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1 **Improving Contextualized Problem-Solving Skills among**
2 **Grade 8 Students Through "Digestive System" Problem-**
3 **Oriented Learning: A Study Intervention Findings in the**
4 **Complex Domain**

5 **NOVELTY**

6 The novelty of this research is the innovative approach to improving the problem-
7 solving skills of Grade 8 students in the context of the Digestive System. This research
8 creates a breakthrough by combining problem-based learning (PBL) with the Science
9 Education for Sustainable Development (SESD) approach. This approach promotes a
10 dynamic and holistic learning environment by providing students with factual
11 knowledge and practical problem-solving skills. This combination provides a new
12 perspective in science education by encouraging students to apply critical thinking and
13 sustainable development principles to real-world challenges, preparing them to face a
14 more complex and interconnected world.

15 **ABSTRACT**

16 Indonesia needs more appropriate learning methods and educational policies to improve
17 literacy and numeracy skills, including problem-solving competence. These two
18 capabilities are fundamental in this era of Industrial Revolution 4.0. This research
19 investigates whether Digestive System learning designed to be oriented toward
20 contextual problems with direct SESD-based teaching encourages students' ability to
21 solve contextual problems better than conventional learning in the classroom. Data
22 collection included paper and pencil assessments of students' problem-solving skills
23 through a quasi-experimental study using a pretest-posttest experiment control group

design. The experimental group received learning about the digestive system based on the principles of education for sustainable development. The sample of the study was class VIII students at SMPN 4 Ponorogo. The experimental group displayed more autonomy, independence, and openness in their approach to problem-solving due to the treatment they received. These results are supported by the ANCOVA analysis with pre-test scores as a covariate: $F(6.860)$. 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 experimental group will have a higher score than a person picked at random from the control group.

Keywords

Contextual, Digestive system, Problem-oriented learning, Problem-solving ability, SESD.

1. 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

1 students in their learning. As one of the consequences of freedom to learn, natural
2 science teachers in Indonesia must improve science learning content and the science
3 learning process to provide meaningful learning to students. One of the aims of science
4 learning is to increase students' competence, including problem-solving.

5 The ability to solve problems is the ability to think by collaborating the skills of
6 critical thinking, analytical thinking, and creative thinking in solving a problem.
7 Problem-solving skills are higher-order thinking skills applied to real-world problems
8 (Makrufi & Hidayat, 2018). Science learning must be able to answer problems relevant
9 to natural symptoms or phenomena that change over time. One of the competencies that
10 students are expected to master in science learning is the competency to solve problems.
11 Dogru stated that in the science education environment, one of the main goals of
12 education is to develop critical, logical thinking, and problem-solving competence
13 (Prastiwi & Nurita, 2018). Science learning has achieved the learning objectives
14 perfectly if the student's ability to solve science problems is considered good enough
15 (Sulastri & Pertiwi, 2020).

16 Based on the results of the Program for International Student Assessment (PISA)
17 in 2018, Indonesia was in 74th position out of a total of 79 countries with a relatively
18 decreased score from 2015, namely a mathematics score of 379, a science score of 396,
19 and a literacy score of 371. In 2015, Indonesia was in the 64th position of 75 countries,
20 with a math score of 386, a science score of 403, and a literacy score of 397 (Hilda et
21 al., 2022). The ability of Indonesian students to solve story problems related to non-
22 routine questions still needs to improve because students still need to understand the
23 problem and look for alternative solutions (Partayasa et al., 2020). Based on this, there
24 needs to be more appropriate learning methods and educational policies in Indonesia for

1 improving literacy and numeracy skills. Meanwhile, these two capabilities are essential
2 in this era of Industrial Revolution 4.0.

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

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

- 20 a. **Identifying the problem** is the ability to recognize and understand students'
21 challenges or problems.
- 22 b. **Plan problem resolution** is a further step from problem identification, where
23 students begin to plan how the problem will be resolved.

1 c. **Solving the problem** is the implementation and planning stage made in the
2 previous stage.

3 d. **Interpreting the results** reflects the process and results of problem-solving
4 designed by students.

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

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

1 Problem-oriented learning, commonly known as Problem-Based Learning
2 (PBL), is offered as one of the teaching models that can enhance students' problem-
3 solving skills. The problem-oriented learning model is one of the learning models that
4 relate problems in everyday life to become issues for students and can be used to hone
5 problem-solving skills, critical thinking, and analytical thinking. Science learning with
6 PBL models is considered suitable for improving the ability to solve science problems
7 in class VIII middle school students. The increase in the ability to solve problems
8 occurs because PBL students are always encouraged to think critically in gathering
9 information that can be used to solve science problems given by the teacher.

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

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

1 Several previous studies that discussed increasing students' problem-solving
2 abilities through several innovations in learning activities, including Sulastri & Pertiwi
3 (2020), found that the Problem-Based Learning learning model with a contextual
4 approach can improve the science problem-solving abilities of junior high school
5 students. Roesch et al. (2015) found that ecological learning in complex domains
6 through problem-oriented learning can improve experimental problem-solving abilities
7 and allow for more autonomous students' rights. Partayasa et al. (2020) showed the
8 findings of their research, namely that students' problem-solving skills in mathematics
9 can be improved through the video-assisted creative problem-solving learning model
10 rather than conventional learning.

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

21 Solving problems independently by students with high problem complexity can
22 also cause a heavy cognitive demand on students' work memories (Roesch et al., 2015).
23 These conditions can arise depending on the type of student activity and the level of
24 openness of learning activities. Next, the researcher will discuss the factors related to

1 high cognitive load in learning, the complexity of the learning material provided by the
2 teacher, and its influence on student's ability to solve problems in more detail.

3 Some research demonstrates the fundamental ¹ of instructional support during
4 learning for successful self-guided problem solving; the guided instruction and training
5 of scientific reasoning appears to improve the cognitive and metacognitive dimensions
6 of problem-solving skills more efficiently than the guided discovery lessons of
7 constructivists (Roesch et al., 2015). A variety of support methodologies have been
8 experimented with like (a) procedural guidance during a ⁴ teacher-led conversation
9 (Socratic method), (b) examples to familiarize oneself with the process of problem-
10 solving and problem-decision examples, (c) worked examples to familiarize oneself
11 with the steps of the problem-solving process and examples of problem decisions, (d)
12 process worksheets that can help organize the problem-solving process, (e) instruction
13 in a computer-based learning environment with a variety model system, and (f)
14 providing basic questions as structural training support for producing practical research
15 problems. Typically, these procedural tools only succeed after extensive orientation and
16 training activities.

17 Efficient intervention research has primarily focused on the fields of ecology
18 (Roesch et al., 2015), thermodynamics (Malik et al., 2022), environmental awareness
19 (Fitriah & Ita, 2022), and fluid dynamics (Makrufi & Hidayat, 2018). Less complex
20 systems categorize some of those science subjects compared to the continuous learning
21 systems used by the researchers. The benefit of subjects with a low level of complexity
22 is that basic learning techniques and sufficient conceptions can be acquired relatively
23 easily. However, some crucial dimensions of experimentation need to be included and
24 thus cannot be improved.

1 Because of this reason, we selected the contextual problem-oriented Food and
2 Digestive System subject to be a trial case ¹ for a learning context in which different
3 components of problem-solving ability can be improved. The Food and digestive
4 system domains are complex because they cannot be observed directly (by the senses)
5 by students and are influenced by several factors that are not simple. Students are only
6 often given explanations of concepts related to this domain and are not linked to daily
7 lifestyle patterns. Because of this, researchers want to know the impact or influence of a
8 contextual problem-based learning model in Food and the Digestive System material to
9 support science learning for sustainable development (SESD), which has never been
10 raised in previous research.

11 Therefore, measuring competence in solving contextual problems in Food and
12 the Digestive System material not only requires measurement strategies to control
13 variables, generate a hypothesis on the causality of the variables, and conclusions on the
14 appropriateness of the research design (all of these are internal validity questions) and
15 yet must also consider reliability aspects like ¹ the use of suitable sample sizes and also
16 long-term effects of the treatment. Only now, some instruments are still available to
17 assess competency in solving problems in the Food and Digestive System material.

18 Various research has demonstrated a significant impact of context- and
19 application-based science teaching. The researchers have found improvements in
20 students' generic attitudes toward natural and applied science, motivation to learn,
21 ability to argue, comprehension of natural science, and mediation of competencies in
22 transfer and implementation. Studying this kind of science principles and concepts with
23 problem-based treatment demonstrates results that are at least compatible with
24 conventional teaching, even sometimes providing much more favorable outcomes than

1 traditional teaching (Sulastri & Pertiwi, 2020). These arguments support contextualizing
2 learning materials to improve students' science problem-solving abilities.

3 Contextualized science education, however, encompasses various teaching and
4 learning objectives, thus placing challenging requirements on both the instructional and
5 learning processes. Several researchers have pointed out the challenges of high-
6 complexity content (Roesch et al., 2015). Such a learning environment can discourage
7 students and reduce the learning effect due to the high cognitive load. However, the
8 problem-solving process in learning requires reduced didactically plausible
9 complexities of both phenomenon and learning environment and concentration and
10 specialization on crucial items and skills.

11 Considering that contextual problem-based learning with the SESD approach is
12 a complex learning activity, the question arises as to whether students' ability to solve
13 science problems can be increased through learning models and approaches taken based
14 on previous research suggestions. After evaluating the theoretical and empirical
15 foundation that is being presented, I will provide a review. Various issues emerge that
16 researchers want to investigate in their research.

17 Therefore, researchers focused on the following issues:

- 18 a) Can the ⁶ Problem-Based Learning learning model using the Science Education for
19 Sustainable Development (SESD) approach improve the ability to solve contextual
20 problems for class VIII SMP students, which includes an understanding of
21 analyzing problems, planning to problem-solve, and carrying out problem-solving
22 that has been planned in the material Food and the Digestive System?
- 23 b) Can the teacher's treatment in learning influence students' feelings of autonomy?

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

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

18 **2. Method**

19 **2.1 Research Design**

20 To obtain valid results in this research, researchers conducted field studies in a
21 classroom environment that students in daily learning activities can use. This design
22 ensures no random assignment of students or teachers to certain learning conditions.
23 Therefore, in the research, the researchers chose the classes to be used through several
24 considerations, including choosing classes with experimental group and control group

1 conditions that were as close as reasonable in terms of class size, male-female student
2 ratio, class level, and school location. Other variables like students' common cognitive
3 ability, level of skill, familial and environmental conditions, institutional-like teacher
4 qualities, and external support to students were not monitored. However, the researcher
5 selected a research location in a school with parallel classes to minimize the influence of
6 other uncontrollable variables. The researcher chose an active involvement in learning
7 in the experimental class, and for the control class, it was left to the subject teacher, who
8 usually handles learning in the class.

9 The study's research questions were examined using a pre-test/post-test quasi-
10 experimental design. This study uses a control group to compare students' problem-
11 solving ability levels in conventional learning with the treatment given to the
12 experimental class. The researcher implemented a pre-test to statistically regulate
13 relevant factors, such as pre-test scores and attainment in multiple school subjects,
14 which were vital to the research questions. These measures boosted the study's internal
15 validity and eliminated other explanations for the post-treatment effect between
16 conditions. Thus, the researcher endeavored to balance the methodological and practical
17 necessities in accomplishing their research goals.

18 2.2 Experimental Conditions

19 In the experimental class, students receive learning developed and structured
20 appropriately oriented to contextual problems (Problem-Based Learning) to create
21 science learning that supports Science Education for Sustainable Development (SES),
22 validated and approved by previous science teachers. Implementing learning treatments
23 in experimental classes includes variations in learning media, methods, approaches, and
24 selected learning activities. Meanwhile, in the control class, students receive

1 conventional model learning activities from teachers who usually teach science subjects
2 in selected classes. Learning in the control class is not tied to learning media, methods,
3 and learning activities like in the experiment class. The duration of the learning
4 treatment in both experimental and control classes was identical.

5 The researcher felt that hiding the concept of the specific promotion given to the
6 experimental group from the control group during the research was the most
7 appropriate; with the first consideration, the 'conventional' feeling in science learning in
8 the control group will be more pronounced. Second, we conveyed the learning
9 mechanism in the experimental group to the control group teacher after the learning
10 activity ended. As an additional basis for researchers to report results, preliminary study
11 (pre-test results) and control class are to be considered for the material given when
12 learning.

13 **2.3 Research Sample**

14 The research was conducted in two parallel VIII classes at SMPN 4 Ponorogo.
15 The total sample consisted of 64 students in two predetermined classes. The average age
16 of students is 11-13 years, with the percentage of male students at 56%, slightly higher
17 than that of female students at 44%. Javanese is the native language for 95% of the
18 surveyed students' mothers and fathers. The percentage of students' gender and mother
19 tongue was similar for both research classes. Research class conditions can be seen in
20 Table 1.

21 **Table 1** Experimental conditions

22 Researchers chose class VIII junior high school students as participants or
23 subjects in the research, which was carried out with the following considerations: the
24 learning material for Food and the Digestive System is contained in the content of the

1 Phase D Natural Sciences independent curriculum, specifically in class VIII of Junior
2 High Schools in the Indonesian education curriculum. Therefore, selecting class VIII
3 junior high school students as research samples is a valid context in terms of
4 curriculum. Even though Food and the digestive system were also studied more deeply
5 at the senior high school level, the researchers still chose class VIII of junior high
6 school as the research sample. With that in mind, researchers realize that mastery of
7 science concepts is essential for achieving aspects of validity at a higher level.

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

18 **2.4 Learning Treatment**

19 Researchers chose contextual problems as issues that students would analyze
20 because these problems were considered to be 'closer' to the environment and students'
21 lives. The researcher's treatment is intended to encourage students' ability to solve
22 contextual problems and realize sustainable learning. This treatment is designed based
23 on moderate constructivist principles. Researchers design learning units to be
24 structured, sequenced, and explicable, accounting for students' understandings,

1 misunderstandings, and levels of competence. The purpose is to establish a pattern of
2 problem-based learning experiences with multiple levels of teacher-directed instruction
3 and open-ended, guided problem-solving phases. By applying a contextual problem-
4 based learning model with the SESD approach, students are expected to gain knowledge
5 of food content and the digestive system, scientific reasoning, and competence in
6 solving contextual problems.

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

14 **2.5 Test Performance of Dependent Variable Operationalization**

15 Researchers have created and applied written performance tests grounded in
16 traditional test theory to determine competence in solving contextual problems.
17 Compared with performance performances, interviews about conceptions and problem-
18 solving strategies, and data-based computer-based tools, paper-and-pencil-based tests
19 present a lower level of validity (Roesch et al., 2015) due to their lack of objectivity.
20 Correlations with the process are limited and cannot fully depict the problem-solving
21 process, including all required competencies and interactions. However, researchers
22 used paper and pencil tests because the sample size was quite large and resources were
23 limited.

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

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

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

23 We then asked participants to rate their gained level of openness, independence,
24 and autonomy on a 4-point Likert scale in both the control and experimental groups.

1 Furthermore, those in the experimental group elaborated on how the learning
2 environment affected their attitudes and motivation towards learning.

3 **2.6 Research Procedure**

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

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

16 **Figure 1 Research procedure**

17 **2.7 Data Analysis**

18 The research data was statistically processed using PASW Statistics 18 software
19 and evaluated using parametric tests according to the per-fiat principle.

20

21 **3. Result and Discussion**

22 **Result**

23 **3.1 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

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

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.

Bivariate correlations between the ability to solve contextual problems and school grades in natural sciences and general cognitive abilities were calculated to assess the construct validity. The small coefficients indicate distinguishable dimensions representing more than technical achievement in the subject or general cognitive ability.

3.2 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 better known as the lecture method (in Kresma, 2014). The following describes the core learning activities, including teacher and student activities in the control group (see Table 4).

Table 4 Learning activities of the control group

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." The following are details of teacher and learner activities in the experimental class (see Table 5 and Figure 2).

Table 5 Learning activities of the experimental group

Figure 2 Lesson implementation in the experimental group

In Figure 3 below, the learners present a sample of the worksheet. 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

3.3 Correlation Analysis Between Lesson Implementation and Result

The research results presented in Table 2 show that each indicator of problem-solving in the control and experimental classes 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

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 result shows that the treatment given to the experimental group has a better impact than conventional learning on improving students' problem-solving skills.

In the experimental class, the indicator with the highest gain score is 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.

3.4 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 ($F = 6.860$).

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

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 scores significantly differed between the experimental and the control groups was confirmed for all test question indicators, as shown in Table 8.

Table 8 Descriptive statistics of pre-test and post-test scores

According to Table 4, 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 2).

Figure 4 Cohen's d effect size

2
1 With a Cohen's d of 0.60, 72.4% of the "treatment" group will be above the
2 mean of the "control" group (Cohen's U3), 76.6% of the two groups will overlap, and
3 there is a 66.3% chance that a person picked at random from the "treatment" group will
4 have a higher score than a person picked at random from the "control" group
5 (probability of superiority). Moreover, to have one more favorable outcome in the
6 "treatment" group than the "control" group, we need to treat 4.9 people on average. This
7 result means that there are 100 people in each group, and we assume that 20 people
8 have favorable outcomes in the "control" group, then 20 + 20.3 people in the
9 "treatment" group will have favorable outcomes here.

10 The results of the questionnaire for our second research question indicate that
11 the experimental group students displayed more autonomy, independence, and openness
12 in their approach to problem-solving due to the treatment they received compared to the
13 control group participants. These results are supported by the ANCOVA analysis with
14 pre-test scores as a covariate: F (6.860) (see Table 9). Although the results only reveal
15 moderate effect sizes, they indicate that experimental group members faced higher
16 cognitive challenges compared to conventional teaching and learning in natural sciences
17 work. Furthermore, students in this group reported a solid motivation to engage in
18 learning activities through independent investigation of contextual problems.

19 Table 9 Tests of Between-Subjects Effects

20 Post hoc analysis indicated significant differences in problem-solving ability
21 indicators between the experimental and control groups, resulting in more substantial
22 competencies among girls. In the experimental group, girls outperformed the average
23 performance of the control group, with small to medium effect sizes (See Table 10).

1 Additionally, girls' performance in the experimental group was above average for boys,
2 with a medium effect size.

3 **Table 10 Descriptive Statistics**

4 **Discussion**

5 Regarding our initial research inquiry, we discovered ¹that the treatment offered
6 was predominantly effective in most contextual problem-solving capabilities, consistent
7 with Sulastri and Pertiwi's (2020) discoveries. Specifically, this approach enhances the
8 skillset required for analyzing problems, devising practical solutions, and executing
9 suitable problem-solving strategies. Additionally, concerning ⁴our second research
10 question, a moderate constructivist learning environment incorporating problem-based
11 learning phases resulted in an anticipated enhancement of ¹students' sense of autonomy.

12 ¹Given the limited number of students and teachers included in this study and the
13 utilization of written paper-and-pencil tests for learning evaluation, caution must be
14 exercised when interpreting the efficacy of the experimental group's treatment for
15 improving competency. It is important to note that factors impacting learning outcomes
16 inherent to the participating students and teachers cannot be fully controlled. Because
17 the sample of junior high school students was limited to the Ponorogo area, this study
18 cannot ascertain the effectiveness of the promotion concept in other regions – see
19 (Sulastri & Pertiwi, 2020; Zulqarnain & Fatmahanik, 2022). We also lack evidence
20 regarding the impacts on upper middle and elementary school grades. We did not have a
21 control group with a specific promotional concept for contextual problem-solving
22 abilities in other domains or less challenging contexts. Consequently, ⁴our study could
23 not investigate the treatments' effectiveness and their effects on other learning domains
24 or contexts.

1 The detected differences⁴ in achievement levels between girls and boys are
2 exploratory findings. Therefore, our procedure does not permit the interpretation of
3 possible causes related to the gender aspects' impact on problem-solving abilities during
4 learning activities (see, for example, Dorisno, 2019).

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

9 The findings are similar to Amir et al., 2021; and Rachmawati et al., 2022,
10 students in the experimental group in the research conducted showed an increase in their
11 curiosity in several ways (for example, identifying problems, formulating problem-
12 solving plans and carrying out problem-solving). This finding⁴ differs from the results of
13 Prokop et al. (2007), who¹ found no differences in perceived curiosity (considering the
14 preferred motivational orientation) under the same experimental conditions among
15 sixth-grade elementary school students in Slovakia—who participated in courses in the
16 field - compared to a control group who took lessons in a conventional classroom.

17 **4. Conclusion**

18 Considering previous research that used less complex domains (e.g., Malik et
19 al., 2022), the data obtained shows that the ability to solve experimental problems can
20 be improved even in complex digestive system material since education is intermediate
21 in challenging contexts and oriented to contextual problems. We discovered that
22 average middle school students could tackle more challenging, interconnected settings
23 and complex domains, contrary to other research that suggests otherwise ((Malik et al.,
24 2022; Zulqarnain & Fatmahanik, 2022)).

1 The learning environment is quite constructivist, which is very interesting and
2 motivating for students. In addition, this encourages students' ability to solve contextual
3 problems ¹at least as much as conventional competency-oriented natural science lessons
4 and allows more autonomy. Furthermore, the ability to formulate epistemic questions
5 can be stimulated earlier than anticipated. However, the increase in contextual problem-
6 solving skills found by researchers in this study was slight compared to that observed in
7 other studies (e.g., Sulastris & Pertiwi, (2020)). Finally, particular components of
8 validity and reliability in resolving contextual problems are beyond the grasp of eighth-
9 grade middle school students.

10 The context for studying problem-solving ability involves three indicators:
11 problem identification, problem-solving planning, and problem-solving. This context
12 produces significant cognitive load and may challenge promoting contextual problem-
13 solving skills in problem-based learning (PBL) classes with low or average
14 performance. It is suggested that in order to develop the fundamental ability to solve
15 contextual problems across different domains, it would be more appropriate to use a
16 more straightforward domain, such as the digestive system, in a less complex learning
17 environment, especially for students in grades 7 to 9., taking into account the findings
18 from (Damayanti & Surjanti, 2022; Fibonacci et al., 2020; Kurnia, 2023; Pradipta &
19 Hariyono, 2021; Pratiwi et al., 2019; Rahman et al., 2019; Sulastris & Pertiwi, 2020) and
20 also from this study, Researchers believe that reducing irrelevant cognitive load to the
21 necessary extent is crucial for promoting the ability to solve contextual problems that
22 require attention. This idea concerns ambitious goals and complex approaches in
23 sustainable development education.

1 While the researcher noted that the study sample did not demonstrate improved
2 awareness of contextual issues in digestive system problems or disorders, the researcher
3 maintains that utilizing a contextual problem-based learning model to teach the
4 digestive system is crucial in enhancing students' proficiency in solving real-life
5 contextual problems. Therefore, it is recommended by researchers that the incorporation
6 of contextualization in the spiral curriculum takes place when students have a basic
7 competency in problem-solving skills. The findings suggest that concepts related to
8 long-term observations and random sample sizes ⁴ in biological systems are highly
9 complex and abstract (see research results Roesch et al., 2015). Teachers should allocate
10 more instructional time to enhancing student competency in this area. For instance, they
11 could develop contextual problem-based learning strategies, create live environments,
12 or utilize field learning or computer-based simulations. Additionally, ¹metacognitive
13 reflection and explicit training in methodological criticism are essential components to
14 consider.

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

22

23 **Acknowledgment**

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References

- Agustina, E. (2015). *Peningkatan Kualitas Pembelajaran IPA Melalui Model Problem Based Learning (PBL) dengan Media Audiovisual pada Siswa Kelas V Tambakaji 05 Semarang*. Universitas Negeri Semarang.
- Amir, A., Tati, A. D. R., & Sarinikmah. (2021). Peningkatan Rasa Ingin Tahu Peserta Didik Melalui Penerapan Model Pembelajaran Problem Based Learning. *Pinisi: Journal of Teacher Professional*, 3(3), 206–211.
- Damayanti, F. A., & Surjanti, J. (2022). Penerapan Model PBL dengan Konteks ESD dalam Meningkatkan Hasil Belajar dan Sustainability Awareness Peserta Didik. *Buana Pendidikan*, 18(1), 93–105.
http://jurnal.unipasby.ac.id/index.php/jurnal_buana_pendidikan/index
- Daryanes, F., Darmadi, D., Fikri, K., & Sayuti, I. (2023). The development of articulate storyline interactive learning media based on case methods to train students' problem-solving ability. *Heliyon*, 9(4), e15082.
<https://doi.org/10.1016/j.heliyon.2023.e15082>
- Dorisno. (2019). Hubungan Gender dengan Kemampuan Pemecahan Masalah Matematika. *Jurnal Tarbiyah Al-Awlad*, 9(1), 1–108.
- Fibonacci, A., Azizati, Z., & Wahyudi, T. (2020). Development of Education for Sustainable Development (ESD) Based Chemsdro Mobile Based Learning for

- 1 Indonesian Junior High School: Reaction Rate. *JTK: Jurnal Tadris Kimiya*, 5(1),
2 26–34. <https://doi.org/10.15575/jtk.v5i1.5908>
- 3 Fitriah, L., & Ita, I. (2022). *BioPhy magazine based on a floating market for problem-*
4 *solving skills and environmental awareness*. 16(4), 509–517.
5 <https://doi.org/10.11591/edulearn.v16i4.20455>
- 6 Gao, G., Xiao, K., Jia, Y., & Wang, H. (2021). Improving students ' problem-solving
7 ability through the ' information system security ' project guided by the theory of
8 inventive problem solving (TIPS). *Innovations in Education and Teaching*
9 *International*, 00(00), 1–10. <https://doi.org/10.1080/14703297.2021.1935292>
- 10 Hariyanto, H., Hikamah, S. R., & Maghfiroh, N. H. (2023). *The potential of the*
11 *discovery learning model integrated the reading, questioning, and answering*
12 *model on cross-cultural high school students ' problem-solving skills*. 17(1), 58–
13 66. <https://doi.org/10.11591/edulearn.v17i1.20599>
- 14 Hidayah, U. N. K., & Arif, S. (2022). Efektivitas Model Pembelajaran Think Talk Write
15 (TTW) Berbantuan Web Liveworksheet Terhadap Kemampuan Menyelesaikan
16 Masalah. *Jurnal Tadris IPA Indonesia*, 2(3), 242–251.
- 17 Hilda, N. R., Zahwa, N., Astuti, T. K., Weryani, W., Prasetyawati, Y., Zulkardi, Z.,
18 Nuraeni, Z., & Sukmaningthias, N. (2022). Studi Literatur: Implementasi Merdeka
19 Belajar Dalam Meningkatkan Mutu Pembelajaran Matematika Selama Pandemi.
20 *Biomatika : Jurnal Ilmiah Fakultas Keguruan Dan Ilmu Pendidikan*, 8(1), 110–
21 119. <https://doi.org/10.35569/biomatika.v8i1.1186>
- 22 Kresma, E. N. (2014). Perbandingan Pembelajaran Konvensional Dan Pembelajaran
23 Berbasis Masalah Terhadap Titik Jenuh Siswa Maupun Hasil Belajar Siswa dalam
24 Pembelajaran Matematika. *Educatio Vitae*, 1(1), 152–164.

- 1 Kurnia, F. (2023). *Implementasi PBL dengan Pendekatan STEM Berbasis Education for*
2 *Sustainable Development (ESD) pada Topik Usaha dan Energi untuk*
3 *Meningkatkan Kemampuan Berpikir Kreatif*. Universitas Lampung.
- 4 Makrufi, A., & Hidayat, A. (2018). *Pengaruh Model Pembelajaran Berbasis Proyek*
5 *terhadap Kemampuan Pemecahan Masalah Pokok Bahasan Fluida Dinamis*. 878–
6 881.
- 7 Malik, A., Fanka, R., Rachman, E., & Kuntadi, D. (2022). Concrete Representational
8 Abstract Approach to Improve Students ' Problem Solving Skills on Heat Material.
9 *Integrative Science Education and Teaching Activity Journal*, 3(2), 186–193.
- 10 Mamin, R., Yunus, S. R., & Ariska, I. (2018). Efektivitas Penerapan Structure Exercise
11 Method (SEM) dalam Problem Based Learning (PBL) terhadap Kemampuan
12 Pemecahan Masalah Peserta Didik Kelas VII SMPN 1 Bua Ponrang (Studi pada
13 Materi Pokok Kalor dan Perpindahannya). *Jurnal IPA Terpadu*, 1(2), 32–39.
- 14 Partayasa, W., Suharta, I. G. P., & Suparta, I. N. (2020). Pengaruh Model Creative
15 Problem Solving (CPS) Berbantuan Video Pembelajaran Terhadap Kemampuan
16 Pemecahan Masalah Ditinjau dari Minat. *JNPM (Jurnal Nasional Pendidikan*
17 *Matematika)*, 4(1), 168–179.
- 18 Pradipta, D. D., & Hariyono, E. (2021). The Effectiveness of Science Learning Tools
19 Based on Education Sustainable Development (ESD) to Improve Problem-
20 Solving Skills. *IJORER : Jurnal Internasional Penelitian Pendidikan Terkini*, 2(3),
21 342–353.
- 22 Prastiwi, M. D., & Nurita, T. (2018). Kemampuan Pemecahan Masalah pada Siswa
23 Kelas VII SMP. *E-Journal-Pensa*, 06(02), 98–103.
- 24 Pratiwi, I. I., Wijaya, A. F. C., & Ramalis, T. R. (2019). Penerapan PBL dengan

- 1 Konteks ESD untuk Meningkatkan Hasil Belajar Kognitif Peserta Didik. *Prosiding*
2 *Seminar Nasional Fisika (E-Journal) SNF2019*, 8.
3 <https://doi.org/10.21009/03.snf2019.01.pe.01>
- 4 Prokop, P., Tuncer, G., & Kvasnicak, R. (2007). Short-term effects of field program on
5 students' knowledge and attitude toward biology: A Slovak experience. *Journal of*
6 *Science Education and Technology*, 16(3), 247–255.
- 7 Purnamasari, S., & Hanifah, A. N. (2021). Education for Sustainable Development
8 (ESD) dalam Pembelajaran IPA. *JKPI: Jurnal Kajian Pendidikan IPA*, 1(2), 69–
9 75.
- 10 Rachmawati, B., Dewi, R. P., & Prakoso, J. (2022). Model Problem Based Learning
11 untuk Meningkatkan Rasa Ingin Tahu dan Prestasi Belajar Siswa Kelas V SDN 2
12 Kebutuh. *Jurnal Inovasi Strategi Dan Model Pembelajaran*, 2(3), 349–356.
- 13 Rahman, A., Heryanti, L. M., & Ekanara, B. (2019). Pengembangan Modul Berbasis
14 Education for Sustainable Development pada Konsep Ekologi untuk Siswa Kelas
15 X SMA. *Jurnal Eksakta Pendidikan (JEP)*, 3(1).
- 16 Roesch, F., Nerb, J., & Riess, W. (2015). Promoting Experimental Problem-solving
17 Ability in Sixth-grade Students Through Problem-oriented Teaching of Ecology :
18 Findings of an intervention study in a complex domain. *International Journal of*
19 *Science*, 37(4), 577–598. <https://doi.org/10.1080/09500693.2014.1000427>
- 20 Sulastri, & Pertiwi, F. N. (2020). Problem-Based Learning Model through Contextual
21 Approach Related with Science Problem Solving Ability of Junior High School
22 Students. *Integrative Science Education and Teaching Activity Journal*, 1(1), 50–
23 58.
- 24 Zulqarnain, M., & Fatmahanik, U. (2022). Identifikasi Kemampuan Pemecahan

- 1 Masalah Kontekstual Ditinjau dari Gaya Belajar Siswa. *Jurnal Tadris IPA*
- 2 *Indonesia*, 2(3), 293–304.
- 3
- 4

1 **Table Lists**

2 **Table 1** Experimental conditions (page 13, row 22)

| 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 |

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

6 **Table 2** Instrument validity and reliability (page 18, row 5)

| Indicator | No. Item | Pearson | |
|-----------------------|----------|-------------|--------------|
| | | Correlation | Cr. α |
| Identify the problem | 1 | .726 | .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 |

8 **Table 3** Property scale (page 18, row 10)

| Indicator | No. Items | Measuring time | | | |
|-----------------------|-----------|----------------|--------------|-----------|--------------|
| | | Pre-test | | Post-test | |
| | | 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.

Tabel 4 Learning activities of the control group (page 19, row 12)

| Phases | Learning Syntax | Teacher's Activity | Students' Activity |
|--------|---|--|---|
| 1 | Conveys objectives and prepares students | The teacher explains the learning objectives, background information, and importance of the lesson to prepare 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 and gives feedback to the students. | Following the teacher's instructions during evaluation and reflection. |

Tabel 5 Learning activities of the experimental group (page 19, row 18)

| 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, and 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 each learner's experience. |
| 2 | Organizing students to learn | Assist students in formulating problems and 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 and encourage | Collect data to support learning, conduct literacy, and discussion to conduct |

| | | | |
|---|--|--|--|
| | | students to carry out experiments to achieve problem-solving. | investigations. |
| 4 | Presentation of investigation results | Assist learners in planning and presenting 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. |

Table 6 Gain score per indicator (page 20, row 6)

| 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 |

Table 7 Descriptive statistics and estimation of parameters for the learning achievement and personality tests (page 21, row 8)

| Indicator | Class | n | Measuring time | | | | ANCONA | |
|-----------------------|---------|----|----------------|-----|----------|-----|---------------------|-----|
| | | | Pretest | | Posttest | | Parameter estimates | |
| | | | M | SD | M | SD | M _b | SE |
| Identify the problem | Eks | 32 | 3.0 | 0.8 | 3.3 | 0.7 | 3.5 | 0.1 |
| | Control | 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 |
| | Control | 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 |
| | Control | 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 |
| | Control | 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.

Table 8 Descriptive statistics of pre-test and post-test scores (page 21, row 18)

| | | n | Pre-test | | Post-test | |
|--------------------|---------|----|----------|------|-----------|------|
| | | | 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 |
| Degree of autonomy | Eks | 32 | 2.6 | 0.9 | 3.1 | 1.0 |
| | Control | 32 | 2.2 | 1.0 | 2.6 | 1.4 |

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

2

3 **Table 9** Tests of Between-Subjects Effects (page 22, row 22)

| 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 | | |

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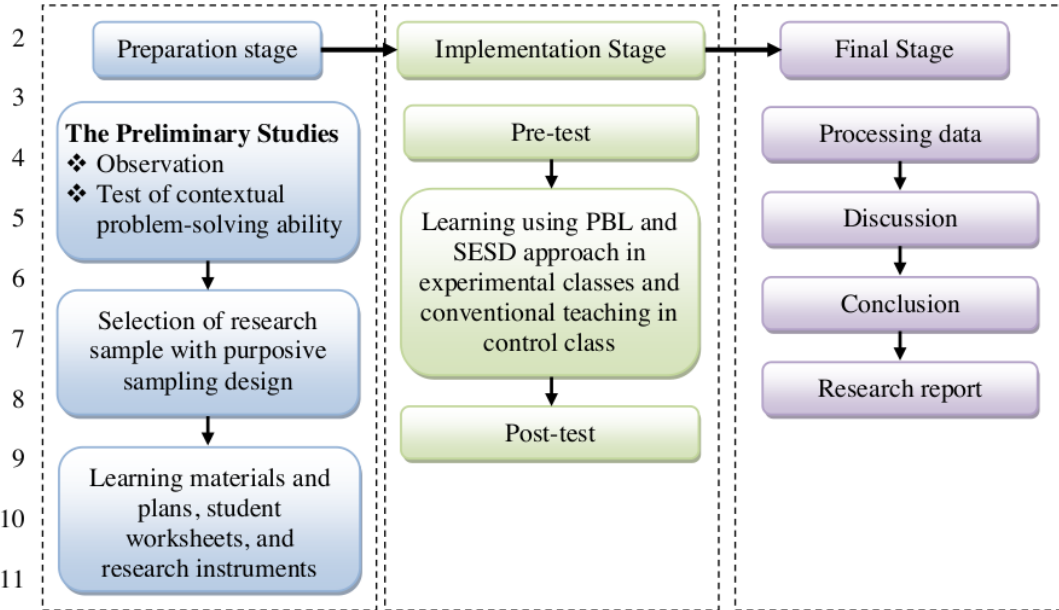
5 **Table 10** Descriptive Statistics (page 23, row 5)

| | Group | Gender | Mean | Std. Deviation | 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 |
| 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 |

6

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1 **Figure Lists**

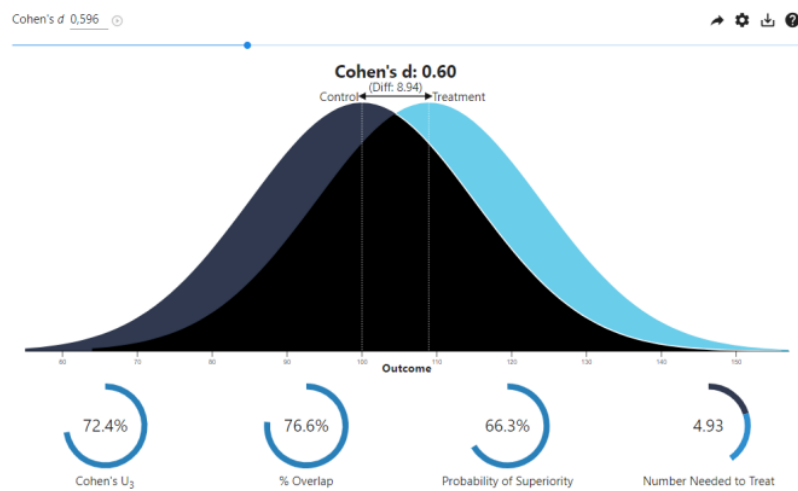


12 **Figure 1** Research procedure (page 17, row 16)



15 **Figure 2** Lesson implementation in the experimental group (page 19, row 19)

16 **Figure 3** Working sample of student worksheet (page 19, row 24)



1

2 **Figure 4** Cohen's d effect size (page 22, row 3)

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