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The Impact of Local Wisdom-Based PBL-ESD on the Cognitive Ability and Sustainability Awareness of Junior High School Students

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Abstract

Education for Sustainable Development (ESD) is key to addressing environmental, social, and economic issues, yet its implementation in schools often lacks context and cultural relevance for students. Previous research on Problem Based Learning (PBL) with an ESD approach has not optimally integrated local wisdom, a crucial element for achieving quality education relevant to a specific region and culture. This study fills that gap by examining the effectiveness of a PBL model integrated with an ESD approach based on local wisdom to improve cognitive ability and build students' Sustainability Awareness profiles. Using a sequential exploratory mixed-methods design on 20 private junior high school students in Bandung City, data were collected through cognitive ability tests (multiple-choice), a sustainability awareness questionnaire, and observation sheets. The results showed a significant improvement in students' cognitive abilities, with a normalized N-gain score of 0.68 (medium category). The students' Sustainability Awareness profile was also in the high category post-intervention, with a total mean score of 0.71, particularly in the emotional awareness domain (100%). This study demonstrates that integrating local wisdom into the PBL-ESD framework is not only academically effective but also successful in building a more meaningful and culturally relevant awareness of sustainability.

Keywords: Problem Based Learning (PBL) · Education Sustainable Development (ESD) · Local Wisdom · Cognitive Ability · Sustainability Awareness

INTRODUCTION

Environmental, economic, and social issues are currently rife in Indonesia. These issues exacerbate the problem of unsustainable development in Indonesia, such as environmental damage (Ali, 2017). In schools, many students are starting to lose their awareness of sustainable living (Fibonacci et al., 2020). Schools have not yet encouraged students to take steps to reduce the impact of environmental problems (Olsson et al., 2016). Students may be unaware of the small actions they can take to make their schools and surrounding environment more sustainable. This problem stems from the lack of education in sustainable practices directly implemented in schools.

Education for Sustainable Development (ESD) was initiated by UNESCO as achievable and realizable goals by 2030 (UNESCO, 2015). ESD aims to ensure that all students acquire the knowledge and skills necessary to promote sustainable development (NCCA, 2009). The purpose of establishing ESD as a follow-up to the sustainable development goals can be considered as a driver for achieving sustainable development goals in the field of education (Nguyena, 2019). ESD can be described as education for environmental, social, and economic

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transformation with the aim of creating a more sustainable society (UNESCO, 2015). ESD supports five basic types of learning to provide quality education and foster sustainable human beings: learning to know, learning to be, learning to live together, learning to do, and learning to transform oneself and society (UNESCO, 2019). The Ministry of National Education (2022) states that the concept of ESD is meaningful, functional, and purposeful education for development that can meet the living needs of the current generation without having to neglect the living needs of future generations, improve the quality of human life by continuing to live within the carrying capacity of the ecosystem, and benefit all creatures on earth in the present and the future.

The implementation of ESD in schools also faces many challenges. Students have difficulty understanding ESD issues. They also struggle to develop problem-solving plans related to ESD (Manni et al., 2013). A qualitative study in Bandung found that students had difficulty solving problems related to Sustainable Development (Nikmah et al., 2019). Research on ESD implementation highlights the importance of educational approaches to improving teachers' understanding of ESD and students' ESD competencies (Batorczak & Hindson, 2012).

Olsson et al. (2016) proposed a new concept for students' ESD competencies, called Sustainability Consciousness. This concept of sustainable awareness considers students' knowledge, attitudes, and behaviors, based on awareness of environmental, social, and economic dimensions to develop a more sustainable lifestyle. Research on sustainable awareness in Indonesia is scarce. Recent research in Indonesia is still measuring sustainability awareness (Clarisa et al., 2020).

The Problem Based Learning (PBL) model is well-suited to address these challenges by fostering critical thinking. While some studies have combined PBL with an ESD approach, a significant research gap remains: these implementations often fail to achieve the core goal of quality education by overlooking the importance of cultural and territorial context. Quality education demands relevance to students' daily lives and the local wisdom they possess.

To fill this gap, this study introduces the novelty of explicitly integrating local wisdom into the PBL- ESD framework. This integration serves to bridge abstract sustainability concepts with the concrete, everyday knowledge of students, thereby making the learning process more meaningful. Therefore, this research aims to investigate the extent to which a PBL-ESD model based on local wisdom can improve cognitive abilities and build the Sustainability Awareness profiles of students on the topic of energy.

METHODS

The research method used is a mixed methods approach. The basic assumption is that using both qualitative and quantitative methods in a single study can provide a better understanding or answer to the research problem than using only one method. Based on the classification of mixed methods research types, the author chose to use an exploratory design, which falls under the sequential model. This mixed methods design involves conducting qualitative research first, followed by quantitative research (Abidin, 2011: 40).

In the initial stage, this research method used qualitative methods for learning implementation activities using observation sheets. In the next stage, quantitative methods were used to assess cognitive ability outcomes using multiple-choice questions. The emphasis was more on the first method, namely the qualitative method, which was then supplemented with

quantitative methods. The blending of data from both methods was intended to connect the results of the first research with the next stage. Based on this description, the research design that the author will use is as follows.

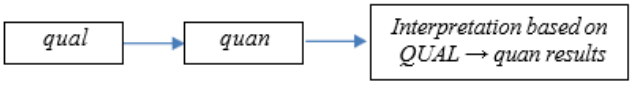

Figure 1. Exploratory Type Design

The independent variable in this study is a PBL learning model integrated with ESD applied in one class at an Adiwiyata school. Independent Adiwiyata schools implement ESD in curricular and non- curricular policies at school, curricular activities include learning activities in the classroom where teachers integrate ESD into the learning process, while non-curricular activities are activities carried out outside the classroom such as implementing a school environmental cleanliness program, conducting extracurricular activities for sustainable development, and providing information to the community around the school environment about sustainable development. While the dependent variable in this study is the achievement of cognitive abilities and sustainability awareness profiles of students who study environmental pollution material integrated with ESD.

The population in this study were grade VII students in the 2024-2025 academic year at a private junior high school in Bandung City. From two classes, one class was selected using convenience sampling from the existing population. Convenience sampling was used due to its ease and convenience in selecting samples without the need for random sampling, thus making it non-probability (Etikan et al. 2020). This technique resulted in class VII-B, consisting of 20 students, being the sample. The data collection uses 3 research instruments, as follows:

Table 1. Research Instrument Matrix

Instrument's Shape	Objective	Data Collection Techniques	Data Processing
Questionnaire	To profile students' Sustainability Awareness	In the form of a questionnaire adopted from a journal,consisting of 15 items	Analyzed using the Guttman Scale
Tes	To see the improvement of students' Cognitive Abilities.	Test questions are used during the pretest and posttest.	The test instrument was analyzed using normalized n gain and t-test.
Observation sheet for the implementation of the Problem Based Learning (PBL) learning model with the ESD (Education for Sustainable Development) approach based on local wisdom	To determine the implementation oflearning and student responses	Observation by three observers using a checklist sheet	Indicators that are implemented are given a score of 1 and indicators that are not implemented are given a score of 0. Then calculate the percentage of implementation of Problem Based Learning (PBL) with the ESD (Education for Sustainable Development) approach at each level using the equation $M = \frac{obtainedscore}{totalscore} x100\%$

The instruments used are tested first to determine whether the instruments to be used in the research are suitable or not. The instrument used to profile Sustainability Awareness attitudes used a questionnaire adapted from a journal, so no revalidation was required. The instrument used to measure cognitive ability improvement used a multiple-choice test. Therefore, the validity of the multiple-choice test was tested by a team of experts, consisting of lecturers. The expert validity results were deemed appropriate for all questions after several revisions.

The analysis of the test item validity obtained 20 questions (100%) with good validity category. For the level of difficulty obtained 11 questions (57%) with the difficult category, 9 questions (43%) with the medium category. Meanwhile, for the discriminatory power obtained 8 questions (38%) with the good category, 11 questions (52%) with the sufficient category and 1 question (10%) with the poor category. For the discriminatory power with poor quality, the questions were replaced. Based on the analysis of the test results that have been carried out, there are several questions that must be improved to be adjusted to the validity of expert opinion.

RESULTS AND DISCUSSION

This section will outline the findings, including cognitive abilities and sustainability awareness profiles. The discussion will analyze the relationship between the findings and the characteristics of the learning process, and then provide recommendations for further research related to cognitive abilities and sustainability awareness profiles.

The Problem Based Learning (PBL) learning model with ESD (Education for Sustainable Development) integration based on local wisdom aims to shape students' character according to the values in character education and the demands of the 21st century. The characters that are expected to be inserted through the ESD character learning model are: religious, honest, tolerant of diversity, discipline, hard work, creative, independent, democratic, curiosity, spirit of nationalism, love of the homeland, achievement, communicative, love of peace, love of reading, care for the environment, care for society and responsible. The syntax of the ESD learning model is presented in Figure 2

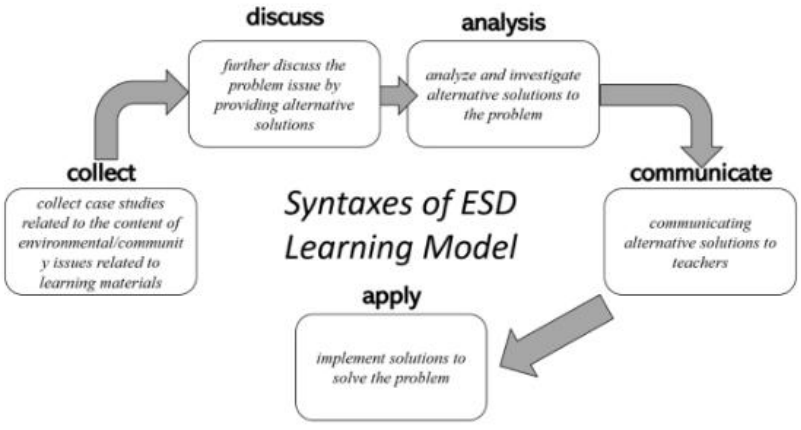

Figure 2. Syntaxes of ESD Learning Model

The ESD character learning model has characteristics and limitations, which are described below: 1) The ESD character learning model can only be applied to materials that have characteristics that can be linked to everyday life (contextual) and are in accordance with the topics in the concept of sustainable development, namely society, economy and environment;

2) Aims to form attitudes and characters so that it does not directly aim to improve aspects of knowledge or skills, although in its implementation and assessment, aspects of knowledge and skills are still inserted; 3) Can only be applied to exact subjects (natural sciences and their fields); and 4) Can be one of the learning models to teach the concept of character education and the concept of education for sustainable development.

The implementation of Problem Based Learning (PBL) with the integration of ESD (Education for Sustainable Development) based on local wisdom in classroom learning was carried out by three observers. The observers were given an assessment sheet and previously coordinated what they should assess and observe to avoid misunderstandings. The assessment sheet was in the form of a checklist sheet where if the learning activity was implemented, a checklist was placed in the assessment column. The observation sheet filled out by the three observers showed the extent to which learning with Problem Based Learning (PBL) with the integration of ESD (Education for Sustainable Development) was implemented. The percentage of implementation of Problem Based Learning (PBL) with the integration of ESD (Education for Sustainable Development) based on the observation sheet is shown in Tables 2 and 3.

Table 2. Recapitulation of Percentage of Teacher Activity Implementation

PBL	Meeting 1		% KM	Meeting 2		% KM	Meeting 3		% KM	%KM Total
	IS	OS		IS	OS		IS	OS		
Introduction	4	4		2	1		1	1		
Student orientation to problems	1	1		1	1		1	1		
Organizing students	2	2		1	1		1	1		
Guiding individual and group investigations	2	1	91%	2	2	88%	1	1	100%	93%
Develop and present work results	1	1		1	1		1	1		
Analyze and evaluate the problem solving process	1	1		1	1		1	1		
	11	10		8	7		6	6		

Notes:
IS: Ideal Situation
OS : Observation Situation

Based on table 2 regarding the implementation of Problem Based Learning (PBL) learning activities with ESD (Education for Sustainable Development) integration carried out by teachers with a total percentage of 93% included in the category of almost all learning activities implemented. Learning activities that support students' cognitive abilities are when the teacher asks students to watch a video about renewable energy related to the possibilities that will occur in the future regarding energy for the lives of living creatures which hone the ability to remember (C1), understand (C2) and analyze (C3) which is accompanied by guidance activities for experimental activities.

Table 3. Recapitulation of Percentage of Student Activity Implementation

PBL	Meeting 1		%KM	Meeting 2		%KM	Meeting 3		%KM	%KM Total
	IS	OS		IS	OS		IS	OS		
Introduction	4	3		2	2		1	1		
Student orientation to problems	1	1		1	1		1	1		
Organizing students	2	2		1	1		1	1		
Guiding individual and group investigations	2	1	82%	2	1	88%	1	1	100%	90%
Develop and present work results	1	1		1	1		1	1		
Analyze and evaluate the problem solving process	1	1		1	1		1	1		
	11	9		8	7		6	6		

Notes:
IS: Ideal Situation
OS : Observation Situation

The overall student implementation of Problem Based Learning (PBL) activities with ESD (Education for Sustainable Development) integration was 90%, meaning that 90% of the learning activities were carried out well. The learning activities were conducted over three meetings with different concepts and linked to existing problems in society.

Cognitive Ability Improvement was tested using a normalized n-gain and a paired sample t-test because it tests two correlated samples. Before conducting the normalized n-gain and t-test, a normality test was performed to determine whether the distribution of pretest and posttest data was normal or not. The normality test used in this study was the Kolomogorov-Smirnov statistical test with a confidence level of 0.05. The following data from the normality test can be seen in Table 4.

Table 4. Kolmogorov-Smirnov Normality Test Results for Pretest and Posttest Data

Data	$\bar{X}$	s	α	D_{hitung}	D_{tabel}
Pretest	29	8,16	0,05	0,17	0,174
Posttest	77,4	9,12		0,14	

Cognitive Ability data before the implementation of the Problem-Based Learning (PBL) model with ESD (Education for Sustainable Development) integration is normally distributed at a confidence level of 0.05. Second, because $D_{hitung} < D_{tabel}$, the distribution of Cognitive Ability data after the implementation of Problem-Based Learning (PBL) with ESD (Education for Sustainable Development) integration is normally distributed at a confidence level of 0.05. After it was known that the pretest and posttest data were normally distributed, the data were tested using the t-test and normalized n-gain to see the increase in Cognitive Ability.

Based on the n-gain value of the increase in Cognitive Ability, the n-gain value was 0.68 with a "moderate" category. So it can be said that students' Cognitive Ability increased after the application of the Problem Based Learning (PBL) learning model with the integration of ESD (Education for Sustainable Development) with a moderate category. In accordance with what has been done previously entitled "Application of the PBL Learning Model to Improve

Students' Cognitive Abilities and Critical Thinking Skills on the Concept of Elasticity and Hooke's Law 1 at Unggul Harapan Persada State High School" (Muslim, 2020) that by applying the PBL learning model can improve students' conceptual mastery and critical thinking.

The cognitive abilities to be provided are at level C1 for remembering, C2 for understanding, C3 for applying, and C4 for analyzing. The average N-gain results for all cognitive abilities from C1 to C4 are shown in Figure 3.

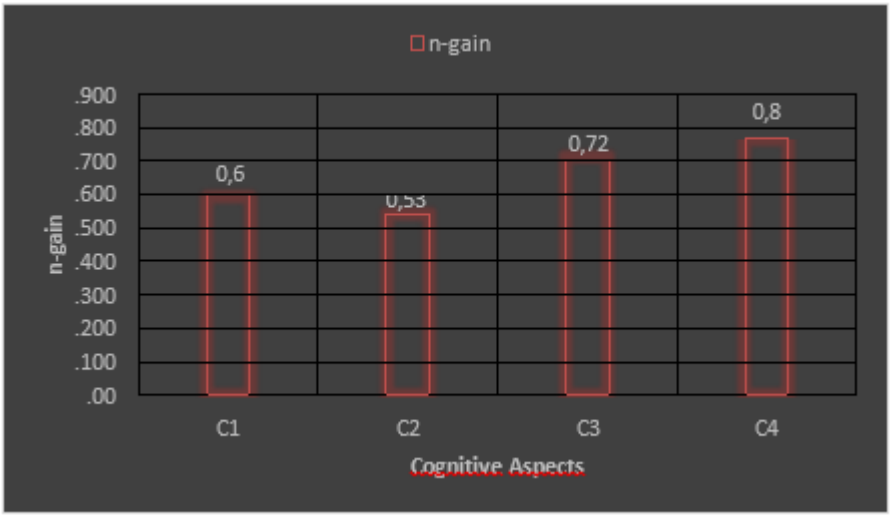

Figure 3. N-gain value diagram of Cognitive Ability for Each Cognitive Domain

Based on the N-gain value for Cognitive Ability, the highest score is 0.8 in the cognitive domain C4, analytical ability, and the lowest score is 0.53 in the cognitive domain C2, understanding ability. This is due to the integration of ESD focused on analyzing environmental issues based on three aspects of ESD: social, economic, and environmental. This aligns with previous research conducted by Muslim (2020) that found that students' analytical skills improved after learning activities using Problem-Based Learning (PBL). Wardana (2022) showed that students who received the PBL model had higher-order analytical thinking skills and a better understanding of physics concepts. Mardana (2011) demonstrated that the PBL model resulted in improved students' critical thinking skills.

To determine the profile of students' Sustainability Awareness after the learning process, a questionnaire was used. The questionnaire used was adopted from a journal entitled "The status on the level of environmental awareness in the concept of sustainable development among secondary school students." The number of statement items is 15 which are categorized into 3: sustainability practice awareness, behavioral and attitude awareness, and emotional awareness. Based on the findings of the respondents, who are grade VII students, have a Sustainability Awareness profile with the Emotional Awareness category. The following will display the results in a table 4.

Table 5. Sustainability Awareness Profile Percentage Recapitulation

No.	Pernyataan	Mean	Standard Deviation
1	I read about environmental issues in the mass media	0,83	0,38
2	I care about environmental issues in my area	0,94	0,24
3	I always discuss environmental issues with my friends	0,40	0,50
4	I feel disappointed with the air pollution	1,00	0,00
5	I feel disappointed with the river pollution	0,94	0,24

No.	Pernyataan	Mean	Standard Deviation
6	I value biodiversity	0,91	0,28
7	I care about the smoke coming from vehicles.	0,77	0,43
8	I try to reduce the amount of waste at home by collecting recyclable materials.	0,66	0,48
9	I compost food scraps into fertilizer	0,26	0,44
10	I don't use plastic bags to wrap things	0,37	0,49
11	I turn on the lights at home during the day	0,14	0,36
12	I save on clean water usage	0,94	0,24
13	I convey information about the environment to my family members	0,66	0,48
14	I participated in environmental awareness activities at school	0,80	0,41
15	I am aware of my responsibility towards the environment	1,00	0,00
	Mean Total	**0,71**	

Based on the table above, with a total mean of 0.71, the Sustainability Awareness profile of seventh- grade students is included in the high category. Within Sustainability awareness, there are three categories: Sustainability practice awareness, Behavioral and attitude awareness, and Emotional awareness, as shown in Table 5.

Table 6. Sustainability Awareness Category

Kategori Sustainability Awareness	Very Rarely Done Or Never Done	Rarely Done	Always Done
Sustainability practice awareness	52%	31%	17%
Behavioral and attitude awareness	9%	49%	42%
Emotional awareness	0%	0%	100%

Sustainability Awareness is grouped into 3 categories according to the table above. Based on table 23, the first category, namely Sustainability practice awareness, that this behavior is very rarely carried out by the majority of students, even never done with a percentage of 52%, students who rarely carry out this behavior are 31% while students who always carry out this behavior are 17%. It can be concluded that students have never carried out Sustainability practice awareness behavior. Sustainability practice awareness or conscious efforts and carrying out sustainability are very rarely or even never carried out by students such as discussing environmental issues with friends, composting food scraps into fertilizer, using plastic bags, discussing environmental problems with family and also taking action to overcome environmental problems, all of which are very rarely done by students based on the questionnaire they filled out. This behavior is a characteristic of the attitude that will be shown if someone already understands the concept of sustainability.

Sustainability awareness can support the concept of sustainable education (ESD). Therefore, the results of the Sustainability Awareness profile, which is high, indicate that the students' attitudes in the study support the ESD concept. This is consistent with Hasan (2022) who stated that a high level of Sustainability Awareness can support the ESD concept.

CONCLUSION

Based on the research results, the integration of ESD (Education for Sustainable Development) in the Problem Based Learning (PBL) learning model can improve Cognitive Abilities and Sustainability Awareness profiles. Characteristics of the Problem Based Learning (PBL) learning model with the ESD (Education for Sustainable Development) approach take concrete problems that exist in Sumedang City. Local wisdom-based learning activities for teacher activities are 93%, while for student activities it is 90% with the category of almost

implemented activities, the best in learning activities to build Cognitive Abilities is at the third meeting where students are required to think ahead in efforts to overcome climate change.

Students' Cognitive Abilities after implementing the Problem Based Learning (PBL) model with the ESD (Education for Sustainable Development) approach obtained an average pretest value of 29.1 and an average posttest value of 77.4 with an n-gain value of 0.68 in the moderate category and the increase was also seen using the t-test that Cognitive Abilities increased significantly with a confidence level of 0.05.

The students' Sustainability Awareness profile is divided into 3 categories, namely Sustainability practice awareness with a percentage of 52% which is very rarely done, Behavioral and attitude awareness with a percentage of 49% which is rarely done and Emotional awareness with a percentage of 100% which is always done by students.

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