Vol. 10, No. 4, 2024, pp. 102-109
DOI: https://doi.org/10.29210/020244319

Contents lists available at Journal IICET

JPPI (Jurnal Penelitian Pendidikan Indonesia)
ISSN: 2502-8103 (Print) ISSN: 2477-8524 (Electronic)

Journal homepage: https://jurnal.iicet.org/index.php/jppi

The effectiveness of service learning-esd content in equipping students with problem-solving skills

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Article Info

Article history:

Received Jun 26th, 2024
Revised Jul 05th, 2024
Accepted Sep 29th, 2024

Keyword:

Effectiveness,
Service learning,
ESD,
Problem-solving skills

ABSTRACT

Service learning contains ESD is one of the learning approaches that is suitable for students in the field of science. This research aims to measure the level of students' problem-solving skills. The method used in this study is a quasi-experimental experiment or Quasi Experimental Design, the experimental design used is one group pre-test-post test. The instrument used in this study is in the form of a test consisting of 15 description questions according to five aspects of problem-solving skills. The instruments were given to students in the experimental class and the control class. The results showed that there was a significant influence on the problem-solving skills of students in the experimental class with the medium N-gain category. It can be concluded that through service learning contains ESD, students have better problem-solving skills.

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Introduction

Continuous learning is a process that is based on the goals and principles that underlie sustainability. This is true for all levels and types of education. To provide good education and foster sustainable human beings, ESD supports five learning foundations: learn to know, learn to be, learn to live together, learn to do, and learn to change self and society (UNESCO, 2018). ESD is an important idea for education in the new millennium because it provides a different focus in addressing a number of important elements overall, such as access, skills relevance, and inclusive equity(Kioupi & Voulvoulis, 2019).The theory of Educational Structural Design (ESD) focuses on the systematic and planned structural design of education with the aim of enhancing learning effectiveness. This theory encompasses various aspects such as learning objectives, materials, teaching methods, and evaluation, all designed comprehensively to achieve optimal learning outcomes. In practice, ESD emphasizes the importance of needs analysis, planning, implementation, and evaluation in the educational process (Johnson & Salas, 2023). ESD also involves learning skills, perspectives, and values that encourage the search for sustainable ways of living. The implementation of ESD is a challenge so it is necessary to refocus the curriculum and educational models to consider students as beings who operate and, at the same time, are part of local and global communities (Handtke et al., 2022).

Recent research indicates that the application of ESD can improve the quality of learning in various ways. First, ESD helps in formulating clear and measurable learning objectives, making it easier for educators and students to understand what needs to be achieved. Second, with a systematic design of learning materials,

ESD ensures that each topic taught is relevant and well-organized, facilitating deeper understanding by students. Third, ESD promotes the use of varied and interactive teaching methods, which can enhance student engagement and motivation (Kim & Reeves, 2023). Additionally, the structured evaluation in ESD allows educators to effectively measure student progress and provide constructive feedback. This helps in identifying students' weaknesses and strengths, so learning strategies can be adjusted to meet individual needs. Case studies in several educational institutions show that schools implementing ESD experience significant improvement in student learning outcomes compared to those that do not implement it (Wang & Hannafin, 2022).Transformative refers not only to educational thinking and practice, but also to how education can transform learning into something more transformative. As a result, ESD does not only teach the knowledge and principles of sustainability(Poza-Vilches et al., 2019).Education for Sustainable Development (ESD) has become a key focus in global efforts to create a more sustainable society. In the context of higher education, the application of ESD is often carried out through various innovative learning methods, one of which is community service-based learning or known as service learning.

Service learning is one of the active educational strategies, this strategy is based on the idea that students will learn better if they directly apply their knowledge to improve real-life situations (Resch & Schrittesser, 2023).For this reason, activities in the community are designed to overcome challenges in the perspective of social justice. Service education cannot be considered without the active participation of students in service. Subsequent reflection exercises meet the actual needs of the community (Martín-Sánchez et al., 2022).A key characteristic of service learning is real-world student learning and civic engagement, and therefore generates synergies between the development of subject-specific and generic skills, as well as taking on social responsibility(Johannisson & Hiete, 2021).

Service learning contains ESD not only enriches the student learning experience, but also contributes to the development of a more sustainable society. However, one of the main challenges in higher education is how to ensure that students not only acquire theoretical knowledge, but also develop practical skills that are relevant to real-world needs. Problem-solving skills are one of the key competencies that are indispensable in various fields of work. In the context of developing problem-solving skills, several teaching methods have been identified as the most effective based on recent research. These teaching methods not only focus on the transfer of knowledge but also on the development of critical and analytical thinking skills essential for problem-solving (Azer, 2023). Problem-Based Learning is one of the most recognized effective methods for enhancing problem-solving skills. PBL involves students in the learning process by presenting them with real-life problems that require solutions. In this process, students are encouraged to conduct investigations, gather information, and work in teams to find appropriate solutions. Research indicates that PBL not only enhances analytical and critical skills but also improves students' teamwork and communication abilities (Barrows, 2022).

Additionally, inquiry-based method is also effective in developing problem-solving skills. In this method, students are encouraged to ask questions, conduct experiments, and discover answers independently or in groups. This method promotes active research and nurtures their curiosity, which is crucial in the problem-solving process. Studies show that inquiry-based learning can enhance students' abilities to think logically and systematically (Kuhlthau et al., 2023). Cooperative learning involves group work where students help each other to achieve common learning goals. This method is effective in improving problem-solving skills as it allows students to share ideas, discuss solutions, and learn from each other's perspectives. Cooperative learning also helps students develop social and emotional skills essential for effective collaboration and communication (Johnson & Johnson, 2023).Therefore, it is important to evaluate how effective ESD-loaded service learning is in equipping students with the problem-solving skills needed.So far, the Tadris Biology Study Program at Islamic-based universities has not made any contribution in helping to deal with pineapple waste in Tangkit Baru Village. This is due to a lack of guidance on problem solving skills. Meanwhile, basically universities are not ivory towers separated from the community.

Based on this presentation, it is known that problem solving skills are really needed by students because they can be used to solve real problems faced in the present and future. It is hoped that these environmental problem-solving skills activities will improve students' problem-solving abilities.This approach encourages students to tackle real-world problems within the context of their learning, promoting deep understanding and application of knowledge in relevant situations. Several studies have successfully demonstrated the benefits of PBL, not only in developing analytical and critical skills but also in fostering collaboration among students. Recent research indicates that PBL not only improves students' knowledge acquisition but also enhances their ability to solve complex problems and formulate creative solutions. Studies also highlight that PBL can boost students' intrinsic motivation and prepare them for real-world situations that require critical thinking and effective collaboration (Hmelo, 2023). PBL continues to evolve in current educational practices. This method

is implemented across various educational levels and disciplines. The implementation of PBL often involves the use of technology to support collaboration and data collection, enhancing students' learning experiences in response to real-world challenges (Savin & Howell, 2023). The novelty of this research is that research was conducted on implementing a service learning program with ESD content in plant ecology lectures which had never previously been researched.

Problem-solving skills are high-level cognitive abilities, the problem-solving thinking stage after the evaluation stage which is part of Bloom's cognitive stage (Afrida & Handayani, 2018).Problem-solving skills are essential abilities that must be possessed by students to face various challenges in the modern era. These skills include the ability to identify problems, analyze information, develop creative solutions and implement those solutions effectively. In the context of ESD, problem-solving skills also include the ability to consider the social, economic and environmental impacts of any proposed solution. Although many educational programs have included ESD elements in their curricula, there is still a gap between the theory taught in the classroom and the practical application in the field. Service learning offers a solution to overcome this gap by integrating academic learning and community service. Through hands-on experience in real-life projects, students can develop a deeper understanding of sustainability issues and strengthen their problem-solving skills.

This study aims to evaluate the effectiveness of Service learning contains ESD in equipping students with problem-solving skills. The main focus of this research is to understand how service learning experiences can affect students' ability to face and solve complex problems, both in academic contexts and in real life. Thus, this research is expected to make a meaningful contribution to the development of higher education curricula that are more responsive to global sustainability challenges and 21st century skills needs.

Method

This study uses the Quasi Experimental Design method. Quasi Experimental Design is an experimental design that is carried out without randomness, but involves placing participants into groups (Crewell, 2015). The experimental design used is one group pre test-post test. The design of the one group pre-test-post test was measured using a pre-test conducted before being treated and a post-test conducted after being treated. To carry out this method, research is carried out on one class and the existence of pre-test and post-test can provide a difference before and after the treatment is given. The purpose of the author using this research method in service learning contains ESD is to find out the extent of the effectiveness of the application effectiveness of service learning contains ESD in containing students with problem-solving skills.The research design is presented in the Table 1.

Table 1. Nonequivalent Control Group Research Design

Class	Pretest	Treatment	Postest
Experiment	O_1	X_1	O_2
Control	O_1	-	O_2

(Crewell, 2015)

Information:
O_1: pretest problem solving skills before learning activities
X_1: using service learning with ESD content
- : using learning methods that are commonly used
O_1: posttest problem solving skills after learning activities

This research was carried out at one of the Islamic-based universities in Jambi City for students in 2024. The instrument used in this study, namely the problem-solving skills test, consists of five aspects according to Heller and Heller (2010). The following is presented a table of aspects of problem-solving skills.

Table 2. Aspects of Problem-Solving Skills

No	Aspects	Question Number	Number of Questions
1	Focus on the problem	1a, 2a, 3a	3
2	Describe problem	1b, 2b, 3b	3
3	Plan the solution	1c, 2c, 3c	3
4	Use a solution to solve problems (execute the plan)	1d, 2d, 3d	3
5	Evaluate solution	1e, 2e, 3e	3

The effectiveness of problem-solving skills was measured by using questions according to the five aspects used. The results of student work are assessed according to the assessment rubric, to be further analyzed. The results of the analysis were converted using the N-gain category of problem solving skills.

Results and Discussions

The test used in this study serves to determine the effectiveness of students' problem-solving skills. The test consists of 15 questions representing five aspects of problem-solving skills. The data on the results of the student problem-solving skills test using the ESD-loaded service learning approach are presented in Table 3.

Table 3. Results of Pretest and Posttest Problem-Solving Skills

Class	Pretest		Posttest	
	Experiment	Control	Experiment	Control
Average	21,99	18,77	62,69	32,37
Highest Score	38,33	31,67	80,00	51,67
Lowest Score	11,67	11,67	55,00	16,67
SD	7,41	6,14	9,67	13,39

Based on Table 3, it can be seen that the average pretetst result in the experimental class is slightly larger than that of the control class. After the application of service learning contains ESD and control classes, the experimental class obtained an average postest score for problem-solving skills of 62.69 while the control class was 32.37. This shows that the average score of the experimental class exceeds the average score of the control class. The average results regarding the improvement of problem-solving skills can be seen in the N-gain value presented in Figure 1.

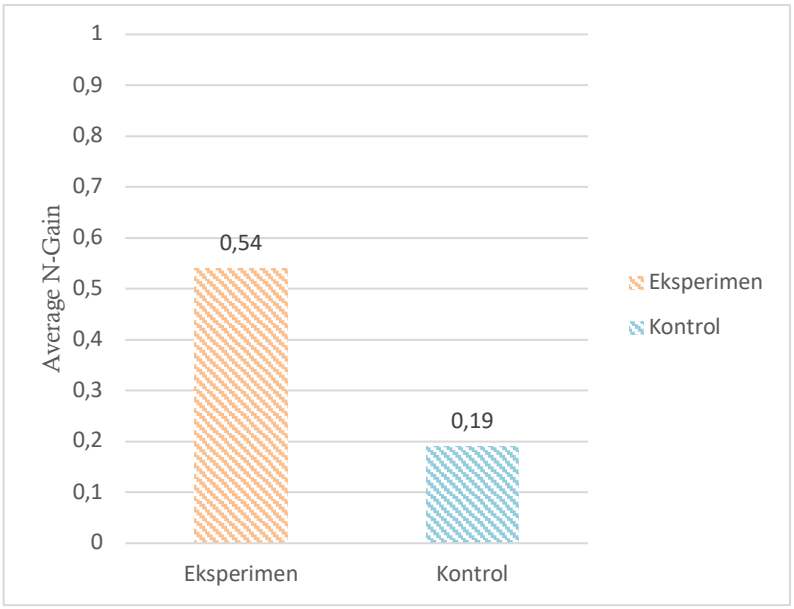

Figure 1. Average N-Gain Problem-Solving Skills

The improvement of problem-solving skills in the experimental class was in accordance with the average N-gain result of 0.54 with the medium category. The score of the experimental class was greater than that of the control class which had a value of 0.19 with a low category. This shows that the increase in N-gain in the experimental class is more significant compared to the control class. The results of this increase in N-gain are in accordance with the category set by Meltzer (2002). Therefore, the improvement of problem-solving skills in the experimental class is in the medium category and the control class is in the low category.

In addition to using N-gain to measure the improvement of problem-solving skills, it is also important to test the significance of the difference in the improvement of problem-solving skills after the application of learning in the experimental and control classes. The steps to test the hypothesis were carried out by conducting a normality test on the average N-gain in both classes. If the data shows a normal distribution, then a parametric test such as an independent sample t test is performed. However, if the data is not distributed normally, a non-parametric test such as the Mann-Whitney test is carried out. For the normality test of

problem-solving skills data, the Shapiro-Wilk test was carried out through SPSS 26 software with a significance criterion of > 0.05 which showed normal distributed data. The results of the normality test analysis between the experimental and control classes are presented in Table 4.

Table 4. Normality Test of Problem-Solving Skills

Test of Normality			
Class	Shapiro-Wilk		
	Statistics	Df	Sig.
N-gain Experiment	0,655	26	0,000
N-gain Control	0,944	19	0,308

*. This is a lower bound of the true significance
a. Liliefors Significance Correction

Based on Table 3, the average N-gain dignifiation value (Sig.) in the experimental class shows a number less than 0.05, indicating that the data do not have a normal distribution. Meanwhile, in the control class, the significance value is greater than 0.05, which indicates that the data is normally distributed. Because there was an abnormality in one of the data groups, a parametric statistical test was used. Furthermore, after the normality test, the step is to conduct a homogeneity test carried out using the Levene test through SPSS 26 software, a significance criterion of > 0.05 which shows the homogeneity of the data. The results of the analysis test between the experimental class and the control class are presented in Table 5.

Table 5. Homogeneity Test of Problem-Solving Skills

Test of Homogeneity of Variance			
Problem-solving skills	Levene Statistic	Sig.	Information
	1,436	0,237	Homogeneous

Based on Table 5, the significance value obtained of 0.237 is greater than 0.05 (0.237 > 0.05) which indicates that the data is homogeneously distributed. Therefore, the results obtained are data that are not distributed, normal, and homogeneous, so the hypothesis test is carried out using the Mann Whitney Test. The Mann Whitney Test test was carried out using SPSS 26 software. The following is a hypothesis proposed for problem-solving skills.

H_0 : There was no significant difference between the problem-solving skills of experimental groups and control group.

H_a : There is a significant difference between upskilling problem solving of the experimental group and the control group.

Table 6. Results of Student Problem-Solving Skills Hypothesis Test

Test Statistic[a]	
	Problem-Solving Skills
Mann-Whitney U	18,500
Wilcoxon W	208,500
Z	-5,256
Asymp. Sig. (2-tailed)	0,000

a. Grouping Variable: Class

Based on Table 6, the results of the hypothesis test using the Mann Whitney Test can be seen that it is rejected, with Sig. (2-tailed) less than 0.05. So it can be stated that it is accepted, meaning that there is a significant difference between the improvement of problem-solving skills between the experimental group and the control group.H_0H_a

The results of the analysis of the influence of service learning containsESDon students' problem-solving skills showed that there was a significant difference in students' problem-solving skills between the experimental class and the control class. In this study, students were divided into six groups so that it was easier for them to solve problems and design a solution in the Student Worksheet. Students in each group are assigned to design, make and produce a product in the form of pineapple waste innovation which is then presented in front of the class. Learning with service learning contains ESD provides opportunities for students to make new discoveries or explorations by making observations, presentations, and services to the community. Through observation activities, presentations and services to the community can provide meaningful funerals for students so that the learning obtained by students is more useful because students are

directly involved in learning activities. The direct involvement of students in community service activities can increase students' understanding of environmental problems according to the results of observation so that the skills of problem solving obtained become better.

Improving problem-solving skills in environmental materials as an ecological factor is the impact of service learning that is integrated with ESD values (equipped with three stages of service learning). Each stage is carried out with direct/real experience by involving students in solving real waste products, collaborating with groups and developing solutions to pineapple waste problems in real life. According to Maxwell (2013), meaningful service activities are when we are involved in concrete situations that occur in real life. In addition (Mughal & Zafar, 2011), also said that learning is through experience in a process where individuals gain meaningful understanding from the direct experience they experience. In line with the research conducted by Palupi Asti Utami and Ekosari Reoktiningkroem (2018), regarding the influence of service learning strategies based on the problem learning model on students' problem-solving skills with the results of analyzing the average data of pretetst and posttest students' problem-solving skills, there was a significant increase with an N-gain value of 0.32 in the medium category.

According to Jarvis (2004), learning in the field allows students to develop practical skills such as observation, analysis and problem-solving that may be difficult to do in the classroom. Learning through various sources has several advantages for students, including facilitating continuous learning, can produce a deep understanding and concentration on learning topics. This also encourages students to explore more information and produce better learning quality (Chaer et al., 2021). ESD-loaded service learning provides a more challenging and authentic learning experience compared to other learning. In line with the opinion of Yu et al., (2015) as quoted in Zhong and Xu, (2019) that training college students to solve real problems can improve problem-solving skills. The following is an example of a product resulting from a problem solving solution in the field in Figure 2.

Figure 2. Soap, Handsanitaizer, Organic Fertilizerand Probiotic Drink.

Apart from that, the increase in problem solving skills in the experimental class occurred because students were directly involved in the implementation stage during the learning process. They are asked to realize the solution design through product creation. Lecturers guide students in carrying out product design process activities to make products that are useful and have selling value. At the manufacturing stage, students prepare a manufacturing schedule with members of their respective groups outside of learning hours (product manufacturing practicum is carried out as a group at home). They also determine the tools and materials needed, formulate product manufacturing procedures and determine the estimated funds needed. At the product testing stage before carrying out community service activities, students make presentations and directly test finished products such as hand sanitizer, liquid soap, organic fertilizer and probiotic drinks (tepache de pina). After the product is deemed feasible in terms of the composition of tools and materials, Lecturers and students are ready to go to the field to carry out community service activities related to product innovation from pineapple waste. A more intense learning process occurs during this stage and student learning progress is strengthened throughout.

Service learning containsESDhas an effect on improving students' problem-solving skills. This is likely due to the fact that learning in experimental classrooms provides learning experiences that are more challenging and relevant than conventional classrooms. For example, in the experimental class, students are invited to observe pineapple growers directly and make processed products from pineapple waste that can be used and have selling value and collaborate with the community. Meanwhile, in the control class, students learn to find concepts through observation of the surrounding environment. The observation activities used may not be able to determine processed waste products that have a selling value and have not been able to cooperate with the

community. Problem-solving skills according to students to relate their knowledge in solving problems and finding solutions to specific problems. A solution is needed to solve a certain problem using the knowledge, abilities, and understanding gained by students (Rios et al., 2020).

To effectively implement Service-Based Learning that integrates Educational Structural Design (ESD), educators need to be equipped with adequate skills and knowledge. Training and workshops can assist educators in understanding ESD concepts and integrating them into project-based learning oriented towards community service (Savery, 2015). Recommended Training for Educators, the first Understanding ESD Concepts: Educators should be prepared with a deep understanding of educational structural design principles, including needs analysis, learning planning, and systematic evaluation. Second, Project-Based Learning: Training should focus on developing project-based learning skills, where students engage in solving real-world problems relevant to their communities. Third, Project Management Skills: Educators need training in project management, including time planning, resource allocation, and monitoring student project progress. Fourth, Guidance and Feedback: Training should include strategies for providing effective guidance to students in completing their projects and offering constructive feedback to improve the quality of their work (Johnson & Salas, 2023).

Workshop Suggestions for Educators: the first, Curriculum Integration Workshop: This workshop can help educators in designing and integrating service-based learning that incorporates ESD into their curriculum effectively. Second, Project Simulations: Conducting project simulations with real-world scenarios faced by communities can help educators and students understand the practical application of the concepts learned. Third, Case Studies and Discussions: Providing case studies and discussions on the implementation of PBL and ESD in various educational contexts can offer additional insights to educators on effective strategies (Association of American Colleges & Universities, 2021).

Conclusions

Service learning containsESDcan improve problem-solving skills in students with a medium category. There was a significant influence and difference on problem-solving skills between the experimental class and the control class. Suggestions for Further Research To further advance our understanding and application of PBL, future research could focus on the following areas: first,Long-Term Impact: Conduct longitudinal studies to examine the long-term effects of PBL on students' academic achievements, career readiness, and lifelong learning skills. Second, Comparative Studies: Compare the outcomes of PBL with other active learning methodologies to identify the unique contributions and advantages of PBL in different educational contexts. Third, Implementation Strategies: Investigate effective strategies and best practices for implementing PBL across diverse educational settings and disciplines. Fourth, Technology Integration: Explore how digital technologies and online platforms can enhance the implementation and effectiveness of PBL in virtual and blended learning environments.By addressing these research gaps, educators and policymakers can better leverage PBL to promote meaningful learning experiences and prepare students for success in an increasingly complex and interconnected world.

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