ^2_{table} , using table χ^2 then make a comparison between χ^2_{count} with χ^2_{table} , the last conclusion.

The formula used to calculate χ^2 is:

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$

χ^2 = Chi-square Score

f_o = Observed Frequency (empirical frequency)

f_e = Expected Frequency (theoretical frequency)

Formula to calculate theoretical frequency (f_e):

$$f_e = \frac{(\sum fk) \times (\sum fb)}{\sum T}$$

f_e = Expected Frequency (theoretical frequency)

$\sum fk$ = number of frequencies in the column

$\sum fb$ = number of frequencies in the line

$\sum T$ = total number of rows or columns

b. Difference test (t-test)

T-Tests was applied to compare the level of ecological literacy based on their study program, place of origin (urban/rural), and sex (male/female). Using t-tests, we can find out whether there are statistically significant differences. Some assumptions that must be fulfilled to carry out the T-Test different test analyses are normally distributed data samples, having the same variance, and the data are interval or ratio. Mathematically, the T-Test difference test calculation is as follows:

$$t = \frac{X_1 - X_2}{\sigma_{gab} \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$\sigma_{gab} = \frac{\sqrt{(n_1+1)\sigma_1^2 + (n_2+1)\sigma_2^2}}{n_1+n_2-2}$$

Explanation:

T : T Value Calculated

X_1 : Average data sampel 1

X_2 : Average data sampel 2

n_1 : Total sampel 1

n_2 : Total sampel 2

σ_1^2 : Standard sample deviation 1

σ_2^2 : Standard sample deviation 2

3. Results and Discussions

3.1. Descriptive statistics

The measurement of the ecology literacy of the students of the Faculty of Agriculture is done by giving questions related to ecological knowledge as in the table above, of the questions that have been asked. An assessment of the respondent's answers will be conducted. They will get 1 point for correct answers, and incorrect answers will be given 0 points. From each answer, a calculation is made using the interval scale which is categorized as ecological blind when choosing a score of 1 with a value of 0, ecological blindness when choosing a score of 2 with a value of 60, a minimum level of ecological literacy when choosing a score of 3 with a value of 70, a standard level ecological literacy when choosing a score of 4 with a value of 90, and a high level of ecological literacy when choosing a score of 5 with a value of 100. Table 1 shows the descriptive statistics of the research respondents' answers.

Table 1. Student's Ecological Knowledge

Question	Mean	Std. Dev
Which one of the following renewable resources?	0.653938	0.476282
What international agreement seeks to regulate the amount of greenhouse gases produced by countries?	0.396181	0.489688
Approximately what percentage of the earth's water is available as potable water?	0.389022	0.488111
How many degrees of average surface temperature has the planet warmed since the industrial revolution?	0.183771	0.38776
The ozone layer is useful for protecting yourself from	0.26253	0.440535
Motor vehicles contribute to air pollution in:	0.732697	0.443081
Where does most of Indonesia's plastic waste end up?	0.696897	0.460149
A person can get the energy of 100 lbs of calories from consuming:	0.317422	0.46603
The deer have no natural predators in the park and the watchman watches deer eat all the same plants in the park. Steps to restore the ecosystem due to deer behavior that eats all similar plants in the park are:	0.281623	0.450328
DDT as a chemical poison that can be found at the lowest level of freshwater.		
DDT is usually eaten by small clams that live in water. Which species will have the highest DDT level in the body?	0.331742	0.471402
One of the USDA certified organic product qualifications?	0.785203	0.411173
What is a watershed?	0.933174	0.250019

3.2. Comparison of Ecological Literacy by Year of enrollment

Table 2 shows the distribution of student's ecological literacy based on the enrollment year. From the total respondents, it is 40.6% categorized on the basic category level. Only 1.9% of them categorized as blind and 7.9% as high. Although the distribution for the year 2016 looks better than the year 2017 and 2018, and the year 2017 better

than 2018, but there is no statistical difference on the frequency distribution among the enrollment year as shown by X^2_{count} that is less than X^2_{table} . This means that the level of student's ecological literacy among year of enrollment are same. This finding also indicates there is no significant impact of sustainable education on students as expected, the older the enrollment year the higher the proportion of the students with higher ecological literacy level.

Table 2. Distribution of Student's Ecological Literacy based on the enrollment year

Literacy Categories	Enrollment Year			Total
	2016	2017	2018	
Ecological blind	1	2	5	8
	0.9%	1.3%	3.3%	1.9%
Low	16	34	34	84
	14.3%	21.9%	22.4%	20.0%
Base	50	67	53	170
	44.6%	43.2%	34.9%	40.6%
Standard	35	41	48	124
	31.3%	26.5%	31.6%	29.6%
High	10	11	12	33
	8.9%	7.1%	7.9%	7.9%
Total	112	155	152	419
	100.0%	100.0%	100.0%	100.0%

$$X^2_{\text{count}} = 8.018$$

$$X^2_{\text{table}} = 465.611 (\alpha=0.05)$$

3.3. Comparing Ecological Literacy based on the Study Program

The average difference test is used to compare the level of ecological literacy of

Table 3. Average different test based on the study program

Variable	Agribusiness (n=169)		Agrotechnology (n= 250)		t_{test}
	Mean	Std. Dev.	Mean	Std. Dev.	
Ecoliteracy	63.9645	16.51907	62.56	19.17596	0.7996 ^{ns}

Table 3 shows that the level of ecological literacy of agribusiness study program students obtained an average value of 63.9645 while the agrotechnology study program was 62.56. It shows that agribusiness study program students have a greater level of ecological literacy than agrotechnology study program students. However, these differences are not statistically significant. This finding is not surprising. Both of these programs are under the auspices of the agricultural faculty of Brawijaya University, which has the same learning curriculum, which

students based on the study programs, namely agribusiness and agrotechnology. The following are the results of the average difference test based on the student's study program:

gives emphasize more on sustainability issues. This finding indicates no discrimination on the implementation of sustainable education on these two study programs.

3.4. Comparing Ecological Literacy based on the place of origin

The average difference test is also used to compare the level of ecological literacy based on the place of the student's origin, namely rural and urban areas. The following are average test results based on the place of the student's origin:

Table 4. Average different test based on the place of origin

Variable	Urban (n=267)		Rural (n= 152)		t_{test}
	Mean	Std. Dev.	Mean	Std. Dev.	
Ecoliteracy	62.77154	18.2659	63.75	17.97027	-0.5327 ^{ns}

Students from urban areas in this study were 267 students, while those from rural areas were 152 students. Based on table 4, students from rural areas have an average value of ecological literacy of 63.75, while students from urban areas have an average ecological literacy score of 62.77154. This shows that the ecological literacy of students from rural areas is higher than students from urban areas. However, this difference is not statistically significant. This means that the level of ecological literacy of students viewed from the place of origin does not have significant differences.

3.5. Comparing Ecological Literacy Based on Sex

The average difference test in this section is used to compare the level of ecological literacy of

students based on the sex of the students, male and female.

The respondents in this study consist of 147 male students and 272 female students. The result of the analysis of the average test in Table 5 shows that male students have an average ecological literacy level of 60.47619, while female students have an ecological literacy level of 64.55882. This shows that female students have higher ecological literacy levels than male students. Since the t_{test} exceed the t_{table} , this difference is statistically highly significance on $\alpha=0,025$. This means that there are significant differences in the level of ecological literacy between male and female students. These findings are in line with that of Pilgrim et al., (2007); they found that a woman has higher ecological awareness than a man.

Table 5. Average different test based on Gender

Variable	Male (n=147)		Female (n= 272)		t_{test}
	Mean	Std. Dev.	Mean	Std. Dev.	
Ecoliteracy	60.47619	19.45607	64.55882	17.26151	2.131**

4. Conclusion

From the results of research related to the ecological literacy of agricultural faculty's students, it can be concluded that most of students are classified on the basic level of the ecological literacy. Secondly, there is no statistical difference on student's ecological literacy based on their year of enrollment, study program and place of origin. Only based on sex, there is a statistical difference, where female students have higher level. In addition, it can be said that although there is no differences in the implementation of sustainable education on the two study program, the improvement is still needed to raise the level of ecological literacy particularly on the older students, so the proportion of student with high level of ecological literacy will be higher.

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