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Journal homepage : https://jurnal.iainponorogo.ac.id/index.php/insecta

Article

Improving Contextualized Problem-Solving Skills in 8th Grade Students Through "Digestive System" Problem-Oriented Learning

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Article Info
Article history:
Received: April 7, 2024
Accepted: May 8, 2024
Published: May 15, 2024

Keywords:
Contextual;
Digestive system;
PBL;
Problem-solving ability;
SESD

ABSTRACT
Problem solving ability is one of the competencies that must be achieved by students to reach sustainable development goals (SDGs). There is a need for more appropriate learning methods and education policies in Indonesia to improve literacy and numeracy skills, including problem-solving competencies, which is fundamental in this era of Industrial Revolution 4.0. Science Education for Sustainable Development (SESD) focuses on developing learners' attitudes and competencies to alleviate life and find an innovation that is relevant to a problem. This study investigated whether Digestive System learning designed to be oriented towards contextual problems with SESD-based direct teaching promotes learners' ability to solve contextual problems better than conventional classroom learning. Data collection included assessment with tests on learners' problem-solving skills through quasi-experimental research using a pretest-posttest experimental control group design. The experimental group received learning about the digestive system with a problem-oriented learning model and the SESD approach. The research sample was the VIII grade students of SMPN 4 Ponorogo. The pre-test scores for the experimental and control groups were similar, at 66.4 and 67.0 respectively. However, the experimental group had a higher post-test score of 82.0, while the control group had an average score of 73.0. Supported by Cohen's d analysis of 0.60 shows that problem-based learning (PBL) with the SESD approach is more effective than conventional learning in improving students' problem-solving skills.

INTRODUCTION

The current focus of the Natural Sciences education curriculum in Indonesia is to equip students with sustainable competencies with student-centered learning and democratic, pluralistic learning synergies (Pradipta & Hariyono, 2021). These sustainable competencies include systems thinking skills, anticipatory skills, normative skills, strategic skills, collaboration skills, critical thinking skills, self-awareness skills, and integrated problem-solving skills. It is hoped that students can master the skills above to achieve the goals of sustainable development or sustainable development goals (SDGs) (Purnamasari & Hanifah, 2021). To achieve the competencies expected in Natural Sciences education above, the

Ministry of Education and Culture initiated a new curriculum policy, namely the independent learning policy, where teachers are free to carry out the teaching and learning process, which can create a conducive learning environment and can motivate students in their learning. As one of the consequences of this learning, natural science teachers in Indonesia are required to improve science learning content and the science learning process so that they can provide meaningful learning to students. One of the aims of science learning is to increase students' competence, including the ability to solve problems.

The ability to solve problems is the ability to think by collaborating the skills of critical thinking, analytical thinking, and creative thinking in solving a problem. Problem-solving skills are higher-order thinking skills applied to real-world problems (Makrufi & Hidayat, 2018). Science learning must be able to provide answers to problems that are relevant to natural symptoms or phenomena that change over time. Dogru stated that in the science education environment, one of the main goals of education is to develop critical, logical thinking, and problem-solving competence (Prastiwi & Nurita, 2018). Science learning has achieved the learning objectives perfectly if the student's ability to solve science problems is considered good enough (Novianti et al., 2023).

Based on the results of the Program for International Student Assessment (PISA) in 2022, Indonesia showed a decrease in learning outcomes internationally due to the pandemic but the ranking rose 5-6 positions compared to 2018. The scores that decreased from 2018 were math score 310, science 341, and reading 294. In 2018 Indonesia was in 74th position out of a total of 79 countries math score of 379, science 396, and reading 371 (Hilda et al., 2022). The ability of Indonesian students to solve story problems related to non-routine questions still needs to improve because students still need to understand the problem and look for alternative solutions (Partayasa et al., 2020). It can be seen that there is a lack of suitability in learning methods and education policies in Indonesia in improving problem solving skills. Meanwhile, this ability is basic in the era of the industrial revolution 4.0.

Teachers can measure students' problem-solving abilities by presenting contextual problems to students and seeing how they behave in analyzing and carrying out the problem-solving process. The purpose of raising students' problem-solving skills is to hone, surface, and improve problem-solving abilities in science learning so that they can apply them when facing problems in everyday life. To gain the ability to solve students' problems, fun and innovative learning is needed so that in the problem-solving process, students can be more motivated.

Hudojo, in 2005, put forward the indicators for solving problems, namely identifying problems, planning problem-solving, resolving problems, and interpreting results (Mamin et al., 2018). According to George Polya, 4 steps need to be taken to solve problems, namely the problem identification stage, the problem-solving planning stage, the problem-solving implementation stage, and the re-examination stage of the findings. Meanwhile, according to Dewey's theory, indicators in solving problems include recognizing problems, defining problems, developing hypotheses, testing hypotheses, and implementing the best hypothesis (Zulqarnain & Fatmahanik, 2022). Based on the opinions above, the ability to solve problems can be classified into the following indicators:

a) **Identifying the problem** is the ability to recognize and understand the challenges or problems students face.
b) **Plan problem resolution** is a further step from problem identification, where students begin to plan how the problem will be resolved.
c) **Solving the problem** is the implementation and planning stage made in the previous stage.

Based on observations and brief interviews with science teachers and several students, it is known that science learning at SMPN 4 Ponorogo is still teacher-centered, where the teacher explains the material in front of the class, and the students listen. Apart from that, sometimes learning is also carried out through discussions and presentations by students, and sometimes practical learning is carried out in the laboratory. However, conventional learning still needs to be implemented. The impact of the learning teacher centers what students have done becomes dependent on the teacher's explanation and less able to analyze contextual problems in the test questions they face.

Judging from the results of preliminary test that have been carried out, it is found that the ability of students to solve problems still needs to improve, teaching and learning activities are often teacher-centered. The expected situation from science learning is that students are competent in solving contextual problems that involve understanding scientific concepts, critical, and analytical thinking skills. Conditions in the field show that most students experience difficulty in solving contextual problems involving the application of science concepts in real-world situations. This condition shows the need for effective learning models and approaches to overcome the gaps. This condition is also the basis for developing a problem-oriented learning (PBL) model based on Science Education for Sustainable Development (SESD).

Problem-oriented learning is offered as one of the teaching models that can enhance students' problem-solving skills. The problem-oriented learning model is learning models that relates problems in everyday life to become issues for students and can be used as a means to hone problem-solving skills, critical thinking, and analytical thinking (Amir et al., 2021). Science learning with PBL models is considered suitable for improving the ability to solve science problems in class VIII middle school students. The increase in the ability to solve problems occurs because PBL students are always encouraged to think critically in gathering information that can be used to solve science problems given by the teacher.

There are 5 stages in the PBL model, namely from the student orientation stage to the problem, the stage of organizing students to learn, the investigation guidance stage (can be individual or group), the stage of presenting the results of the investigation, and the evaluation stage of the student's problem-solving process. Through the PBL stages, it is hoped that students' problem-solving abilities can increase, especially in the investigation stage, individually and through study groups.

The PBL model is considered to have several advantages, including being able to encourage students to develop competence in solving real-world problems, having the opportunity to construct their understanding through the learning process, students experiencing scientific activities when conducting group activities, familiar with accessing various sources of information, have the competence to assess their learning abilities, students are familiar with scientific communication activities through discussion activities and presentation of discussion results, and individual learning difficulties of students can be resolved through group discussions (Agustina, 2015).

Several previous studies that discussed increasing students' problem-solving abilities through several innovations in learning activities, including Sulastri & Pertiwi (2020), found that the Problem-Based Learning learning model with a contextual approach can improve the science problem-solving abilities of junior high school students. Roesch et al. (2015) found that ecological learning in complex domains through problem-oriented learning can improve experimental problem-solving abilities and allow for more autonomous students' rights. Partayasa et al. (2020) showed the findings of their research, namely that students' problem-solving skills in mathematics can be improved through the video-assisted creative problem-solving learning model rather than conventional learning.

However, many studies show an increase in students' problem-solving abilities through various learning models, for example, project-based learning (Gao et al., 2021; Makrufi & Hidayat, 2018), TTW learning model (Think, Talk, Write) assisted by web live worksheet (Hidayah & Arif, 2022), Discovery Learning model integrated Reading, Questioning, and Answering (RQA) (Hariyanto et al., 2023), as well as through approaches Concrete Representational Abstract (Malik et al., 2022). Daryanes developed a form of interactive learning media, Articulate Storyline, which can improve students' problem-solving abilities (Daryanes et al., 2023). Similar research was also carried out by Fitriah & Ita (2022), who developed BioPhy magazine, which was proven to improve problem-solving skills and increase environmental awareness.

Because of this reason, the researcher selected the contextual problem-oriented Food and Digestive System subject to be a trial case for a learning context in which different components of problem-solving ability can be improved. The Food and digestive system domains are complex because they cannot be observed directly (by the students' senses) and are influenced by several factors that are not simple. Students are only often given explanations of concepts related to this domain and are not linked to daily lifestyle patterns. Because of this, researchers want to know the impact or influence of a contextual problem-based learning model in Food and the Digestive System material to support science learning for sustainable development (SESD), which has never been raised in previous research.

Danneberg in 2016 argued that ESD learning focuses on developing learners' attitudes and competencies to alleviate life and find an innovation that is relevant to a problem. Science Education for Sustainable Development (SESD) can generate learner competencies in aspects of collaboration between critical thinking, decision making skills based on problem solving, increasing communication competencies, collaboration, conflict management, and planning. The SESD approach is suitable for integration in PBL and can improve 21st century competencies in students, one of which is the competence to solve problems. ESD-based learning tools are proven effective in providing an increase in students' problem-solving competencies in science teaching and learning activities (Pradipta & Hariyono, 2021).

The novelty of this research is the innovative approach that combining problem-based learning (PBL) with the Science Education for Sustainable Development (SESD) approach in the context of the Digestive System in 8th grade students. Therefore, researchers focused on the following issues: "Can the Problem-Based Learning learning model using the Science Education for Sustainable Development (SESD) approach improve the ability to solve contextual problems for class 8 Junior High School students, which includes an understanding or analyzing problems, planning to problem-solve, and carrying out problem-solving that has been planned in the material Food and the Digestive System?"

METHODS

Research design

To obtain valid results in this research, researchers conducted field studies in a classroom environment that students in daily learning activities can use. This design ensures no random assignment of students or teachers to certain learning conditions (Abdullah et al., 2021). Therefore, in the research, the researchers chose the classes to be used through several considerations, including choosing classes with experimental group and control group conditions that were as close as reasonable in terms of size of class, male-female student ratio, as well as class level, and school location. However, the researcher selected a research location in a school that has parallel classes to ensure that the influence of other uncontrollable variables was minimized.

The researcher chose an active involvement in learning in the experimental class, and for the control class, it was left to the subject teacher, who usually handles learning in the class. The study's research questions were examined using a pre-test/post-test quasi-experimental design. This study uses a control group to compare the level of problem solving ability of students in conventional learning with the treatment given to the experimental class.

Experimental Conditions

In the experimental class, students receive learning developed and structured appropriately oriented to contextual problems to create science learning that supports Science Education for Sustainable Development (SESD), validated and approved by previous science teachers. Implementing learning treatments in experimental classes includes variations in learning media, methods, approaches, and selected learning activities. Meanwhile, in the control class, students receive conventional model learning activities from teachers who usually teach science subjects in selected classes. Learning in the control class is not tied to learning media, methods, and learning activities like in the experiment class. The duration of the learning treatment in both experimental and control classes was identical.

Research sample

The research was conducted in two parallel VIII classes at SMPN 4 Ponorogo. The total sample consisted of 64 students in two predetermined classes. The average age of students is 11-13 years, with the percentage of male students at 56%, slightly higher than that of female students at 44%. The percentage of students' gender were similar for both research classes. Research class conditions can be seen in Table 1.

Table 1. Experimental Conditions

Aspect		Experimental conditions	
		Experiment	Control
Specific treatment to increase problem-solving ability		Yes	No
Food and Digestive System topics		Yes	Yes
Sample size (n)		32	32
Age	M	12	12
	SD	0.56	0.58

Note: n, number of test subjects in the partial sample; M, mean value; and SD, standard deviation.

Researchers chose class VIII junior high school students as participants or subjects in the research, which was carried out with the following considerations: the learning material for Food and the Digestive System is contained in the content of the Phase D Natural Sciences independent curriculum, specifically in class VIII of Junior High Schools in the Indonesian education curriculum. Therefore, selecting class VIII junior high school students as research samples is a valid context in terms of curriculum.

Learning treatment

Researchers chose contextual problems as issues that students would analyze because these problems were considered to be 'closer' to the environment and students' lives. The researcher's treatment is intended to encourage students' ability to solve contextual problems and realize sustainable learning. By applying a contextual problem-based learning model with the SESD approach, students are expected to gain knowledge of food content and the digestive system, scientific reasoning, and competence in solving contextual problems.

Issues related to a healthy lifestyle, as well as problems or disorders in the digestive organs that often occur in everyday life and food suitability issues, are the main issues that students will analyze. Through this issue, students can feel and experience awareness of the importance of conducting scientific investigations to investigate the causes and effects of human activities and food choices for the health of the digestive system and for multi-perspectivity and responsibility in making decisions in sustainable development.

Test performance of dependent variable operationalization

Researchers have created and applied written performance tests grounded in traditional test theory to determine competence in solving contextual problems. However, researchers used paper and pencil tests because the sample size was quite large and resources were limited.

The test developed by the researchers consisted of contextual problem-oriented Food and digestive system questions consisting of 9 questions with the following details:

a) Multiple choice questions on Food and the digestive system consists of 6 questions (item numbers 1-6) to measure indicators for identifying problems in the aspects of preventing problems from arising and analyzing the causes of problems; planning problem-solving in the aspects of strategy selection and priority scale determination; as well as carrying out problem-solving in the aspects of implementing steps and complying with the plans developed. This Multiple choice questions uses a 1-4 point rating scale to measure students' problem-solving abilities. In this test, students are asked to choose one answer they think is the most correct from the 4 answer choices available. Each answer choice will get a score of 1-4 according to the level of correctness of the answer.

b) The description test in Food and the digestive system consists of 3 questions, each of which assesses two aspects of the indicator of solving the problem. The indicators measured in the description questions are indicators of analyzing the problem in the aspect of describing the problem and realizing the urgency of the problem, indicators of planning problem-solving in the aspects of plan formulation and strategy selection, well as indicators for implementing problem-solving in the aspects of effective communication and reflection and learning. Each description test item will be given 1-4 points for each aspect according to the suitability of the student's answer to the problem presented.

Research procedure

An instrument for assessing students' ability to solve science problems on Food and the digestive system was developed by researchers by presenting 9 contextual problem-oriented questions. After developing the test instrument, it was administered to the experimental and control class students as a pre-test to measure value. Afterward, the experimental class underwent contextual problem-oriented learning utilizing the SESD approach, while the control class engaged in conventional learning with the subject teacher. After the lesson, the experimental and control groups underwent a post-test to assess their problem-solving abilities. They completed a questionnaire to determine the level of autonomy achieved by the students.

In general, the procedure of this research is divided into three stages, namely the preparation stage, the implementation stage, and the final stage. Each stage is outlined in the research procedure shown in Figure 1.

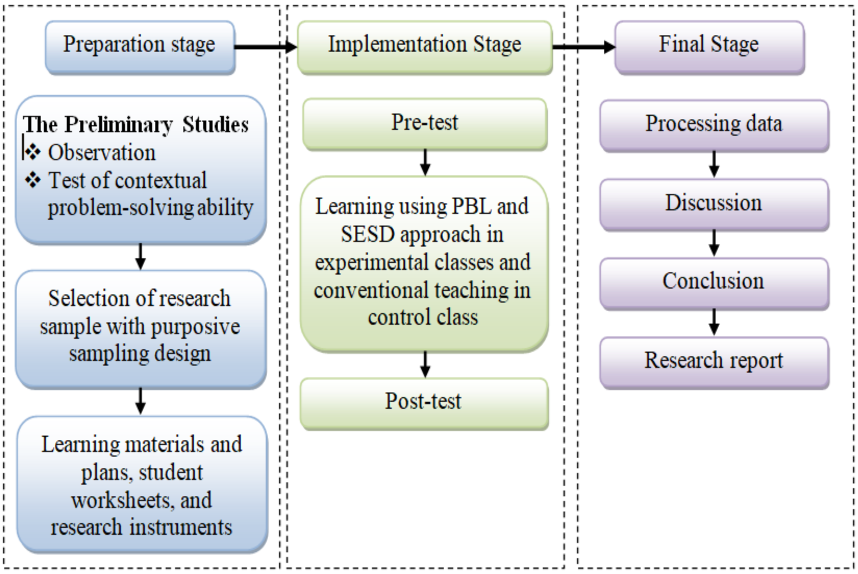

Figure 1. Research Procedure

Data analysis

The research data was statistically processed using IBM SPSS Statistics 25 software and evaluated with parametric tests according to the per-fiat principle using ANCOVA test and supported by Cohen’s d effect size.

RESULTS AND DISCUSSION

Test instruments

Based on the instrument validity test, it is known that the score of Pearson correlation for each item is greater than the r table (0.264), so it can be concluded that each item developed is valid. Moreover, the Cronbach Alpha value is more than 0.8, so the test items are declared reliable. It is shown in Table 2.

Table 2. Instrument Validity and Reliability

Indicator	No. Item	Pearson Correlation	Cr.α
Identify the problem	1	.726	0,900
	2	.734	.899
	7	.701	.901
Plan problem solution	3	.605	.905
	4	.698	.901
	8	.769	.897
Solve the problem	5	.695	.902
	6	.620	.905
	9	.764	.898

Test result

The reliability value was unexpectedly higher in the pre-test when compared to the post-test (refer to Table 3). The internal consistency of the problem-solving ability test subscale is adequate for group comparisons. The moderate internal consistency of specific scales may be attributed to limitations on the number of items per subtest scale.

Table 3. Property Scale

		Measuring time			
		Pre-test		Post-test	
Indicator	No. Item	n	Cr.α	n	Cr.α
Identify the problem	1	190	.900	205	.886
	2	186	.899	203	.889
	7	193	.901	200	.884
	7	192	.901	198	.888
Plan problem solution	3	190	.905	197	.891
	4	200	.901	210	.884
	8	191	.897	197	.883
	8	189	.898	201	.881
Solve the problem	5	189	.902	199	.883
	6	191	.905	199	.889
	9	184	.898	189	.885
	9	190	.902	197	.885

Note: n, total score per question items; and Cr.α, Cronbach's alpha.

Based on Table 3, it is not evident what the value was obtained from items per indicator of problem-solving ability increases from pre-test to post-test. The indicator score for identifying problems in the post-test is higher than the pre-test score for each question item. However, the Cronbach alpha reliability value was higher in the pre-test than in the post-test. The description of the data in Table 3 above shows that the score on each question item during the post-test is higher than the pre-test. This score identifies that implementing learning affects students' abilities to solve contextual problems in Food and the digestive system.

Lesson implementation

Learning activities in the experimental and control classes were carried out simultaneously on Friday, September 22, 2023 during the fifth to sixth lesson hours. The learning material presented was Food and Digestive System material in the Functional Structure of Living Things Chapter.

Learning in the control class was carried out through conventional learning by the science subject teacher who taught the control class. Djamarah argues that conventional learning methods are traditional learning methods or better known as the lecture method (in Kresma, 2014). The following is a description of the core learning activities carried out including teacher and student activities in the control group (see Table 4).

Table 4. Learning Activities of Control Group

Phases	Learning Syntax	Teacher's Activity	Students' Activity
1	Conveys objectives and prepares students	The teacher explains the learning objectives, background information, importance of the lesson, prepares students for learning.	Listen and carry out what the teacher says and instructs.
2	Demonstrating knowledge	The teacher presents the learning material step by step according to the textbooks.	Listening to the learning material presented by the teacher.
3	Guiding research	The teacher plans and guides the activities in the textbook.	Pay attention to the teacher's explanation and do the activities in the package book.
4	Checking understanding and providing feedback	The teacher checks whether the students can carry out the task well, gives feedback to the students.	Following the teacher's instructions during evaluation and reflection.

Learning in the experimental class was conducted using a problem-oriented learning model with the Science Education for Sustainable Development (SESD) approach integrated into the Learner Worksheet by raising the issue of "Health and Food Sustainability for the Future". Amran (2018) mentions several steps in ESD-based learning, namely: a) conduct case studies related to community/environmental problem issues that are in line with the learning domain, b) discuss more deeply related to alternative problem solving, c) analyze alternative problem solving, d) present alternative problem solving in front of the class, and e) apply alternative solutions that have been formulated (Kurnia, 2023). These steps are then integrated with PBL syntax with details of teacher and student activities in the experimental class as follows (see Table 5 and Figure 2).

Table 5. Learning Activities of Experimental Group

Phases	Learning Syntax	Teacher's Activity	Students' Activity
1	Orient students to the problem	Conveying learning objectives and achievements, grouping students into groups, making relevance between previous material and material to be presented, showing authentic problems related to learning material.	Listening to what the teacher says, gathering according to the group formed, asking questions in apperception, reasoning / analyzing the problems raised by the teacher according to the experience of each learner.
2	Organizing students to learn	Assist students in formulating problems, describing techniques to find solutions to problems.	Formulate a problem or limitation of the problem at hand.
3	Guided inquiry (can be individual or group)	Assist students in collecting information or data relevant to the problem, encourage students to carry out experiments to achieve problem solving.	Collect data to support learning, conduct literacy and discussion to carry out investigations.
4	Presentation of investigation results	Assist learners to plan and present the results of the investigation.	Make an investigation report and present it in front of the class.
5	Evaluate students' problem solving process	Provide evaluation of the reflection on the results of students' investigations.	Follow the teacher's instructions in conducting evaluation and reflection.

(Source: Sofyan et al., 2017)

Figure 2. Lesson Implementation in Experimental Group

In Figure 3 below, a sample of the worksheet is presented by the learners. The sample shows the analysis done by learners in dealing with the issues raised in the lesson. It can be seen that learners can collect the desired information and can answer questions with a distinctive analysis style in each group.

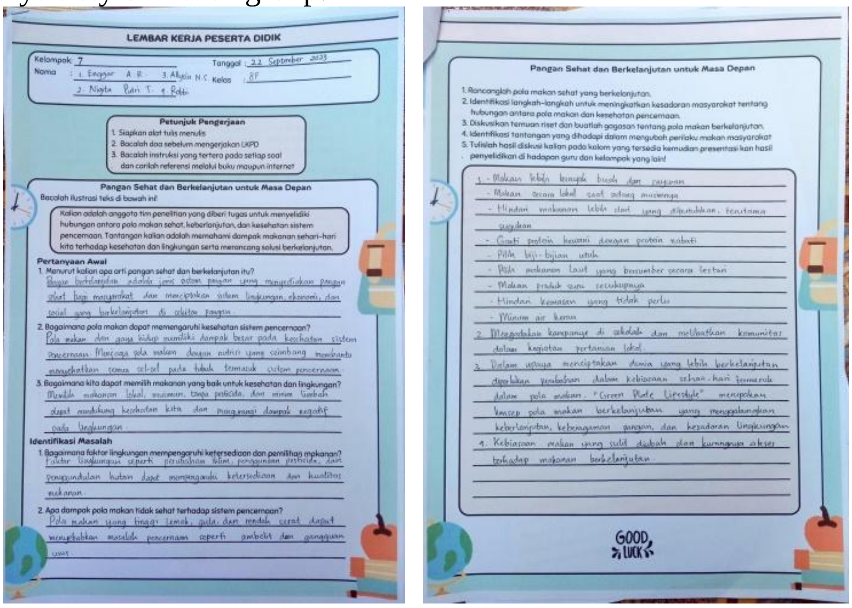

Figure 3. Working Sample of Student Worksheet

Correlation analysis between lesson implementation and result

In accordance with the research results presented in Table 6, it is known that each indicator of problem solving in the control class and experimental class has increased in value. Furthermore, the researcher will put forward each indicator based on its gain score and analyze which learning syntax affects the increase.

Table 6. Gain Score per Indicator

Indicator	Control Grup			Experimental Group		
	Pre-test	Post-Test	Gain Score	Pre-test	Post-Test	Gain Score
Identify the problem	377	382	5	384	424	40
Plan problem solution	385	383	-2	385	422	37
Solve the problem	372	375	3	382	409	27

Based on table 6 above, it can be seen that the gain score of the experimental group is higher than the gain score of the control group. This shows that the treatment given to the experimental group has a better impact than conventional learning on improving students' problem solving skills. Similar to the findings of Pradipta & Hariyono, 2021; Sulastri & Pertiwi, 2020; Amir et al., 2021; Rachmawati et al., 2022; and (Kurnia, 2023), students in the experimental group in the research conducted showed an increase in their curiosity in several ways higher than control group.

In the experimental class, the indicator with the highest gain score is the indicator of analyzing the problem with a score of 40, followed by the indicator of planning problem solving with a score of 37, and the lowest indicator of solving the problem with a score of 27. These improvements are the impact of the learning carried out, especially in the phase of orienting students to the problem. In this phase the teacher directs students to the problem at hand and guides them in reasoning and analyzing the problems that arise so that the ability of students to analyze problems can increase significantly

Hypothesis testing

A MANOVA analysis with subsequent univariate post hoc tests indicates no significant difference between the experimental and control groups of students in general cognitive abilities and Natural Sciences scores. If these variables significantly contributed to the explained variance in competency development, they were included as covariates in the analysis of covariance. The results of the MANOVA analysis showed no significant difference in the ability of the experimental and control groups to solve contextual problems as reported during the pre-test.

Post-test scores for all groups, except for some variables in the control group, were higher on the post-test achievement test than the pre-test (refer to Table 7). These findings indicate that students experience a positive learning effect from taking the test. Additionally, the level of autonomy perceived by students increased following the learning process in both control and experimental classes.

Table 7. Descriptive Statistics and Estimation of Parameters for the Learning Achievement and Personality Tests

			Measuring time				**ANCOVA**	
			Pretest		**Posttest**		**Parameter estimates**	
Indicator	Class	n	M	SD	M	SD	M_b	SE
Identify the problem	Eks	32	3.0	0.8	3.3	0.7	3.5	0.1
	Cont.	32	2.9	0.9	3.0	0.9	3.1	0.2
Plan problem solution	Eks	32	3.0	0.9	3.3	0.8	3,4	0.1
	Cont.	32	3.0	0.8	3.0	0.9	3,2	0.2
Solve the problem	Eks	32	3.0	0.9	3.2	0.8	3.4	0.1
	Cont.	32	2.9	1.0	2.9	1.0	3.0	0.2
Degree of autonomy	Eks	32	2.6	0.9	3.1	1.0	3.5	0.1
	Cont.	32	2.2	1.0	2.6	1.4	2.4	0.1

Note: n, number of test subjects; M, average indicator; SD, standard deviation; mb, adjusted (corrected) mean estimate; and SE, standard error.

To address our initial research query, we utilized ANCOVA with planned comparisons and considered pre-test scores as covariates to examine differences in learning effects between experimental groups based on the directional hypothesis. The experimental group's results were then compared with those of the control group, and we found that pre-test score covariates had moderate to strong effects on explaining the variance of all variables. The hypothesis that there was a significant difference in scores between the experimental group and the control group was confirmed for all test question indicators, as shown in Table 8.

Table 8. Descriptive Statistics of Pre-test and Post-test Scores

			Pre-test		**Post-test**	
		n	M	SD	M	SD
Test scores	Eks	32	66.4	19.4	82.0	13.8
	Control	32	67.0	17.7	73.0	16.3

Note: n, number of test subjects; M, average indicator; SD, standard deviation.

According to Table 8, the pre-test scores for the experimental and control groups were similar, at 66.4 and 67.0, respectively. However, the experimental group had a higher post-test score of 82.0, while the control group had an average score of 73.0. This analysis indicates that problem-based learning (PBL) with the SESD approach is more effective than conventional learning in enhancing students' problem-solving skills. Based on the Cohen's d effect size, the Cohen's d result is 0. 596 or can be rounded to 0.6 (see Figure 4).

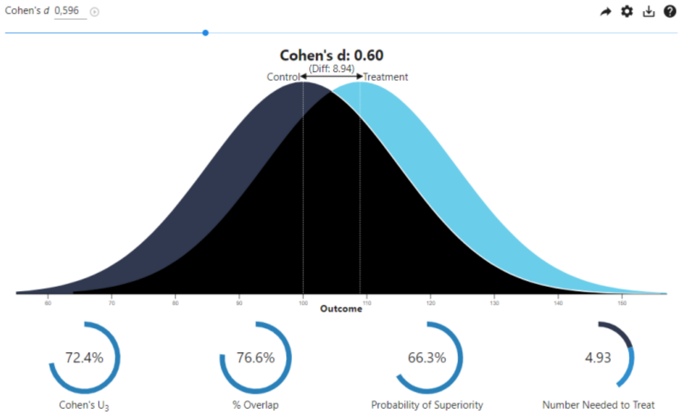

Figure 4. Cohen's d Effect Size

With a Cohen's d of 0.60, 72.4% of the "treatment" group will be above the mean of the "control" group (Cohen's U3), 76.6% of the two groups will overlap, and there is a 66.3% chance that a person picked at random from the "treatment" group will have a higher score than a person picked at random from the "control" group (probability of superiority). Moreover, to have one more favorable outcome in the "treatment" group than the "control" group, we need to treat 4.9 people on average. This result means that there are 100 people in each group, and we assume that 20 people have favorable outcomes in the "control" group, then 20 + 20.3 people in the "treatment" group will have favorable outcomes here.

Table 9. Tests of Between-Subjects Effects

Dependent Variable: Post-Test			
Source	**df**	**F**	**Sig.**
Corrected Model	3	69.072	<.001
Intercept	1	69.910	<.001
Class	1	14.433	<.001
Pre-test	1	181.017	<.001
Class * Pre-test	1	6.860	.011
Error	60		
Total	64		
Corrected Total	63		

These results are supported by the ANCOVA analysis with pre-test scores as a covariate: F (6.860) (see Table 9). Although the results only reveal moderate effect sizes, they indicate that members of the experimental group faced higher cognitive challenges compared to conventional teaching and learning in natural sciences. Furthermore, students in this group reported a solid motivation to engage in learning activities through independent investigation of contextual problems.

Table 10. Descriptive Statistics

	Group	**Gender**	**Mean**	**SD**	**N**
Pre-Test	Experiment (PBL)	Male	62.33	12.902	18
		Female	72.14	14.522	14
		Total	66.63	14.289	32
	Control (Conventional)	Male	64.06	13.588	18
		Female	67.50	15.366	14
		Total	65.56	14.258	32
	Total	Male	63.19	13.088	36
		Female	69.82	14.860	28
		Total	66.09	14.170	64

	Group	Gender	Mean	SD	N
Post-Test	Experiment (PBL)	Male	77.89	12.428	18
		Female	86.86	10.494	14
		Total	81.81	12.301	32
	Control (Conventional)	Male	72.78	14.256	18
		Female	76.21	17.295	14
		Total	74.28	15.488	32
	Total	Male	75.33	13.433	36
		Female	81.54	15.047	28
		Total	78.05	14.384	64

Post hoc analysis indicated significant differences in problem-solving ability indicators between the experimental and control groups, resulting in more substantial competencies among girls. In the experimental group, girls outperformed the average performance of the control group, with medium effect sizes (See Table 10). Additionally, girls' performance in the experimental group was above average for boys, with a medium effect size.

CONCLUSION

Answering the research question, we found that the treatments were mostly effective in improving contextual problem-solving skills. Specifically, the treatments enhanced the skills required to analyze problems, design practical solutions, and execute appropriate problem-solving strategies. The difference in achievement levels detected between girls and boys is an exploratory finding. Therefore, the research procedure does not interpret possible causes regarding the impact of gender aspects on problem-solving ability during learning activities (see, for example, Dorisno, 2019). The context for studying problem-solving ability involves three indicators may challenge promoting contextual problem-solving skills in problem-based learning (PBL) classes with low or average performance. It is suggested that in order to develop the fundamental ability to solve contextual problems across different domains, it would be more appropriate to use a more straightforward domain, such as the digestive system, in a less complex learning environment, especially for students in grades 7 to 9., taking into account the findings from (Damayanti & Surjanti, 2022; Fibonacci et al., 2020; Kurnia, 2023; Pradipta & Hariyono, 2021; Pratiwi et al., 2019; Rahman et al., 2019; Sulastri & Pertiwi, 2020) and also from this study, Researchers believe that reducing irrelevant cognitive load to the necessary extent is crucial for promoting the ability to solve contextual problems that require attention. This idea concerns ambitious goals and complex approaches in sustainable development education.

AKNOWLEDGMENT

The researcher would like to express his highest thanks and appreciation to all parties who have participated in this research. Thank you for your extraordinary dedication and cooperation in producing valuable knowledge and discoveries for Indonesian education.

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