

THE EFFECTIVENESS OF SUBJECT SPECIFIC PEDAGOGY BASED ON PROBLEM-BASED LEARNING TO EMPOWER STUDENT'S ECOLOGICAL LITERACY

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Abstract: This study aims to examine the effectiveness of Subject Specific Pedagogy (SSP) based Problem-Based Learning (PBL) to facilitate the students' ecological literacy. This research involved in a Biology Education Program of a Faculty of Teaching and Learning Science in a public university in Indonesia. The research used a posttest-only control design. The participants were undergraduate students who had learned or were learning Ecology, as many as 46 students in the experiment class and 57 students in the control class. The posttest score of the ecological literacy for the experimental class was 80.77% while the control class was 68.14%. Using an independent t-test, it was indicated that the sig value = 0,00, therefore it might be said that there is difference of ecological literacy between experiment class and control class. Accordingly, it is concluded that the PBL-based SSP affects the ecological literacy of biology education students.

Keywords: *Subject Specific Pedagogy, Problem-Based Learning, effectiveness, Ecological Literacy*

KEEFETIFAN SUBJECT SPECIFIC PEDAGOGY BERBASIS PROBLEM-BASED LEARNING UNTUK MEMBERDAYAKAN ECOLOGICAL LITERACY MAHASISWA

Abstrak: Penelitian ini bertujuan untuk menguji keefektifan *Subject Specific Pedagogy* (SSP) berbasis *Problem-Based Learning* (PBL) untuk memberdayakan literasi ekologi mahasiswa. Penelitian ini dilaksanakan pada Program Studi Pendidikan Biologi di Fakultas Keguruan dan Ilmu Pendidikan di sebuah universitas negeri di Indonesia. Desain penelitian yang digunakan adalah *posttest-only control design*. Sampel penelitian terdiri atas mahasiswa yang sudah atau sedang mempelajari Ekologi, yaitu sejumlah 46 di kelas eksperimen dan sejumlah 57 di kelas kontrol. Pada kelas eksperimen, mahasiswa belajar menggunakan pendekatan SSP berbasis PBL, sedangkan di kelas kontrol siswa mengikuti perkuliahan dengan pendekatan ceramah (tradisional). Didapatkan skor *posttest* literasi ekologi untuk kelas eksperimen sebesar 80,77% sedangkan kelas kontrol sebesar 68,14%. Menggunakan *independent t-test*, diperoleh $t(df)=value$, $sig=0,00$, sehingga dikatakan terdapat perbedaan literasi ekologi antara kelas eksperimen dan kelas kontrol. Oleh sebab itu, pendekatan SSP berbasis PBL disimpulkan efektif untuk memfasilitasi literasi ekologi pada mahasiswa pendidikan biologi.

Kata Kunci: *Subject Specific Pedagogy, Problem-Based Learning, Keefektifan, Literasi Ekologi*

INTRODUCTION

The UI GreenMetric is a world ranking to measure the university's ability to maintain a sustainable campus environment and its surroundings (Team, 2016). One of the UI GreenMetric objectives was to see the contributions of the academic discourse on sustainability of education and campus greening programs including the application of

environment-based curriculum in each subject as well as creating an environmentally friendly campus. A total of 28 universities in Indonesia have participated in UI GreenMetric in maintaining a sustainable campus environment through the Green Campus program.

Green Campus is a place to implement eco-friendly practices by combining the role of education to promote sustainability programs

in campus environment (NEEATeam). Campus residents can examine environmental issues and provide solutions through the Green Campus activity (UNS, 2014). Sebelas Maret University (UNS) is ranked 76th in the world and ranked 5th nationally with a value of 5,960 (Rizki, 2016). Sebelas Maret University and 6 other universities were selected as pilot projects to implement the Green Campus program under the guidance of the Ministry of Environment (UNS, 2014). The implementation of the Green Campus program can be supported by using an environment-based curriculum given in the course. According to Roy (2008) the environment-based curriculum can be applied to environmental issues on campus and its surroundings to reduce waste and energy consumption. Environmental-based education if managed well can be beneficial to improve eco-friendly behavior (Cheang, So, & Zhan, 2017; Li & Lang, 2015) two of the most important sources of influence, on views of the human-nature relationship (HNR).

Environmental-based education builds on environmental knowledge; about the causes and consequences of ecological disasters, ecological security, and concepts of human positions in nature (Kallas, Solovjeva, & Minakova, 2015). IUCN (2002) added solutions for environmental improvement through education which had been formulated in the design of agenda 21. One of the formulas contained in agenda 21 states that education plays an important role in realizing sustainable development (UNESCO-UNEP, 1996). UI GreenMetric recognizes the important role of higher education in addressing environmental issues because as a basic step of raising awareness through education for sustainable development (Team, 2016). The concrete steps of Agenda 21 are formulated in Education for Sustainable Development (*EfSD*).

Education for Sustainable Development (*EfSD*) is a type of teaching approach based on the ideals and principles underlying sustainable development and concerning with all levels and types of education. Education for sustainable development allows one to develop knowledge, values and skills in taking decisions on making a better quality of life in the future (Hooi, Hassan, & Mat, 2012). Ecological science is an environment-based education that can be used to decide on various actions to be taken related to environmental issues (Kiker, Bridges, Varghese, Seager, & Linkov, 2005).

Utilization of ecological science for the internalization of environmental cares can be done through a study of related literature on ecological. The literature on ecological literacy today emphasizes the role of scientific knowledge and ecological thought to enable better decision making (McBride B., Brewer, Berkowitz, & Borrie, 2013). McGinn (2014) defines ecological literacy as one's own knowledge of the ecological system, the urge to know it, not only knowing about the system but also feeling responsible for the ecological situation and ultimately acting on his/her knowledge and responsibilities. Orr (1992) states that to know the ecological literacy, one must understand the basic knowledge of ecological and its sustainability beside his/ her eagerness to solve an environmental problem.

In relation to differences of the definition of Ecological literacy, Al-Dajeh (2012) found there are three components behind the same definition. Components of Ecological literacy according to Al-Dajeh include: Knowledge, Attitude, and Concern. Each component has several aspects that support the goal to determine the level of one's Ecological literacy. Knowledge component using the aspect expressed by Lewinsohn (2015) aims to facilitate the level of student knowledge related to the concept of ecological. The second dimension is attitude using the scale of the assessment of NEP (New Ecological Paradigm). Instruments for attitude components use NEP instruments that have been validated and have been applied in several countries (Ogunbonde, 2013). While the third component is the concern which is a form of concern or action of every human being in preserving the environment (Eurobarometer, 2008).

Biology FKIP UNS students' preliminary data of ecological literacy ability showed relatively low results in one component of ecological literacy. The results of ecological literacy ability of FKIP UNS Biology Education students of 2014 viewed from each dimension are as follows; a). ecological knowledge is 57.10%, b). ecological concerns is 71.74%, and c). NEP is 62.83%. The average ability of ecological literacy of Biology Education students is still relatively low so it must be followed up to increase students' awareness in maintaining the environment around the campus and to succeed the Green Campus program at Sebelas Maret University.

The study of environmental materials can motivate the students to enhance ecological literacy. Ecological literacy can be improved in simple ways, such as providing information that is easy to understand. The ecological literacy of students in formal education can be enhanced through the provision of courses relevant to ecological (McBride B. B., Brewer, Berkowitz, & Borrie, 2013). Ecological learning in lectures can provide knowledge for students as a special experience that forms attitudes and behavioral habits (Irham & Wiyani, 2013). Selection of appropriate approaches, strategies and learning models can determine the effectiveness of learning (School Education Department of Education & Training, 2005). Specific learning designs according to field of study will maximize learning activities that produce better knowledge along with the formation of attitudes and behavioral habits.

Prayitno & Wangid (2005) states that Subject Specific Pedagogy which is developed specifically for character and knowledge is proven to be able to improve students' character and knowledge. Hartati, et al. (2009) states that several components of SSP tool includes: RPS, teaching materials, learning media, and evaluation. Learning that refers to specific learning tools on ecological materials is one effective way and is expected to improve students' ecological literacy.

Subject Specific Pedagogy is included in the development field that has an output product in the form of semester learning plan (RPS), teaching materials, learning media and evaluation instruments. Development of Subject Specific Pedagogy is packaged in a set of whole lessons, including the learning model used. According to Sujarwo (2011) each learning model has specific characteristics. According to Rustaman (2005) learning konstruktivisme emphasizes the active role of students to interact with teachers and other students to improve the development of concepts and skills of critical thinking. One model of constructivism learning that can facilitate students to improve the ability of ecological literacy is Problem-Based Learning (PBL).

Problem-Based Learning is part of the experimental learning that provides meaningful learning experiences for students (Hmelo-Silver C. E., 2004). Barrows & Tamblyn (1980) states

that in PBL students learn by solving problems and reflecting on their experiences. According to Barrows (1993) one of the goals of PBL learning is to develop knowledge flexibly and to use skills in solving problems effectively. Problem-Based Learning can facilitate every concept and method used as needed in the process of developing a solution to a particular problem (Lewinsohn, Attayde, Fonseca, Ganade, & Jorge, 2015). The purpose of Problem-Based Learning can facilitate students to improve their skills and knowledge in developing the students' ecological literacy skills.

METHOD

The students' ecological literacy data Intake uses ecological literacy questionnaire instrument consisting of three components, namely: knowledge, concern, and attitude. The instrument rubric of the knowledge component is based on the ecological concept according to Lewinsohn (2015). He states that ecological concept has 10 aspects including ecosystem resilience, productivity, nutrient cycling, functional redundancy, trophic cascade, habitat fragmentation, community assembly, dispersal, population control, ecophysiological adaptation, and one additional aspect of anti-anthropocentrism, the development of it is in corresponding to knowledge and cognitive dimensions according to Taxonomy Bloom which has been revised by Anderson (2014).

Instruments for attitude components use NEP (New Ecological Paradigm) instruments that have been validated and have been applied in several countries (Ogunbonde, 2013). The NEP has five aspects including the fragility of nature's balance, the reality of limits to growth, the possibility of an eco-crisis, anti-anthropocentrism, rejection of exceptionalism (Ogunbonde, 2013; Dunlap, 1978). Currently, NEP instruments have been enhanced and developed into fifteen statements with 5 points Likert scale (Kopnina, 2011; Dunlap R. E., 2000; Hawcroft & Milfont, 2010).

Instrument of concern component is developed to measure the students' readiness in eco-friendly behaving. Furthermore, it is arranged with three aspects including the basic concept that covers 22 questions, the frequency with 15 questions, and the eagerness of acts with 15 questions. Preparation of an instrument

of concern for each aspect uses a questionnaire containing question and statement with 5 point Likert scale assessment.

Student sample taking is done by using propotionate stratified random sampling technique toward Biology Education student at Sebelas Maret University. The research design uses posttest-only control design with two classes: control class and experimental class. The control class were 7th semester students with 69 population but only 57 students who participated in filling the questionnaires. Meanwhile, the experimental class were 6th semester students with 46 students.

The analysis of the results of the study used independent t-test to find differences in ecological literacy between the control class and the experimental class. The t test is also conducted to find the difference of average score of each component of ecological literacy between the control class and the experimental class.

RESULT AND DISCUSSION

Result

The application of ecological literacy instrument is applied on biology students of 6th semester to know the effect of SSP product based on PBL towards students' ecological literacy capability. The result of posttest of ecological literacy instrument on biology students of 6th semester can be seen in Table 1. Below:

Table 1. Ecological experimental class literacy results

Literacy Ecological	Score (%)
Knowledge	71,01
Concern	87,39
Attitude	83,93

The application of ecological literacy instruments in the control class of 7th semester students of biology resulted differently compared to experimental class. The highest average value of ecological literacy is on components of concern which is about 87.39% while the

Table 3. The Posttest Ecological Literacy Scores of the Eksperimental and Control Class

Class Group	Score	Range	Minimum Score	Maximum Score	Mean	Std. Deviation (S.D)
Eksperimental	Posttest	12,90	66,15	79,05	71,67	3,36
Control	Posttest	19,21	55,72	74,93	68,14	4,11

knowledge component has the lowest score of 71.01%. The average posttest result of the application of ecological literacy instrument to 7th semester students of biology can be seen in Table 2. Below:

Table 2. Ecological control class literacy results

Literacy Ecological	Score (%)
Knowledge	61,61
Concern	75,89
Attitude	66,92

Based on the data in Table 2, it can be seen that the ecological literacy score of control class has the highest value in the concern component of 75.89% while the lowest value in the knowledge component of 61.61%. The comparison of the mean score of each ecological literacy component in the experimental and control class can be presented in Figure 1. as follow:

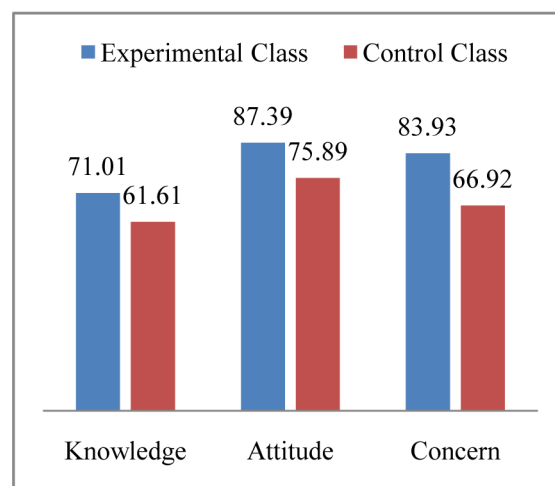


Figure 1. Average Score of each Ecological literacy Component of Experimental Class and Control Class

The descriptive analysis result of posttest ecological literacy score in eksperimental and control class groups are presented in Table 3 below:

Table 4. Summary of Prerequisite Test

Test Prerequisite	Sig.	Conclusion
a. Normality test		
Control Class	0,20	Ho received, Normal
Experimental Class	0,20	
b. Homogeneity test	0,42	Ho accepted, Homogeneous

Based on Tabel 3, it can be seen the average score posttest in eksperimental class and control class is different, the average score of posttest eksperimental class is higher than the control class, where the posttest score average of eksperimental class is 71,67 with S.D is 3,36 and the posttest score average of control class is 68,14 with S.D 4,11.

Posttest results from the experimental and control class were then analyzed using independent t-test to test the effectiveness of Subject Specific Pedagogy based on Problem-Based Learning on Conservation Ecological material preceded by preliminary statistical parametric test that was normality test and homogeneity test as in Table 4.

Based on Table 4 it can be seen that the value of homogeneity and reliability is eligible for t test. Homogeneity value is 0,420 so Ho is accepted. The reliability value for the experimental class and the control class is 0,200 so Ho is accepted and the data is normally distributed. The average test result of the ecological literacy component between the control class and the experimental class is listed in Table 5.

Table 5. Ecological literacy Test Results

T test	Sig.	Conclusion	Decision
Ecological literacy	0,00	Sig <0,05	Ho Denied There is a difference

Through the result of t-test of ecological literacy using independent t-test, it is obtained significance value of 0,00 (<0,05) so that Ho is rejected and there are differences in ecological literacy between experimental class and control class. The t test results for each average ecological literacy component can be seen in Table 6.

Table 6. T-test Result of Ecological literacy Components

T test	Sig.	Conclusion	Decision
Knowledge	0,00	Sig <0,05	Ho Reject- ed, There is a difference
Concern	0,03	Sig <0,05	
Attitude	0,00	Sig <0,05	

Based on the result of t test in Table 6, it can be seen for each component of ecological literacy that Ho is rejected. In the other word, there is a difference in each component of ecological literacy between the control class and the experimental class.

Discussion

The result of t test shows that Subject Specific Pedagogy based on Problem-Based Learning on Conservation Ecological subject is effective in increasing students' ecological literacy. The results obtained from the t test which is to determine whether there is aecological literacy difference between the control class and the experimental class that apply the SSP based on PBL produce sig = 0,000 (<0,05), so Ho is rejected and it can be concluded that there is a difference between the ecological literacy in the control class and experimental class. The t-test results can conclude that the subject- Specific Pedagogy based on Problem-Based Learning produces different values of ecological literacy toward biology education students.

The effectiveness of Subject Specific Pedagogy based on Problem-Based Learning on Conservation Ecological is also explained by the difference of ecological literacy posttest score of students' in control class (7th semester) and experimental class (6th semester). The average score of posttest of control class is 68,14% while the average score of posttest of experimental class is 71,67%.

Based on the results of t-test on the ecological literacy ability of biology education students, it can be assumed that Subject Specific Pedagogy based on Problem-Based Learning is

effective in increasing the students' ecological literacy. According to Hart (1978) the insertion of ecological concepts on learning can be the best predictor of improving eco-friendly attitudes and behavior. Additionally, Lewinsohn (2015) explores the importance of understanding one's ecology concept towards one's ecological literacy ability, ecology concept is crucial to the ability of ecological literacy because it can support a person to facilitate decision-making on environmental issues and take action to choose the right solution. The concept of ecological must be in accordance with the curriculum applicable in educational institutions, the curriculum used must promote environment-based learning (Maknun, 2011). The development of curriculum by inserting ecological concepts about environmental issues is needed to prepare students to think about active and effective role in protecting the environment in the future (Ugulu, Aydin, Yorek, & Dogan, 2008).

The effectiveness of Subject Specific Pedagogy based on Problem-Based Learning is better than the conventional learning tool in courses in order to increase students' ecological literacy because PBL-based SSP has learning subject achievement, graduated learning achievement, the material, as well as clear and specific learning method in relation to the ecological literacy component that includes knowledge, concern, and attitude. One part of the SSP development which is in the form of Semester Learning Plan with the addition of ecological literacy component is proven to have the potential to increase students' ecological literacy according to the expected goal. Subject Specific Pedagogy based on Problem-Based Learning has steps of learning activities that are related to subject learning as well as graduate learning achievements, and student characteristics and models used, so it can support the development of students' ecological literacy.

Learning activities included in Subject Specific Pedagogy based on Problem Based Learning consists of finding and analyzing problems, finding solutions through independent discussion activities and groups, presenting the results of discussions, and linking solutions to other sciences and summarizing them. Problem-based learning can increase the high curiosity of the students that leads them to find solutions to the problems encountered. This statement is

supported by Lewinsohn (2015) who states that problem-based learning (PBL) can facilitate every concept and method used as needed in the process of developing solutions to a particular problem. Problem-Based Learning is one of the intracutive-centered approaches that empowers students to research, integrate theory and practice, and apply knowledge and skills to develop feasible solutions to problems faced (Savery, 2006).

Problem-based learning (PBL) is part of an experiential learning tradition that requires students to solve problems using their existing experience (Barrows & Tamblyn, 1980). Problem-based learning is perfect for helping students to become active learners because of learning the real-world problems and getting students responsible for their learning. Those can make students develop strategies and skills to build knowledge or concepts (Collins, Brown, & Newman, 1989).

The activity of Subject Specific Pedagogy based on Problem-Based Learning consists of identifying the characteristics of a problem well. This stage allows students to grow a flexible and open way of thinking in addressing a problem. Problems encountered let students evaluate the effectiveness of their knowledge, reasoning, and strategies to create a solution so that it can solve a problem (Koschmann, Myers, Feltovich, & Barrows, 1994). Furthermore, problems that have been identified is to be sought their solution immediately. Finding solutions from a problem faced by students is done independently or in groups (Salomon, 1993). The search for solutions to problem solving is done in groups to enable students to distribute cognitive loads among group members and let the whole group solve problems. According to Brown (1995), group discussion in the PBL stage can improve high-level thinking and encourage the development of students' knowledge.

The last stage of the learning activities is a reflection activity that aims to help students understand the relationship between learning objectives and problem-solving activities. Reflection helps students to connect new knowledge gained with prior understanding, and understand how learning strategies and problem solving to reapply (Hmelo-Silver C. E., 2004).

The t test is also conducted to find out that there is a significant difference in each ecological

literacy component between the control class and the experimental class. The average score of ecological knowledge of control class is 61,61% while the mean score of the experimental class is 71,01%. The average score of ecological knowledge has increased due to PBL based SSP tools on Conservation Ecological materials. The result of t test is used to know whether there is difference of ecological knowledge score between control class and experiment class. The t test shows that there is a difference between the control class and the experimental class using the PBL based SSP with the value of sig = 0,00 (<0,05) so that H_0 is rejected and it can be concluded that there is a difference between ecological knowledge in Biology Education Study Program Faculty of Teacher Training and Education Science SebelasMaret University Surakarta with the application of Subject Specific Pedagogy based on Problem-Based Learning.

The score of ecological knowledge is improved because problem-based learning can stimulate students' knowledge to be more flexible and open to identify problems and to find solutions to any problems (Hmelo-Silver, 2004). One of the goals of problem-based learning is to require students to build a broad and flexible knowledge in learning a fact. According to Kolodner (1993), the knowledge of students will be increasing and growing when applying the knowledge they have on various situations and problems. The score of ecological knowledge is increasing because Subject Specific Pedagogy which is developed specifically for specific purposes will yield the results in accordance with expectations, in this study the SSP is specifically focused on improving the concept of ecological or components of student knowledge. Prayitno & Wangid (2005) in his research stated that the SSP developed specifically to develop student knowledge is able to increase students' knowledge.

The results are in line with expectation because the development of PBL based SSP on Conservation Ecology materials focuses on the component of ecological knowledge. Besides, through the preliminary analysis, it is known that the ecological knowledge of students is at low category. The development of indicators in the semester learning plan is focused on improving the ecological knowledge component by including indicators of knowledge that include

ecosystem resilience, productivity, nutrient cycling, functional redundancy, trophic cascade, habitat fragmentation, community assembly, dispersal, population control, ecophysiological adaptaion and anti anthropocentrise. These results, theoretically, can influence the behavior formed but according to Fisher & Fisher (1992) the knowledge, although needed, is not enough to form eco-friendly behavior. Knowledge can work best to influence behavior when combined with mutual motivation through emerging behavioral skills. This opinion is supported by the research of Ajzen et al. (2011) and Fisher et al. (1994) who claim that knowledge does not consistently affect behavior, when the effect is relatively small and must be mediated through one's skills they possessed.

The average score of ecological concern of control class is 75,89%, while the average score of the experimental class is 87,39%. The average score of ecological concerns has increased and the t test results show the same thing, hence it can be concluded that the Subject Specific Pedagogy based on Problem-Based Learning on Conservation Ecological material can effectively increase the students' ecological literacy. The results obtained from the t test is to determine whether there is a difference of ecological concern between the control class and the experimental class using PBL based SSP which is resulted sig = 0,03 (<0,05) so that H_0 is rejected, therefore it can be concluded that there is difference of ecological concern of the student Biology Education Studies Faculty of Teacher Training and Education Sebelas Maret University Surakarta with the application of Subject Specific Pedagogy based on Problem-Based Learning.

The score of ecological concern is increasing because the ecological concepts gained from problem-based learning can support students' awareness in protecting the environment. Awareness is one form of human behavior that arises when having a concept of good knowledge. Knowledge possesses can increase one's awareness in protecting the environment (Ajzen, Joyce, Sheikh, & Cote, 2011). This is in line with the wrong outcome of the learning process that aims to improve the behavior of learners. A person's awareness will increase when a problem presented to them and urge them to make decisions and take action;

from environmental problems occurred, someone will raise awareness to protect the environment better. However, according to DeChano (2006), the level of ones' concern is not influenced by the knowledge they have. This behavior is strongly influenced by existing attitudes such as research that has been done by Hye-Eun (2007) who states that there is a strong correlation between attitudes and person's behavior. The score of ecological concern shows high results which means that there is readiness to behave from students to be more environmentally friendly (Ajzen, Joyce, Sheikh, & Cote, 2011).

The average score of ecological attitude is increasing in control class which is 66,92% while the mean score of ecological attitude of the experimental class is 83,93%. The average score of ecological attitude is increasing considerably and the result of t test shows that Subject Specific Pedagogy based on Problem-Based Learning on Conservation Ecological was effective in increasing the students' ecological literacy. The results obtained from the t test is to determine whether there are differences in ecological attitude between the control class and experimental class that apply the PBL based SSP which results $\text{sig} = 0,00 (<0,05)$ so that H_0 is rejected and it can be concluded that there are differences in student ecological attitude Biology Education Studies Program Teacher Training Faculty and Education Sebelas Maret University Surakarta with the application of Subject Specific Pedagogy based on Problem-Based Learning.

Ecological attitude results have increased because the concept of ecological owned by students through learning using PBL-based SSP gives a good influence on attitudes that are formed on students. According to Shamuganathan & Karpundewan (2015), one solution in teaching ecological literacy is by giving a problem on environmental issues because by that, one will behave more responsibly in protecting the environment. Their attitudes then can be more eco-friendly as described by Fishbein and Ajzen (1980) in the research that has been conducted. According to Vining & Ebreo (1992), the attitudes of environmental care owned also refers to the amount of awareness of the environment. Readiness to behave is influenced by attitudes possessed to perform a particular action and apply subjective norms. (Ajzen et al., 2011).

Another thing that affects the formation of attitude according to Stutzman & Green (1982) is a factual knowledge that becomes a prerequisite for any desired attitude.

According to Kollmus & Agyeman (2002), there are several opinions that knowledge can influence attitudes and will ultimately shape environmentally responsible behaviors. It turns out to be less precise because there is a large and unexplained gap between attitudes and behavior. Shamuganathan & Karpudewan (2015) stated that there has been an attempt to address this gap in Fishbein & Ajzen (1974) research through the theory of reasoned action and theory of planned behavior according to Ajzen (1985). According to Fishbein & Ajzen (1980) as a matter of fact that there is a correlation between attitudes and behaviors yet attitudes do not have a direct effect on behavior, but only affect the readiness to behave and in turn determine the behavior that is formed.

Based on the results of each component of ecological literacy above, it can be concluded that the development of Subject Specific Pedagogy based on Problem-Based learning is proven effective to increase student's ecological literacy. Zverev (1995) considers that integrated ecological education using a model can develop person permanently to be directed to the formation of knowledge and practical scientific skills, valuable orientation, as well as moral and aesthetic relationships that give someone the ecological responsibility to protect the environment sustainably.

CONCLUSION

The effectiveness of Subject Specific Pedagogy based on Problem-Based Learning on Conservation Ecological by using t test on the average score of ecological literacy shows a good significance value between the control class and the experimental class. Result of t test show $\text{sig} = 0,00 (<0,05)$ so that there is difference of average score of ecological literacy between control class and experiment class using SSP based on PBL. The value of t test is also different in each ecological literacy component between the control class and the experimental class. The t test for each ecological literacy component has $\text{sig} <0,05$ so that there is difference in each component of ecological literacy between control class and experiment class.

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REFERENCES

- Ajzen, I., & Fishbein, M. 1980. *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs: Prentice-Hall.
- Ajzen, I., Joyce, N., Sheikh, S., & Cote, N. G. 2011. Knowledge and the Prediction of Behavior: The Role of Information Accuracy in the Theory of Planned Behavior. *Basic and Applied Social Psychology*, 101-117.
- Al-Dajeh, H. I. 2012. Assessing Environmental Literacy of Pre-vocational Education Teachers in Jordan. *College Student Journal*, 492-507.
- Anderson, L. W., & Krathwohl, D. R. 2014. *Kerangka Landasan untuk Pembelajaran, Pengajaran, dan Asesmen: Revisi Taksonomi Pendidikan Bloom*. Yogyakarta: Pustaka Belajar.
- Barrows, H. S., & Tamblyn, R. 1980. *Problem-Based Learning: An Approach to Medical Education*. New York: Springer.
- Barrows, H., & Kelson, A. 1993. *Problem-based learning in secondary education and the Problem-based Learning Institute (Monograph)*. Southern Illinois University School of Medicine: Springfield.
- Brown, A. L. 1995. The advancement of learning. *Educ. Res*, 4-12.
- Chu, H.-E. e. 2007). "Korean Year 3 Children's Environmental Literacy: A Prerequisite for a Korean Environmental Education Curriculum. *International Journal of Science Education*, 731-746.
- Collins, A., Brown, J. S., & Newman, S. E. 1989. Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In Resnick, L. B. *Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser*, 453-494.
- DeChano, L. 2006. A multy-country examination of the relationship between environmental knowledge and attitude. *International Research in Geographical and Environmental Education*.
- Dunlap, R. E. 1978. The new environmental paradigm. *Journal of Environmental Education*, 10-19.
- Dunlap, R. E. 2000. Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale. *Journal of Social Issues*, 425-442.
- Eurobarometer. 2008. *Attitudes of European Citizens toward the Environmental*. Europa: Special Eurobarometers 295.
- Fishbein, M., & Ajzen, I. 1974. Attitudes toward objects as predictors of single and multiple behavioral criteria. *Psychological Review*, 59-74.
- Fisher, J. D., & Fisher, W. A. 1992. Changing AIDS-risk behavior. *Psychological Bulletin*, 455-474.
- Fisher, J. D., Fisher, W. A., Williams, S. S., & Malloy, T. E. 1994. Empirical tests of an information-motivation-behavioral skills model of AIDS-preventive behavior with gay men and heterosexual university students. *Health Psychology*, 283-250.
- Hart, E. 1978. Examination of BSCS Biology and Nonbiology Student's Ecology Comprehension, Environmental Information Level, and Environmental Attitude. *Journal of Research in Science Teaching*, 75-78.
- Hartati, T., & dkk. 2009. *Productive Pedagogy & Subject Spesific Pedagogy*. Bandung: UPI Bandung.

- Hawcroft, L., & Milfont, T. 2010. Use (and abuse) of the new environmental paradigm scale over the last 30 years: A meta-analysis. *Journal of Environmental Psychology*, 143-158.
- Hmelo-Silver, C. E. 2004. Problem-Based Learning: What and How Do Students Learn? *Educational Psychology Review*, 235-266.
- Hooi, K. K., Hassan, F., & Mat, M. C. 2012. An Exploratory Study of Readiness and Development of Green University Framework in Malaysia. *Social and Behavioral Sciences*, 525-536.
- Irham, M., & Wiyani, N. A. 2013. *Psikologi Pendidikan*. Yogyakarta: Ar-ruzz Media.
- IUCN. 2002. *Education and Sustainability Responding to the Global Challenge*. Cambridge UK: IUCN, Gland, Switzerland and Cambridge, UK.
- Kallas, E. V., Solovjeva, T. P., & Minakova, L. Y. 2015. Implementation of Ecological Education in a Higher School. *Procedia-Social and Behavioral Sciences*, 453-459.
- Kiker, G., Bridges, T., Varghese, A., Seager, P., & Linkov, I. 2005. Application of multicriteria decision analysis in environmental decision making. *Integrated Environmental Assessment and Management*, 95-108.
- Kollmus, A., & Agyemen, J. 2002. Mind the gap: why do people act environmentally and what are the barriers to pro environmental behavior? *Environmental Education Research*, 239-260.
- Kolodner, J. 1993. *Case-Based Reasoning*. San Mateo, CA: Morgan Kaufmann.
- Kopnina, H. 2011. Applying The New Ecological Paradigm Scale in the Case of Environmental Education: Qualitative Analysis of The Ecological Worldview of Dutch Children. *Journal of Peace Education and Social Justice*, 374-388.
- Koschmann, T. D., Myers, A. C., Feltovich, P. J., & Barrows, H. S. 1994. Using technology to assist in realizing effective learning and instruction: A principled approach to the use of computers in collaborative learning. *J. Learn. Sci*, 225–262.
- Lewinsohn, T. M., Attayde, J. L., Fonseca, C. R., Ganade, G., & Jorge, L. R. 2015. Ecological literacy and beyond: Problem-based learning for future professionals. *AMBIO*, 44:154-162.
- Maknun, D. 2011, December. Praktikum Proyek Ekologi Berbasis Kondisi Ekobiologis Lokal dalam Meningkatkan Literasi Lingkungan dan Tindakan Konservasi Mahasiswa. *Holistik*, 1-39.
- McBride, B. B., Brewer, C., Berkowitz, A. R., & Borrie, W. T. 2013. Environmental literacy, ecological literacy, ecoliteracy: What do we mean and how did we get here? *Ecosphere*.
- McGinn, A. E. 2014. Quantifying and Understanding Ecological Literacy: A Study of First Year Students at Liberal Arts Institutions. *Dickinson College Honor Theses*, 1-55.
- NEEATeam. (t.thn.). Dipetik Mei 1, 2017, dari www.epa.gov: <http://www.epa.gov>
- Ogunbonde, C. 2013. The NEP Scale: measuring ecological attitude/worldviews in an african context. *Enviro Dev Sustain*, 15: 1477-1494.
- Orr, D. 1992. *Ecological Literacy: Education and the Transition to a Post-modern World*. Albany: State University of New York Press.
- Prayitno, S. M., & Wangid, M. N. 2005. Subject Specific Pedagogy Thematic Integrative Model For The Development Of Students' Respect And Responsibility. *Jurnal Pendidikan Karakter*, 195-207.

- Rizki. 2016, December 30. *UI Green Matric*. Dipetik July 26, 2017, dari www.ui.ac.id: www.ui.ac.id
- Roy, R., Potter, S., & Yarrow, K. 2008. Designing low carbon higher education systems Environmental impacts of campus and distance learning systems. *International Journal of Sustainability in Higher Education*, 116-130.
- Rustaman, N. 2005. *Strategi Belajar Mengajar Biologi*. Malang: UM PRESS.
- Salomon, G. 1993. *No distribution without individual cognition: A dynamic interactional view*. New York: Cambridge University Press.
- Savery, J. R. 2006. Overview of Problem-based learning: Definitions and Distinctions. *Interdisciplinary Journal of Problem-Based Learning*, 1(1).
- School Education Department of Education & Training. 2005. *Professional Learning in Effective Schools: The Seven Principles of Highly Effective Professional Learning*. Melbourn: Leadership and Teacher Development Branch Office of School Education Department of Education & Training.
- Shamuganatha, S., & Karpudewan, M. 2015. Modeling Environmental Literacy of Malaysian Pre-University Students. *International Journal of Environmental & Science Education*, 757-771.
- Stutzman, T. M., & Green, S. B. 1982. Factors affecting energy consumption: two field tests of the Fishbein-Ajzen model. *Journal of Social Psychology*, 183-201.
- Team, U. G. 2016. *Guidline of UI GreenMetric World University Ranking 2016*. Depok: Universitas Indonesia.
- Ugulu, I., Aydin, H., Yorek, N., & Dogan, Y. 2008. The impact of endemism concept on environmental attitudes of secondary school students. *Nature Montenegrina*, 165-173.
- UNESCO-UNEP. 1996, June. Education for sustainable development.
- UNS, T. G. 2014. *Rencana Strategi Pengembangan Green Campus*. Surakarta: Universitas Sebelas Maret.
- Vining, J., & Ebreo, A. 1992. Predicting recycling behavior from global and specific environmental attitudes and changes in recycling opportunities. *Journal of Applied Social Psychology*, 1580-1607.
- Zverev, I. 1995. *Priorities of ecological education. I Moscow scientific-practical conference on continuous ecological education*. Moscow: Moscow State University.