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Improving 8th Grade Students' Contextualized Problem-Solving and Analitycal Thinking Skills Through Problem-Based Learning in The Digestive System: A Study Intervention Findings in the Complex Domain

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ABSTRACT One of the points of science learning is to extend students' competence, counting problem-solving and analytical thinking. Conditions within the field appear that most students encounter trouble in fathoming relevant issues including the application of science concepts in real-world circumstances. This condition appears the require for compelling learning models and approaches to overcome the holes. This condition is additionally the premise for creating a problem-based learning (PBL) show based on Science Education for Sustainable Development (SESD). Research questions were investigated using a quasi-experimental pre-test/post-test design. This design is used to compare the learning outcomes achieved in the treatment class with those of the control class. The subjects of this study consisted of the students of class VIII of SMP Negeri X Ponorogo. Meanwhile, students of VIII class F, which is the experimental class, and students of class VIII D, which is the control class, were used as the research sample. From the t-test using independent sample test it is known that he use of PBL model and SESD approach has no significant impact on students' problem-solving skills but there is a significant impact on students' analitycal thinking skills. From the MANOVA test we know that the overall significance values of Pillai's Trasce, Wilks' Lambda, Hotelling's Trace and Roy's Maximum Root are 0,000 < 0,05, so the use of PBL model and SESD approach has a significant impact on the 8th grade student's ability both to solve contextual problems and analytical thinking on the subject of food and digestive system.

Keywords Analitycal thinking, Contextualized problem-solving, Food sustainability, Problem-oriented learning, Science Education for Sustainable Development

1. INTRODUCTION

The current center of the Normal Sciences instruction educational programs in Indonesia is to prepare students with maintainable competencies with student-centered learning and equitable, pluralistic learning synergies (Pradipta & Hariyono, 2021). These feasible competencies incorporate frameworks considering abilities, expectant abilities, standardizing abilities, key abilities, collaboration abilities, basic considering abilities, self-awareness abilities, and coordinates problem-solving abilities. It is trusted that students can ace the abilities over to realize the objectives of maintainable advancement or feasible improvement objectives (SDGs) (Purnamasari & Hanifah, 2021).

To attain the competencies anticipated in Natural Sciences instruction over, the Service of Education and Culture started a modern educational programs arrangement, to be specific the free learning arrangement, where instructors are free to carry out the instructing and learning prepare, which can make a conducive learning environment and can propel students in their learning. As one of the results of flexibility to memorize, natural science instructors in Indonesia must improve science learning substance and the science learning handle to supply meaningful learning to students. One of the points of science

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learning is to extend students' competence, counting problem-solving and analytical thinking.

The capacity to solve problems is the capacity to think by collaborating the abilities of basic considering, explanatory considering, and imaginative considering in understanding a issue. Problem-solving abilities are higher-order considering abilities connected to real-world issues (Makrufi & Hidayat, 2018). Analytical thinking is a high-level thinking ability that plays a role in solving problems, both in learning and everyday life, by separating the important parts of a problem, finding the relationship between these parts, then drawing conclusions and solving problems. Analyzing involves the process of breaking down material into smaller parts and determining the relationship between the parts and the overall structure (Lorin, 2015).

Hudojo, in 2005, proposed the following problem-solving indicators: identify the problem, plan a solution to the problem, solve the problem, and interpret the results (Mamin et al., 2018). According to George Polya, there are four steps to solve a problem, namely, problem identification phase, problem-solving planning phase, problem-solving implementation phase, and result review phase. Meanwhile, according to Dewey's theory, the indicators of problem solving include identifying the problem, defining the problem, building hypotheses, testing hypotheses, and implementing the best hypotheses. (Zulqarnain & Fatmahanik, 2022).

Based on the above opinions, problem solving ability can be classified by the following indicators:

a. Problem identification is identifying and understanding the student's task or problem.
b. Problem solving planning is the next step after problem identification, where students start planning a solution to the problem.
c. The solution to the problem is the implementation and planning phase carried out in the previous phase.

Analytical thinking skills include the ability to apply logical thinking to gather and analyze information, design and test solutions, and develop plans (Assegaf & Sontani, 2016). Siswono believes that analytical thinking is the ability to elaborate and analyze information used to understand knowledge, using logical thinking rather than guesswork (Utomo, 2013).

It can be concluded that analytical thinking ability indicators are divided into three cognitive processes, namely:

a. Distinguishing, i.e. identifying the things being stated and asked about in the question.
b. Organizing, i.e. having multiple strategies and selecting a strategy for solving a given problem, as well as implementing the selected problem-solving strategy.
c. Assigning, i.e. drawing a conclusion to answer the presented problem question.

Based on the comes about of the Program for Universal Understudy Appraisal (PISA) in 2018, Indonesia was in 74th position out of a add up to of 79 nations with a generally diminished score from 2015, to be specific a science score of 379, a science score of 396, and a proficiency score of 371. In 2015, Indonesia was within the 64th position of 75 nations, with a math score of 386, a science score of 403, and a proficiency score of 397 (Hilda et al., 2022). The capacity of Indonesian students to fathom story issues related to non-routine questions still ought to make strides because students still got to get it the issue and search for elective arrangements (Partayasa et al., 2020).

Based on perceptions and brief interviews with science subject instructors and a few students, it is known that science learning at SMPN X Ponorogo is still teacher-centered, where the instructor clarifies the fabric before the course, and the students tune in. Separated from that, now and then learning is additionally carried out through talks and introductions by students, and some of the time down to earth learning is carried out within the research facility. In any case, this learning still must be executed. The affect of the learning educator centers what students have done becomes dependent on the teacher's clarification and less able to analyze relevant issues within the test questions they confront.

Judging from the comes about of preparatory considers that have been carried out, it is found that the capacity of solving problems and analitycal thinking still should make strides. The anticipated circumstance from science learning is that students are competent in fathoming relevant issues that include understanding logical concepts and basic and explanatory considering abilities. Conditions within the field appear that most students encounter trouble in fathoming relevant issues including the application of science concepts in real-world circumstances. This condition appears the require for compelling learning models and approaches to overcome the holes. This condition is additionally the premise for creating a

problem-based learning (PBL) show based on Science Education for Sustainable Development (SESD).

Problem-Based Learning

Problem-based learning (PBL) is offered as one of the educational models that can improve students' problem-solving and analitycalb thinking skills. Problem-based learning model is one of the learning models that relate students' problems with problems in daily life and can be used to hone problem-solving skills, critical thinking, and analytical thinking. Science learning using PBL model is considered to be suitable for improving the problem-solving and analitycal thinking ability of science students in the second year of junior high school.

The improvement of problem-solving and analitycal thinking skills is because in PBL students are always encouraged to think critically while collecting information that can be used to solve science problems given by the teacher. The PBL model includes five phases, namely, a phase of student orientation to the problem, a phase of organizing students' learning, a phase of investigation guidance (which can be done individually or in groups), a phase of presenting the findings, and a phase of evaluation of students' problem-solving process.

The PBL phase aims to improve students' problem-solving and analitycal thinking skills, both individually and in learning groups, especially in the investigation phase. The PBL model is considered to have several advantages, such as the promotion of students' ability to solve real-world problems, the opportunity to build understanding through the learning process, the experience of scientific activities in group activities, familiarity with access to various sources of information, the ability to assess learning abilities, students' familiarity with scientific communication activities through discourse exercises and introduction of talk comes about, and the determination of students' person learning troubles through gather dialogs (Agustina, 2015).

This finding is evident even though some previous studies (Roesch et al., 2015; Sulastri & Pertiwi, 2020; and Partayasa et al., 2020) focused on improving students' problem-solving and analytical thinking skills through various innovations in learning activities. The results show that problem-based learning models can improve students' problem-solving skills. However, many studies have shown that students' problem-solving skills can be improved through different learning models, such as project-based learning (Gao et al., 2021; Makrufi & Hidayat, 2018) and the TTW (Think, Talk, Write) learning model, supported by web-live worksheets (Hidayah & Arif, 2022), discovery learning models with integrated Read, Question, Answer (RQA) (Hariyanto et al., 2023), and concrete, representational, and abstract learning approaches (Malik et al., 2022), Articulate Storyline, a form of interactive learning media (Daryanes et al., 2023), and the BioPhy journal (Fitriah and Ita, 2022).

Science Education for Sustainable Development (SESD)

Sustainable development is development pursued with the aim of improving the quality of life of society at a global level, for both present and future generations. This planned development significantly minimizes the use of natural resources beyond the carrying capacity of the Earth (Purnamasari & Hanifah, 2021). Sustainable development has 169 outcomes, including 17 specific targets known as SDGs (Sustainable Development Goals), one of which can be pursued through education.

The learning concept of Education for Sustainable Development (ESD) was officially proclaimed by UNESCO in Johannesburg in 2002 and was intended as a learning approach to support sustainable development. The role of ESD in learning is to increase students' capabilities and confidence. Students learn to adapt to complex situations and develop high level competencies, problem solving skills and values in sustainable development (Kurnia, 2023).

In ESD based learning, the skills expected of students are high level skills and not basic skills such as writing, arithmetic and reading skills. Students' creativity, problem solving and action abilities are called high level competencies (Novianti, Suhendar, & Ratnasari, 2023). Sustainable competencies include the ability to create solutions (solve problems) and analitycal thinking.

Amran (2018) mentions several steps in ESD based learning, namely: a) conducting a case study on a community/environmental problem that coincides with the learning area, b) a more detailed discussion of alternative problem solutions, c) analyzing and solving the alternative problem, i.e. presenting alternative solutions to the problem in front of the class, and e) implementing the formulated alternative solutions (Kurnia, 2023).

ESD-based learning can be implemented in the curriculum at all education levels by integrating ESD contexts in various subject areas including science education. Science learning to support sustainable development (SESD) can be achieved by integrating ESD content with learning models, learning media and science learning tools (Fibonacci, Azizati, & Wahyudi, 2020).

Danneberg stated in 2016 that ESD learning focuses on developing students' attitudes and abilities to make life easier and find innovations related to problems. Science Education for Sustainable Development (SESD) can improve students' abilities in the aspects of collaboration between critical thinking, analitycal thinking, decision-making skills based on problem solving, improving communication skills, collaboration, conflict management and planning (Pradipta and Hariyono, 2021).

Based on this description, SESD approaches are suitable for integration into problem-based learning (PBL) and can improve students' skills in the 21st century, including problem-solving skills. ESD-based learning tools have proven to be effective in improving students' abilities in solving science teaching and learning activities (Pradipta & Hariyono, 2021).

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) to students' problem-solving and analitycal thinking skills, which has never been raised in previous research.

Therefore, researchers focused on the following issues:

a) Can the learning treatment improve the ability to solve contextual problems for 8th grade Junior High School students?
b) Can the learning treatment improve the ability of analitycal thinking for 8th grade Junior High School students?
c) Can the learning treatment improve both the ability to solve contextual problems and the ability of analitycal thinking for 8th grade Junior High School students?

For the research conducted, researchers expect a moderate effect from the learning carried out in developing students' specific science problem-solving abilities. The treatment provided includes learning models and approaches that are well demonstrated. Researchers consider that 8th grade junior high school students are still early enough to be encouraged to learn about Food and the digestive system and integrate them into everyday problems (contextual) and sustainable development (food suitability). Thus, the researcher hypothesizes that students will differentiate between good or bad design regarding solving the problem raised.

On the other hand, researchers suspect that the complexity of contextual problems related to Food and digestive system learning content will provide a more meaningful learning effect than conventional classroom learning and increase students' sense of autonomy in the learning process. The researcher then also raised the assumption that students who took part in the experimental class would gain more autonomy than students from the control group. This assumption is considered reasonable because the structure of the learning model in the experimental class allows students to further develop their cognitive abilities compared to the control class with conventional learning.

2. METHOD

2.1 Research Approach

The type of research conducted in this study is based on quantitative research. According to Sugiyono, quantitative research is a research methodology based on the philosophy of positivism, designed to collect research data from a specific sample, sampling using random techniques, collecting data using instruments, and analyzing the research results using quantitative/statistical analysis to verify the proposed hypotheses.

Research questions were investigated using a quasi-experimental pre-test/post-test design. This design is used to compare the learning outcomes achieved in the treatment class with those of the control class. Using pretests, researchers try to statistically control factors that are considered relevant to the research question. All these measures were taken to increase the internal validity of the study and to rule out alternative explanations for the post-treatment effects between different conditions. Thus, researchers try to find an appropriate compromise between methodological and practical requirements to achieve the research objectives.

2.2 Research Design

The study was conducted using a quasi-experimental pretest/posttest design. The researchers

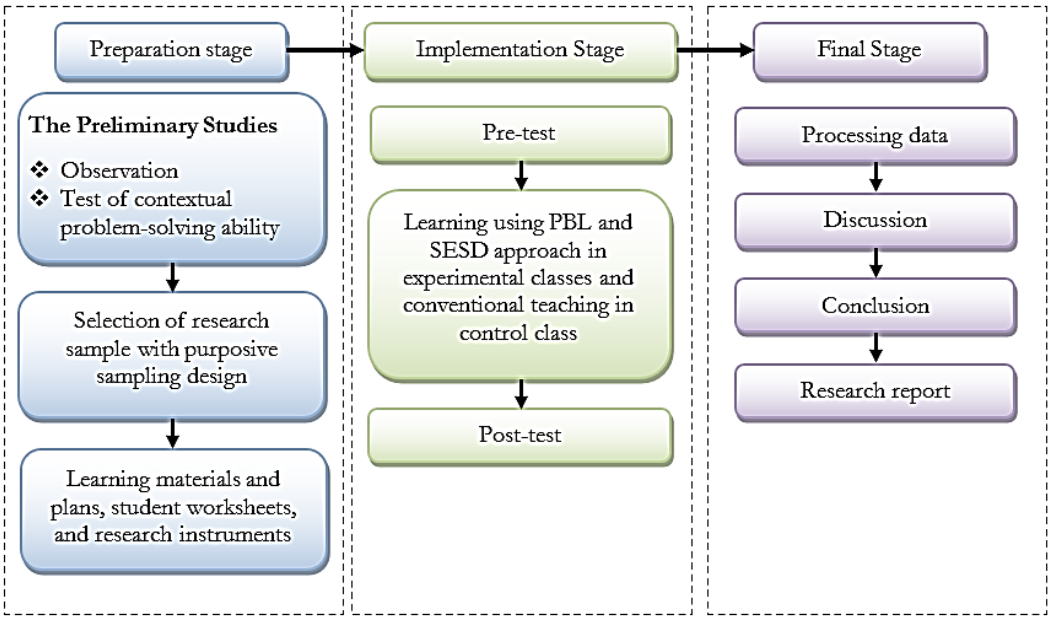

Figure 1 Research design

conducted the study in two class VIII classes, specifically class VIII F as the experimental class and class VIII D as the control class. A tool to assess the level of ability to solve contextual science problems and analytical thinking skills of students related to food and digestive system was developed by the researchers by presenting 12 questions that provide three indicators of ability to solve contextual problems and three indicators of analytical thinking ability.

After the test instrument was developed, it was administered to students of the treatment and control groups as a measure of pre-test scores. The experimental class then underwent situational problem-based learning using the SESD approach, while the control class conducted traditional learning with a subject teacher.

At the end of the lesson, students of the treatment and control groups were again given the test instrument to check the final evaluation of their problem-solving ability after learning (post-test) and a questionnaire to measure their level of problem-solving and analitycal think ability.

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.

2.3 Subject and Research Location

The subjects of this study consisted of the students of class VIII of SMP Negeri X Ponorogo. Meanwhile, students of VIII class F, which is the experimental class, and students of class VIII D, which is the control class, were used as the research sample. The sample was determined using targeted random sampling technique.

The study was conducted in two parallel VIII classes of SMP Negeri X Ponorogo. The total sample consisted of 64 students belonging to two predefined class groups, namely class VIII F as the treatment group and class VIII D as the control group. The average age of the students was between 11 and 13 years old and the percentage of female students was 44% which is slightly lower than the percentage of male students which is 56%.

The researchers selected 8th grade junior high school students as participants or subjects in the study, which was carried out considering the following points: The learning materials on nutrition and digestive system are included in the independent curriculum of Science Phase D, i.e., grade 8, of the junior high school grade of the Indonesian curriculum. Therefore, selecting eighth-grade junior high school students as the learning group is a valid context from the perspective of the curriculum.

Even though Food and the digestive system were also studied more deeply at the senior high school level, the researchers still chose class VIII of junior high school as the research sample. With that in mind, researchers realize that mastery of science concepts is essential for achieving aspects of validity at a higher level.

It is necessary to explain further regarding the selection of students. Education in Indonesia has a system of grouping educational phases through an independent curriculum. Phases A through F correspond to different levels of schooling, starting with grades 1 and 2 of elementary school and ending with class 10 of high school. Students who are in Middle School, both Middle School and High School, tend to need instructional support more intensive than other levels. Middle school students generally achieve in the middle of the achievement spectrum. Therefore, researchers seek to mitigate the impact of exceptional student abilities that could skew research results or contribute to more significant data variance (due to the inclusion of students with either low or high levels of achievement).

2.4 Test Instruments

The test developed by the researchers consists of situational problem-oriented questions about Food and digestive system and consists of 12 questions that include the following details:

a) The essay or description test on Food and the digestive system consists of 6 questions (item numbers 1-6) to measure indicators for problem identification; problem-solving planning; and the solution to the problem. This essay test uses a 1-4 point rating scale to measure students' problem-solving abilities.
b) The essay or description test on Food and the digestive system consists of 6 questions (item numbers 7-12) to measure indicators for distinguishing; organizing; and assigning. This essay test uses a 1-4 point rating scale to measure students' analitycal thinking abilities.

2.5 Data Analysis

Researchers analyzed the research data statistically using IBM SPSS Statistics 25 software with the principle of per-fiat using the t-test and MANOVA test. The first stage of data analysis carried out is testing the validity and reliability of the test instruments that have been developed.

After the test instrument is declared valid and reliable, data collection is then carried out on the sample. After the data has been collected, a prerequisite test is carried out before being analyzed parametrically.

3. RESULT AND DISCUSSION

3.1 Result

Validity and Reliability of the Test Instruments

Based on the validity test of the instrument, it is known that the Pearson correlation value of each item is higher than the r table (0.264), so it can be assumed that each item developed is valid. Furthermore, the Cronbach's alpha value is more than 0.8, so the test items are considered reliable, which is shown in Table 1.

Table 1 Validity and reliability of the test instrument

Indicators	No. Item	Pearson Correlation	Cr. α
Problem identification	1	.726	.900
	2	.734	.899
Problem-solving planning	3	.605	.905
	4	.698	.901
The solution to the problem	5	.695	.902
	6	.620	.905
Distinguishing	7	.764	.898
	8	.701	.901
Organizing	9	.769	.897
	10	.705	.905
Assigning	11	.693	.901
	12	.763	.898

Normality Test

Since the number of samples used was 64 (more than 50), Kolmogorov-Smirnov test was used. The significance value as per table 2 is 0,200 > α 0,05 so the data is normally distributed and we can continue to the next test.

Table 2 Test of Normality

	Tests of Normality					
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Residual for Posttest	,096	64	,200*	,959	64	,032

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

Homogeneity of Varience Test

Table 3 shows the results of the Homogeneity of Variance Test. Based on this output, we can conclude that the variance of the post-test data is homogeneous for the experimental and control classes as the significance value is 0,327 > α 0,05

Table 3 Homogeneity of Variance Test

Levene's Test of Equality of Error Variances[a]			
Dependent Variable: Post-Test			
F	df1	df2	Sig.
,977	1	62	,327

Test the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Pretest + Group

Hypothesis Testing

After the required tests, i.e. normality test and homogeneity test were fulfilled, the researcher carried out parametric tests calculations of hypothesis testing were carried out using IBM SPSS 25 for Windows. The following hypotheses are tested:

Hypothesis 1

H_1 = The use of PBL model and SESD approach has a significant impact on the ability of students of class VIII to solve contextual problems regarding the teaching material Food and Digestive System.

H_0 = The use of PBL model and SESD approach has no significant impact on the ability of students of class VIII to solve contextual problems regarding the teaching material Food and Digestive System.

Hypothesis 2

H_1 = The use of PBL model and SESD approach has a significant impact on the analytical thinking skills of students of class VIII on the subject of food and digestive system.

H_0 = There is no significant impact of the use of PBL model and SESD approach on the analytical thinking skills of students of class VIII on the subject of nutrition and digestive system.

Hypothesis 3

In the calculations to test this hypothesis, the researcher used t-tests to test hypotheses 1 and 2, and then the researcher used a multivariate analysis of variance (MANOVA) test to test hypothesis 3.

H_1 = The use of PBL model and SESD approach has a significant impact on the ability to solve contextual problems and analytical thinking of students of class VIII on the subject of food and digestive system.

H_0 = The use of PBL model and SESD approach has no significant impact on the ability to solve contextual problems and analytical thinking of students of class VIII on the subject of food and digestive system.

Table 4 Group statistics for problem-solving abilities

Group Statistics				
Group	N	Mean	Std. Deviation	Std. Error Mean
Exp	32	82,63	13,488	2,384
Con	32	75,72	15,865	2,805

Based on table 4 and 5, we can see that the mean score of experimental class with 32 students surveyed was 82,63. On the other hand, the mean score of the control class with respondents and 32 students was

Table 5 Independent sample test for problem-solving abilities

Independent Sample Test				
t-test for Equality of Means				
	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	1,876	,065	6,906	3,681
Equal variances not assumed	1,876	,065	6,906	3,681

75,72. From the t-test using independent sample test, we can see that t = 1,876 less than t table = 1,999. The significance value shows 0,065 > 0,05; so H_0 is accepted and H_1 is rejected. The t-test result shows that there is no significant impact of the use of PBL model and SESD approach on the contextual problem-solving skills of students of class VIII on the subject of nutrition and digestive system.

Table 6 Group statistics for analitycal thinking abilities

Group Statistics				
Group	N	Mean	Std. Deviation	Std. Error Mean
Exp	32	81,16	13,186	2,331
Con	32	73,03	16,859	2,980

Table 7 Independent sample test for analitycal thinking abilities

Independent Sample Test				
t-test for Equality of Means				
	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal variances assumed	2,147	,036	8,125	3,784
Equal variances not assumed	2,147	,036	8,125	3,784

Based on table 6 and 7, we can see that the mean score of experimental class with 32 students surveyed was 81,16. On the other hand, the mean score of the

control class with respondents and 32 students was 73,03. From the t-test using independent samples test, we can see that t = 2,147 was higher than t table = 1,999. The significance value shows 0,036 < 0,05; so H_1 is accepted and H_0 is rejected. The t-test result shows that there is significant impact of the use of PBL model and SESD approach on the 8th grade student's analitycal thinking skills on the subject of nutrition and digestive system.

Table 8 Descriptive statistics

Descriptive Statistics				
	Group	Mean	Std. Deviation	N
Problem-Solving Abilities	Exp	82, 6250	13,48775	32
	Con	75,7188	15,86482	32
	Total	76,9297	15,94735	64
Analitycal Thinking Abilities	Exp	81,1563	13,18628	32
	Con	73,0312	16,85897	32
	Total	75,6797	16,10298	64

Based on Table 8, we can see that the presented descriptive statistics are in the form of a comparison of the mean (average) scores of the ability to solve contextual problems and think analytically of students in the experimental class using the PBL model and the SESD approach with the control class using the traditional model.

Table 9 Multivariate tests

Multivariate Tests[a]				
Effect		Value	Hypothesis df	Sig.
Intercept	Pillai's Trace	,974	4,000	,000
	Wilks' Lambda	,026	4,000	,000
	Hotelling's Trace	38,059	4,000	,000
	Roy's Largest Root	38,059	4,000	,000
Group	Pillai's Trace	,392	4,000	,000
	Wilks' Lambda	,608	4,000	,000
	Hotelling's Trace	,644	4,000	,000
	Roy's Largest Root	,644	4,000	,000

From Table 9, we can see that the overall significance values of Pillai's Trasce, Wilks' Lambda, Hotelling's Trace and Roy's Maximum Root are 0,000 < 0,05, so H_1 is accepted and H_0 is rejected. It means that the use of PBL model and SESD approach has a significant impact on the 8th grade student's ability to solve contextual problems and analytical thinking on the subject of food and digestive system.

3.2 Discussion

Lesson Implementation

The researchers chose contextual problems as topics for students to analyze because, in their opinion, these problems are "close" to the environment and students' lives. The researchers' treatment aims to promote students' ability to solve contextual problems, analitycal thinking skills, and realize sustained learning. This treatment is based on moderate constructivist principles. The researchers design structured, sequenced and explainable learning units, taking into account students' understanding, misconceptions and ability levels.

The goal is to establish a pattern of problem-based learning experiences with multiple levels of teacher-led instruction and an open guided problem-solving phase. By applying a contextualized problem-oriented learning model with the SESD approach, students are expected to acquire knowledge about food content and the digestive system, scientific thinking, analitycal thinking, and the ability to solve contextualized problems.

Problems related to a healthy lifestyle, digestive problems and disorders that frequently occur in daily life, and questions about food compatibility are the main problems that students will analyze. Through these problems, students will be able to recognize and experience the importance of conducting scientific research to investigate the causes and effects of human activities and food choices on digestive health, as well as multiple perspectives and responsibilities in decision-making in the field of sustainable development.

Learning exercises within the test and control classes were carried out at the same time on Friday, September 22, 2023 amid the 5th to 6th lesson hours. The learning fabric displayed was Food and Digestive System fabric to 8th grade junior high school students.

Learning within the control lesson was carried out through routine learning by the science subject educator who instructed the control lesson. Djamarah contends that routine learning strategies are conventional learning strategies or better known as the address strategy (in Kresma, 2014). The taking after could be a depiction of the center learning exercises carried out counting educator and understudy exercises within the control bunch.

Tabel 10 The control groups's learning activities

Phases	Learning Syntax	Teacher's Activity	Students' Activity
1	Communicate the objectives and prepare students	The teacher explains the learning objectives, background and meaning of the lesson and prepares the students during the study.	Listen to and do what the teacher says and gives instructions.
2	Demonstrate knowledge	The teacher presents the learning material step by step according to the textbook.	Listen to the material presented by the teacher.
3	Lead the study	The teacher plans and gives instructions for the activities in the textbook.	Listen carefully to the teacher's explanations and carry out the activities in the booklet.
4	Check for understanding and give feedback	The teacher checks whether the students can perform the tasks well and gives feedback to the students.	Follow the teacher's instructions during evaluation and reflection.

Tabel 11 Experimental group's learning activities

Phases	Learning Syntax	Teacher's Activity	Students' Activity
1	Matching students to the problem	Dividing students into groups, linking previous and upcoming material, showing real problems related to the learning material.	Listen to the teacher and gather information according to the groups formed, ask cognitive questions and discuss/analyze the problems raised by the teacher according to each learner's experience.
2	Organizing students for learning	Help students formulate problems and explain problem-solving techniques.	State the limitations of the problem or issue at hand.
3	Guided investigation (can be done individually or in groups)	Help students to gather information and data relevant to the problem.	Collect data to support learning, conduct literacy exercises, and debate to conduct research.
4	Presentation of findings Evaluating students' problem-solving process	Encourage students to conduct experiments to achieve problem solving Support learners in planning and presenting their findings..	Prepare a research report and present it to the class.
5	Communicating learning objectives and achievements	Evaluate students' reflections on their findings.	Follow teacher guidance when assessing and reflecting.

Teaching in the experimental class was carried out using a problem-based learning model, integrating the Science Education for Sustainable Development (SESD) approach into learner worksheets by addressing the theme "Health and Sustainable Food for the Future" (Figure 2). Below are particular of teacher and learner activities in the experimental class (Figure 3).

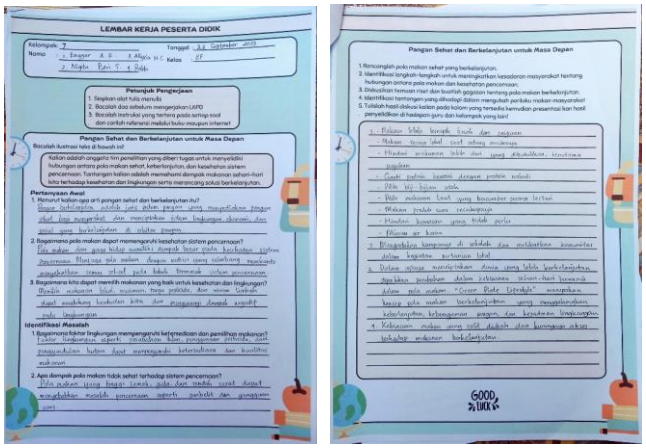

Figure 2 Students' worksheet about health and sustainable food

Discussion of Hipotheses

Based on the test of the first hypothesis using t-test, it was found that H_1 was rejected and H_0 was accepted. This indicates that there is no significant difference in the situational problem-solving skills

Figure 3 Students' activity during the experimental learning

between students who follow the situational problem-based learning model with SESD approach and students who follow the traditional learning model in the 8th grade, face-to-face takes place in SMPN X Ponorogo.

Beside that the results of the data analysis show that the average problem-solving skills of students who follow the problem-based learning model with SESD approach is 82,63 higher than 75,72 of the group of students who follow the traditional learning model.

Based on the test of the second hypothesis using t-test, it was found that H_0 was rejected and H_1 was accepted. This indicates that there is a significant difference in analytical thinking skills between students who follow the situational problem-based learning model with SESD approach and students who follow the traditional learning model in the 8th grade.

The results of the data analysis show that the average analytical thinking ability of students following the problem-based learning model with SESD approach is 81,16 higher than the group of students following the traditional learning model, i.e. 73,03.

The results of the third hypothesis test show that H_0 is rejected and H_1 is accepted. Therefore, there is a significant difference in the ability to solve problems and think analytically between students following the PBL learning model with SESD approach and students following the traditional learning model.

The MANOVA test results in the multivariate test table are based on the significance values of Pilla's trace, Wilk's Lamda, Hotelling's trace, and Roy's Ikrgest Root values obtained are 0,000 < 0,05. This shows that there is a significant difference in the ability to solve problems and think analytically between students following a PBL learning model using SESD approach and those following a traditional learning model designed for grade 8. Furthermore, it can be seen that the problem-solving and analytical thinking skills of students in the experimental group were higher on average.

Regarding our initial research inquiry, we discovered that the treatment offered was predominantly effective in most contextual problem-solving and analitycal thinking capabilities, consistent with (Roesch et al., 2015; Sulastri & Pertiwi, 2020; and Partayasa et al., 2020) discoveries. Specifically, this approach enhances the skillset required for analyzing problems, devising practical solutions, executing suitable problem-solving strategies, distinguishing, organizing, and also assigning.

Given the limited number of students and teachers included in this study and the utilization of written

paper-and-pencil tests for learning evaluation, caution must be exercised when interpreting the efficacy of the experimental group's treatment for improving competency. It is important to note that factors impacting learning outcomes inherent to the participating students and teachers cannot be fully controlled. Because the sample of junior high school students was limited to the Ponorogo area, this study cannot ascertain the effectiveness of the promotion concept in other regions – see (Sulastri & Pertiwi, 2020; Zulqarnain & Fatmahanik, 2022). We also lack evidence regarding the impacts on upper middle and elementary school grades. We did not have a control group with a specific promotional concept for contextual problem-solving abilities in other domains or less challenging contexts. Consequently, our study could not investigate the treatments' effectiveness and their effects on other learning domains or contexts.

However, based on our research compared to previous studies, it is reasonable to assume that acquiring the fundamental elements of problem-solving and analitycal thinking skills may be more attainable in less demanding educational environments and simpler domains (e.g., Malik et al., 2022).

The findings are similar to Amir et al., 2021; and Rachmawati et al., 2022, students in the experimental group in the research conducted showed an increase in their curiosity in several ways. This finding differs from the results of Prokop et al. (2007), who found no differences in perceived curiosity (considering the preferred motivational orientation) under the same experimental conditions among sixth-grade elementary school students in Slovakia—who participated in courses in the field - compared to a control group who took lessons in a conventional classroom.

4. CONCLUSION

Considering previous research that used less complex domains (e.g., Malik et al., 2022), the data obtained shows that the ability to solve experimental problems and analitycal thinking can be improved even in complex digestive system material since education is intermediate in challenging contexts and oriented to contextual problems.

The hypotheses testing of this research show that there is no significant impact of the learning treatment to the students' problem-solving skills. However, there is a difference between the average of students' problem-solving skills in experimental class and control class. Next, based on the test of the second hypothesis using t-test, it was found that there is a significant difference in analytical thinking skills between students who follow the situational problem-based learning model with SESD approach and students who follow the conventional learning.

The MANOVA test results in the multivariate test shows that there is a significant difference in the ability to solve problems and think analytically between students following a PBL learning model using SESD approach and those following a traditional learning model designed for grade 8 in Food and Digestive System material.

In the end, overall, the research results show that didactic research in areas that can improve indicator components of the ability to solve specifically challenging contextual problems and analitycal thinking must clarify optimum methods, educational levels, and the application of suitable learning contexts and domains with appropriate cognitive strain-especially for average or low-achieving student groups. In addition, findings from research interventions indicate the need to create a spiral curriculum to promote/improve the construct of comprehensive contextual problem-solving and analitycal thinking abilities.

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