



Eco-Enzyme Project-Based Learning in the Elementary School: Improving SDGs 12.5 Waste Management Knowledge

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ABSTRAK

Salah satu cara untuk membuat sekolah lebih bersih dan nyaman adalah dengan meningkatkan pengetahuan pengelolaan sampah di sekolah. Berdasarkan analisis masih banyak sampah yang berserakan di lingkungan sekolah dasar, meskipun terdapat materi tentang hak dan kewajiban terhadap lingkungan terdapat pada materi pembelajaran di kelas. Berdasarkan analisis bahwa kurang bervariasi model pembelajaran yang digunakan pada saat pembelajaran meningkatkan kemampuan pengetahuan pengelolaan sampah pada materi hak dan kewajiban terhadap lingkungan. Tujuan penelitian ini adalah menganalisis peran model pembelajaran project-based learning (PjBL) Eco-enzyme terhadap peningkatan pengetahuan pengelolaan sampah SDGs 12.5. Rancangan penelitian yang diterapkan adalah true eksperimen menggunakan kelas lima yang terdiri dari dua kelas yaitu kelas 5A berperan menjadi kelas eksperimen dan kelas 5B berperan menjadi kelas kontrol. Teknik pengumpulan data yang diterapkan adalah Wawancara, tes, dan dokumentasi. Teknik analisis data yang digunakan adalah uji paired t-test dan uji koefisien determinasi. Hasil penelitian menunjukkan bahwa model pembelajaran project-based learning (PjBL) Eco-enzyme berperan terhadap peningkatan pengetahuan pengelolaan sampah SDGs 12.5 berdasarkan hasil uji paired t test dan koefisien determinasi, peningkatan yang signifikan pada hasil posttest pengetahuan pengelolaan sampah SDGs 12.5 pada kelas eksperimen sebesar 81,6%. Dapat disimpulkan bahwa model pembelajaran project-based learning (PjBL) eco-enzyme berperan terhadap peningkatan pengetahuan pengelolaan sampah SDGs 12.5.

ABSTRACT

Improving school waste management knowledge is one way to make schools cleaner and more comfortable. Based on the analysis, there is still much garbage scattered in the elementary school environment, even though there is material about the rights and obligations towards the environment contained in the learning material in the classroom. Based on the analysis, less varied learning models are used during learning to improve waste management knowledge on the material of rights and obligations towards the environment. This study aims to analyze the Eco-enzyme project-based learning (PjBL) learning model's role in improving waste management knowledge of SDGs 12.5. The research design applied is a true experiment using the fifth grade, consisting of two classes, namely, class 5A, which acts as an experimental class, and class 5B, which acts as a control class. The data collection techniques applied were interviews, tests, and documentation. The data analysis techniques used were paired t-test and determination coefficient test. The results showed that the Eco-enzyme project-based learning (PjBL) model played a role in increasing knowledge of waste management SDGs 12.5 based on the results of the paired t-test and the coefficient of determination, a significant increase in the post-test results of waste management knowledge SDGs 12.5 in the experimental class of 81.6%. The project-based learning (PjBL) eco-enzyme learning model increases knowledge of waste management SDGs 12.5.

1. INTRODUCTION

Waste is objects or materials without value, so people throw away these items. Each person's way of disposing of waste is different, causing various impacts and even causing problems. Waste is a major problem that worsens due to population growth (Praimee, 2021; Rahmayani & Aminah, 2021). The increase

in population quantity and rapid economic development are some of the factors causing changes in the increasingly excessive lifestyle of Indonesian citizens; excessive or consumptive lifestyles increase waste production. The increase in population quantity and rapid economic development are some factors. Indonesia is one of the countries experiencing population growth that is very fast compared to other countries. The population size in Indonesia continues to increase year after year, especially in the Indonesia (Fitri & Zahar, 2019; T. Purba, 2022). Every corner of the place visited is always clean of rubbish, including places of learning, namely schools, where teachers and students grow and develop knowledge. Developing knowledge must be in a body condition supplied by food; one of the school facilities is a canteen; the canteen is used to overcome student hunger. In the school canteen, students can buy food from sellers around the school. From this, food waste arises, which, if not managed, will cause problems. In schools, food waste is significantly 19.44%, plastic 14.58-17.93%, solid plastic 3.35%, and other inorganic waste 16.21%. Food waste from classrooms and offices shows that everyone, especially students, always brings food to class and the office (Arazo & Professor, 2015). To improve school cleanliness and comfort, what can be done is to manage school waste well. A bad school environment can cause discomfort and disrupt teaching and learning (Gunawan & Ananda, 2017; Manurung, 2008). Managing waste in the surrounding environment requires sufficient waste management knowledge by SDGs 12.5.

However, despite this, knowledge of waste management still needs to be improved in the school environment. The low level of awareness among the public is caused by a need for more knowledge about the effects caused by waste (Enggara et al., 2019; Sudarsono & Suharsono, 2016). Also, local people believe that their actions have become a habit. Waste management means reducing the amount of existing waste, reusing it, separating it according to its type and characteristics, hoarding, collecting, temporarily storing, transporting, intermediate storage, recycling, energy recovery, disposal, and post-disposal monitoring (Harman & Yenikalayci, 2022). The most important waste management is waste processing through processing processes and landfills (Mahyudin, 2017). The waste produced will have various impacts, both positive and negative. Whether or not the impact of the waste problem is caused depends on the management system. Waste hurts human health and the surrounding environment if thrown carelessly without a good waste management (Marliani, 2015; T. Purba, 2022). The next step is to improve school waste management cleanliness and comfort. Therefore, waste management must be carried out in every circle, one of which is from the education sector.

It is recommended that teachers implement a student-centered learning model to achieve learning objectives well (Umar & Ko, 2022; Widani et al., 2019). Students who are given learning behaviors through a student-centered educational approach show an increase in successfully achieving course learning objectives. Eco-enzyme is a learning model that can be used in the project-based (PjBL) learning process. Project-based learning is a way to focus on aspects of the learning process, not the product (Gulay, 2015). This approach was carefully chosen to show how the current education system should function. A learning model that can improve attitudes, knowledge, skills, and competency is implementing the project-based learning (PjBL) model. The project-based learning model is implemented to achieve competency in attitudes, knowledge, and skills (Fathurrohman, 2015). Project-based learning is a modern teaching method aimed at students, correlating the experiences students have with school life and encouraging students to think critically when acquiring new information (Bani Issa & Khataibeh2, 2021; G. F. Purba et al., 2022). Students are expected to gain meaningful knowledge by using real-life projects. Project work significantly improves communicative competence because PBL involves students in real-life tasks (Secundaria et al., 2022). In determining the learning model, it must be adjusted to the learning objectives. This research uses the Eco-enzyme project-based learning (PjBL) model. Students must be given freedom in creating the project, but it must be on the learning topic to create a project and produce good results. The project-based learning model (PjBL) is used because it allows students to create projects more freely, develop learning independently, be more real, and achieve better results (Sholekah, 2020). All learning models have their respective strengths and weaknesses to complement each other. One of the areas for improvement of the PjBL model is that classroom conditions could be more conducive during the project, which makes students noisy and requires teacher expertise to manage the class well. Students need help gathering information (Suciani et al., 2018). The project-based learning model has many advantages, such as increasing students' motivation to learn, improving their problem-solving skills, increasing their ability to solve more complex problems, and encouraging students to collaborate (Melinda & Zainil, 2020)

One of the efforts to manage waste in Indonesia is by including it in the sustainable development of the Sustainable Development Goals (SDGs), a national and world program. Sustainable Development Goals (SDGs) with interconnected targets can only be achieved if their interactions are considered (Urbancic, 2022). The Sustainable Development Goals (SDGs) range from education to waste management. The Global Goals consist of 17 sustainable development goals (SDGs) that were agreed upon by UN member states in 2015 and aim to improve welfare indicators by 2030 (Pasara, 2021). Each sustainable development

goal (SDG) has its focus and indicators. The 12th Sustainable Development Goals (SDGs) state that responsible consumption and production ensure sustainable production and consumption patterns. Point 12 consists of 8 targets; in this research, the focus is on target 12.5, which, by 2030, will seriously reduce waste production through prevention, reduction, recycling, and reuse (Bappenas, 2015).

Waste management in elementary schools will be very appropriate if it starts from the basic education sector. Education is the key to achieving all the other SDGs (Chandir, 2021). One effort to realize the SDGs 12.5 program is by making environmentally friendly products in the form of eco-enzymes for elementary school children. Making eco-enzymes is an activity that utilizes organic waste that is no longer used. Eco-enzyme is a liquid produced from the fermentation of organic waste, such as the remains of fruit and vegetables that have not yet rotted (Budiyanto et al., 2022; Rizkita et al., 2023). There are many ways to process waste that can be used for organic and inorganic waste. One of the best methods for converting organic waste into environmentally friendly products, namely eco-enzymes, is to reduce the volume of waste produced, especially in the food waste (Galintin & Rasit, 2021). Making eco-enzymes is the same as making compost by using organic waste. The principle of making eco-enzymes is by adding water as a growth medium. The resulting liquid is easy to use and benefits (Natasya et al., 2023; Prarikeslan et al., 2023). Every waste management method produced always has various functions, including eco-enzymes. Eco-enzymes can function as antifungal, antibacterial, and insecticidal agents. This liquid can also be used as a cleaner, for example, eco-enzyme from orange peel (Ismail et al., 2023; Muliarta, 2021). Fresh fruit and vegetables (FFV) account for part of the food waste thrown away worldwide, accounting for 60% of all food waste worldwide, making the issue of food waste even more important. In the eco-enzyme production project, students can understand their rights and obligations towards the waste produced and how to convert organic waste into useful products (Low et al., 2021).

There is research that is in line with this research regarding the use of Eco-Enzyme Project-Based Learning (PBL) to develop children's listening and speaking abilities, which states that there is an increase in the listening and speaking abilities of children in age group B in DKI Jakarta for the 2022-2023 school year on the influence eco enzyme project-based learning model (Silitonga & Susanti, 2023). The next research that is in line is research regarding assistance with waste utilization project-based learning in schools through training in making eco-enzymes for teachers at SMAN 3 Tidore Islands City, which obtained the results that as many as 96% of teachers felt they had received benefits and knowledge about learning biology, eco-enzyme technology, Apart from that, understanding the implementation of the STEM approach and Biology Lab management, as well as socializing the dangers of waste and waste management to students, which is a request from the school (A R Tolangara, Sundari, Suparman, 2020). Further research that is in line is about project-based learning training with eco-enzyme activities to support the implementation of the independent curriculum, which found that the activities provide teachers with an idea of how to carry out project-based learning with eco-enzyme activities as part of the use of waste so that they can provide experience real learning for students (Noerviana et al., 2023). This research aims to see and analyze the eco-enzyme Project Learning (PjBL) learning model's role in waste management knowledge. SDGs 12.5 The Project Learning (PjBL) model provides students with direct experience in solving waste problems by working on projects to make environmentally friendly products Eco-enzyme.

2. METHOD

This research utilizes a quantitative approach using experimental techniques. The experimental method is productive and is most often chosen (Sugiyono, 2017). Experimental research methods to determine the effect of treatment on others must be in conditions that can be controlled, and this research method is a quantitative method with the presence of control and experimental groups (Dessy Wiranti et al., 2017; Putri & Fitria, 2021). This research uses a real experimental design consisting of two classes used during research, two classes acting as experimental classes and the other acting as a control class; this research was conducted at SD Kragilan 1, which is located in Serang Banten V for the 2022/2023 academic year. The data that has been collected uses interview data, tests, and documentation. Interviews were conducted to find out the learning process activities, while the tests in this study used two tests, namely, a pretest and a post-test, in the two classes used in the research. This research used tests to determine how big a role the eco-enzyme project-based learning model plays in waste management knowledge. Tests will be given at the beginning and end using multiple-choice tests. Documentation is a way to collect data indirectly aimed at research subjects. Documentation is a picture of activities during the learning process. The research instrument grid during the pretest and post-test can be presented in Table 1.

Table 1. Measuring Tool or Instrument Grid

Variable	Main Material	Basic Competencies	Indicator	Cognitive	Question Number
Variable Y knowledge of SDGs waste management	By reading the text and listening to the teacher's explanation, students can differentiate their rights, obligations, and responsibilities as citizens regarding the waste produced.	3.2 Understand the rights, obligations, and responsibilities as citizens in everyday life	3.2.1 Students can understand responsibility in everyday life by analyzing the types of waste (Organic and Inorganic) produced.	C4	2,4,5
			3.2.2 Students can categorize types of waste (Organic and Inorganic) as a form of exercising their rights and obligations to manage waste daily.	C5	1,3,6,7,8
		4.2 Explain the rights, obligations, and responsibilities as citizens in everyday life	4.8.1 Students can analyze their rights and obligations in managing organic and inorganic waste through the SDGs program using the 3R concept (Reuse, Reduce, Recycle)	C4	8,9,10,11,13,14
			4.8.2 Students can categorize rights and obligations in managing organic and inorganic waste by the SDGs program using the 3R concept (Reuse, Reduce, Recycle)	C5	15,12

The data obtained will then be analyzed, but prerequisite tests must be carried out before data analysis. The prerequisite test uses the normality test to determine whether the sample to be used is normally distributed. After that, continue with the homogeneity test to determine whether the variance is the same in the two research groups. After the data is normal and homogeneous, the analysis uses the paired sample test. to determine how much influence the project-based learning model has on increasing knowledge of SDG 12.5 waste management. The paired sample test and coefficient of determination are used to carry out this analysis.

3. RESULT AND DISCUSSION

Result

Data on the influence of the Eco-enzyme project-based learning (PjBL) learning model on knowledge of SDGs 12.5 waste management using pretest and post-test. The working width is used as a reference for teachers to know the extent of the role of the Eco-enzyme project-based learning (PjBL) learning model on SDGs 12.5 waste management knowledge. Learning was carried out in control and experimental classes; each class used as a research sample received a different treatment. The experimental class received treatment using the Eco-enzyme project-based learning (PjBL) learning model, and the control class received treatment using the conventional learning model without varying it with other learning models. In both experimental and control classes, a pretest is carried out at the beginning of learning and ends with a post-test. Both learning activities follow the steps or syntax of each learning model. The following are the average results of the pretest and post-test for both control and experimental classes, which are shown in [Table 2](#).

Table 2. Pretest and Post-Test Results for Control and Experimental Classes

Test Type	Control Class	Experimental Class
Pretest	62	58
Post-test	63	94

Based on [Table 1](#), it is known that the average score for knowledge of SDGs waste management was 12.5 in the experimental class when carrying out the pretest; they got a score of 58 and post-test 94, and the pretest control class got a score of 62 and the post-test got a score of 63. The experimental class achieved the highest post-test score at 94, and the control class scored 63. The SDGs 12.5 waste management knowledge test scores were analyzed using a paired sample t-test with the help of SPSS 22 to determine whether or not there was a role in the influence of the Eco-enzyme project-based learning (PjBL) learning model. The results of the paired sample t-test analysis are shown in [Table 3](#).

Table 3. Paired Sample t-Test Results

Paired Model	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Posttest Control – Posttest Experiment	-33.886	10.023	1.694	-37.329	-30.443	30.443	34	0.000

Based on the analysis results in [Table 2](#), it can be seen that the Sig. on Levene's test is 0.128. So, the scientific writing ability data is homogeneous because the Sig. more than 0.05. Paired Sample t-test analysis can be seen in the assumed equal variance with a Sig (2-tailed) value of 0.000. Because this research uses appropriate hypothesis testing, the significance value (2-tailed) is 0.000. This value is smaller than 0.05 or $0.000 < 0.05$, so the decision can be taken is that the Eco-enzyme project-based learning (PjBL) learning model plays a role in the influence of SDGs 12.5 waste management knowledge. Therefore, the Eco-enzyme project-based learning (PjBL) learning model can be used. To find out how big the role of the Eco-enzyme project-based learning (PjBL) learning model is, it is shown in [Table 4](#).

Table 4. Test Results Coefficient Determination

Model	R	R Square	AdjustedR Square	Std. Error of the Estimate
1	0.904	0.816	0.814	8.150

To find out how big the role of the eco-enzyme project-based learning (PjBL) learning model is on knowledge of SDGs 12.5 waste management with R square, the r-square value = 0.816 from the table above is multiplied by 100%, and a presentation of 81.6% is obtained so that at the end of this research, it can be said that the role of the project-based learning (PjBL) learning model using eco-enzyme is 81.6%.

Discussion

Discussion of the results of data analysis that has been carried out by the project-based learning (PjBL) learning model. Previous studies stated that the project-based learning (PjBL) model improved students' cognitive learning outcomes, as seen from the average test scores. Based on research that has been carried out and strengthened by the opinion above, it can be concluded that the Eco-enzyme project-based learning (PjBL) learning model has a role in increasing knowledge of waste management based on the results of paired t-test calculations and a coefficient of determination of 81.6% (Rafsanjani et al., 2020). By directly putting into practice the manufacture of eco-enzymes using a project-based learning model, the learning atmosphere in the classroom becomes enjoyable. Project-based learning (PjBL) is an innovative, active, and fun type of learning that focuses on projects or activities. Ultimately, PjBL produces real work, such as essays and reports, and completes written assignments (Setyawan et al., 2019). Students can express opinions, ask questions, and make conclusions and answers without shame and fear during the learning process. The learning model teachers apply when providing material to students greatly influences students' ability to understand learning material. Various learning models are available to help students become active so that learning becomes meaningful, one of which is project-based learning. Project-based learning encourages students to participate more actively in activities (Chun et al., 2015).

The research results have increased significantly; this can be seen from the average post-test score of students in the control class, 64, and the experimental class, 98. This increase in scores is, of course, inseparable from the role of implementing the learning model carried out. Apart from that, the teacher's role in delivering material is to follow the steps of the learning model used according to learning outcomes. Eco-Enzyme Project Based Learning (PjBL) is designed so students can practice making a product directly. From the products they make, students can increase their knowledge of learning. The t-paired sample t-test is $t_{count} (30.443) > t_{table} 2.034,52$, meaning H_0 is rejected and H_a is accepted. Therefore, the eco-enzyme Project Based Learning (PjBL) learning model increases knowledge of SDGs 12.5 waste management. Meanwhile, the sig (2-tailed) value is $0.000 < 0.05$. Thus, it is determined that the Project-based learning (PjBL) Eco-enzyme model plays a significant role in waste management knowledge between the experimental and control classes. Next, a coefficient of determination test is needed to determine the magnitude of the influence of the variables X (Free) and Y (Bound). The coefficient of determination test results show an R square value of 0.81 or $KD = 0.81 \times 100 = 81\%$. The eco-enzyme project-based learning (PjBL) learning model has an impact of 81.6% on knowledge of waste management up to 12.5, and other variables influence 18.4%.

There is research that is in line with this research regarding the use of Eco-Enzyme Project-Based Learning (PBL) to develop children's listening and speaking abilities, which states that there is an increase in the listening and speaking abilities of children in age group B in DKI Jakarta for the 2022-2023 school year on the influence eco enzyme project-based learning model (Silitonga & Susanti, 2023). The next research that is in line is research regarding the assistance of waste utilization project-based learning in schools through training in making eco enzymes for teachers at SMAN 3 Tidore Islands City, which obtained the results that as many as 96% of teachers felt they had received benefits and knowledge about learning biology, eco enzyme technology, Apart from that, understanding the implementation of the STEM approach and Biology Lab management, as well as socializing the dangers of waste and waste management to students, which is a request from the school (A R Tolangara, Sundari, Suparman, 2020). Further research that is in line is about project-based learning training with eco-enzyme activities to support the implementation of the independent curriculum, which found that the activities provide teachers with an idea of how to carry out project-based learning with eco-enzyme activities as part of the use of waste so that they can provide experience real learning for students (Noerviana et al., 2023).

The advantage of this research is that it can integrate the government's global program, namely (SDGs) at point 12.5, which aims to reduce waste generation by 2030 significantly, prevention, reduction, recycling, and reuse combined with elementary school material, specifically in the fifth grade, theme 2 about rights and obligations towards the environment by making an eco-enzyme environmentally friendly product using the project-based learning (PjBL) learning model. From this research, students can find out their rights and obligations towards the environment, one of which is by using the waste produced so that there is no accumulation of waste in the school area and using it into an environmentally friendly product in learning activities at school. In this research, there are several limitations in doing so, namely time. Implementing eco-enzyme products is limited, so researchers must adapt to the available time. What must be known is that making this product will take a long time. Carrying out knowledge tests using multiple choice is a concern that children will answer no based on their knowledge.

On the other hand, the limitations of multiple choice questions are related to the type of assessment, usefulness for students, and challenges in writing questions (Yousuf et al., 2022). The main criticism of multiple choice exams is that they encourage superficial learning and memorizing facts. The limitation of

this research is that it only focuses on one institution, namely elementary school education. The recommendations from this research will be for future researchers to raise the topic of SDG 12.5 waste management in all sectors to encourage all communities in Indonesia to manage waste by SDG 12.5.

4. CONCLUSION

This research found that the Eco-enzyme project-based learning (PjBL) learning model influences knowledge of SDGs 12.5 waste management. Based on the research results that have been reviewed, the role of the Eco-enzyme project-based learning (PjBL) learning model increases knowledge of SDG 12.5 waste management. It can be seen from the results of the paired samples test, which shows an influence of the Eco-enzyme project-based learning (PjBL) learning model on knowledge of SDG 12.5 waste management.

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