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PROBLEM-BASED LEARNING MODEL IMPLEMENTATION TO IMPROVE STUDENTS PROBLEM-SOLVING SKILLS

Nur Dalilatul Hayaro Indra Waskita*, Beni Setiawan, and Muhamad Arif Mahdiannur
Department of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Indonesia
*Email: nur.18072@mhs.unesa.ac.id

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Abstract: This research aims to improve students' problem-solving skills about additives in food and beverages. This study used one group pretest and posttest design. This study involved thirty-one students from grade 8 at one of the state junior high schools in Gresik Regency, East Java, for the 2021/2022 Academic Year. Data collection techniques using observation assessment sheets, written test assessment sheets, and response questionnaire forms. Based on this study, the results of the percentage of learning implementation of the first meeting of the first session were 91%, the first meeting of the second session was 94%, the second meeting of the first session was 92%, and the second meeting of the second session was 95% by meeting the excellent category. The problem-solving skills were obtained n-gain 0.78 high categories, including the stage of formulating the question 0.67 medium categories, the hypothesis 0.57 with the medium category, determining the solution obtained 0.83 with the high category. The calculation of n-gain in each stage obtained an average n-gain of 0.74 by fulfilling the high category—the response questionnaire form from students with a percentage with excellent categories and positive student responses. The results of this study show that implementing problem-based learning can improve problem-solving skills, especially additives in food and beverages.

Keywords: *Additives, Problem-based Learning, Problem-solving Skils.*

INTRODUCTION

Quality human resources are viewed from the level of education [1]. Therefore, various efforts are made to improve the quality of education. The tight challenges society faces demand a paradigm shift in the education system that can provide students with different important 21st-century skills [2]. 21st Century Skills is learning skills and innovation, which consists of several aspects: critical thinking and problem solving, communication and collaboration, creativity and innovation [3]. Science is one of the subjects with characteristics in its learning activities to observe more natural phenomena, conduct experiments, and learn active processes. The science learning process must prepare students to think logically, critically, and creatively, argue correctly, and solve real-life problems [4]. Because, in essence, learning science is not just memorizing concepts and answering questions. Still, students are expected to be able to understand, observe, analyze, and solve problems that are useful in everyday life. Therefore, academic achievement in science is associated with students' problem-solving ability [5].

Problem-solving skills are one of the learning objectives in terms of curriculum aspects [6]. Problem-solving is a thought process in which students can develop skills to understand problems, analyze problems using interpretation and reasoning to solve problems, and evaluate work [7]. According to Polya, there are four stages of problem-solving ability, including; (1) understanding the problem, (2) device a plan (compiling a problem-solving plan), (3) carrying out the plan (implementing the problem-solving plan), (4) look back (re-examine the results obtained) [8]. Problem-solving skills can add experience in understanding, formulating, and applying concepts taught directly to students [9]. Therefore, these problem-solving skills are very important for students to master [10].

Based on these problems, improvements are needed in science learning. Science learning requires a learning model that can involve students actively contributing to learning in the classroom and can train students in problem-solving skills. The suitable learning model to train students in problem-solving skills is PBL [11]. PBL is an authentic problem-based learning method designed to help teachers provide information in the form of a wealth of material and help students develop thinking, problem-solving skills, intellectual abilities and become independent learners [12]. The stages of the problem-based learning model include problem orientation, organizing students, guiding investigations, developing and presenting work results, and analysis and evaluation [13].

PBL is one of the learning models included in Constructivist Theory. Student-centered learning methods allow students to be active participants in problem-solving, answering questions, collaborating in learning, working in groups to solve problems or projects, and realizing that learning is the responsibility of every student [14]. Constructivism is an approach that sees learning as a processing activity to acquire more profound, meaningful knowledge, and students play an active role in discovering and constructing their knowledge [15]. The use of the PBL model to improve problem skills in this study because the PBL learning model has a distinctive feature that

always starts with a problem that makes students get a more meaningful learning experience because students are directly involved in the learning stages [16].

Additive material is material related to students' daily lives. Because the material has contextual problems, the use of additive material is suitable for applying it to the problem-based learning model [17]. The age of students still at the junior high school level is closely related to food with food additives, attracting students to buy and consume. These food additives can include dyes, sweeteners, flavorings, and even preservatives, which, if misused by the seller, can cause adverse health impacts and cause side effects if excessive on consumers.

Previous relevant research that supports this research was found that the results of problem-based learning models can improve student activity and problem-solving skills [18]. The same research, problem-based learning models can improve student motivation and learning outcomes [19]. The same study showed an increase in operational management learning outcomes during the Covid-19 pandemic that using the Problem Based Learning method can increase student interest and learning outcomes [20]. In addition, states that students do learn more actively in all four phases of problem-based learning [17]. They are more creative, appear confidently quite well, and are better able to communicate and work together in solving problems.

Some studies that show the implementation of problem-based learning are as follows: Problem-based learning improves student activity and problem-solving skills of junior high school students [18], increases motivation and learning outcomes of civic education for junior high school students [19], increases student interest in implementing operations [20], improve active attitudes, self-confidence and communication of high school students [17], improving understanding in IPA [21]. Research that has been carried out shows that improving problem-solving skills with the PBL model strategy will make students more active in learning science to find solutions to real-world problems easily. One example of science learning material sourced from real-life situations is additives. Based on the background above, this study aims to improve students' problem-solving skills by applying problem-based learning models.

RESEARCH METHODS

This research is a pre-experimental study with a research design of one group pretest and posttest design. This design is possible given the constraints and limitations of researchers, both in terms of sample identification, research location, and researcher time constraints. This research was carried out by one group design without a comparison group, with a pretest given at the beginning of the session to find out the initial state of the subject before being given treatment and the posttest given at the end of the treatment.

This research was carried out at one of the junior high schools in Gresik in the Gasal Semester of the 2021/2022 Academic Year within 5 hours which was divided into two meetings with the participation of 31 class VIII students as a sample consisting of 19 men and 12 women. The type of sample used in this study was purposive sampling. Sampling was carried out because researchers could only use one class due to existing restrictions during the Covid-19 pandemic. So researchers chose one class that could represent the characteristics of the entire population. Because in Purposive sampling, researchers not only study existing samples but choose samples that they believe, based on previous information, will provide the data they need [22].

The instruments used in this study are 1) observation sheets for the implementation of learning; 2) the written test is given consisting of five description questions; 3) response questionnaires that are distributed to find out students' responses to the learning methods implemented. The data analysis techniques are 1) observational analysis of the implementation of learning; 2) analysis of written test results; 3) analysis of response questionnaires. The results of data analysis of the implementation of problem-based learning to determine the implementation of learning that the researcher has compiled have been observed by observers on the observation sheet presented in the form of categories in Table 1 and then interpreted in Table 2:

Table 1. Assessment Criteria for Each Phase of Learning Implementation

Score	Category
4	Excellent
3	Good
2	Enough
1	Less

Table 2. Assessment Criteria for Implementation of Learning

Interval Score	Category
$0\% \leq K \leq 25\%$	Not Good Enough
$25\% < K \leq 50\%$	Good Enough
$50\% < K \leq 75\%$	Good
$75\% < K \leq 100\ \%$	Very

[23]

The problem-solving improvement test was analyzed using the normality and n-gain tests. The normalized gain analysis is used to find out how much the yield increases between pretest and posttest using equation 1:

$$<g> = \frac{\%<Posttest> - \%<Pretest>}{100 - \%<Pretest>}$$

The criteria analyze the following according to table 3:

Table 3. Criteria *N-gain*

Range	Criteria
0.70<g<1.00	High
0.30<g0.70	Keep
0.00g≤0.30	Low

[24]

The results of the data obtained from students' responses on the calculation scale used in the questionnaire used the Guttman scale. In the measurement scale with this type, an unequivocal answer will be obtained, namely "yes-no" with a score of 1 for the answer "Yes" and a score of 0 for the answer "No. Then the results of the percentage are categorized according to Table 4:

Table 4. Criteria for Student Responses Percentage

Percentage (%)	Category
81-100	Excellent
61-80	Good
41-60	Enough
21-40	Less
0-20	Very Lacking

[25]

RESULTS AND DISCUSSION

In this research activity, all data in this study will be analyzed descriptive quantitative to determine the quality of learning implementation with the PBL model applied, improving student problem-solving skills and student responses to learning activities. The average results of the percentage of learning achievement obtained in learning can be seen in Table 5.

Based on Table 5, the percentage of learning implementation of the first meeting of the first session was 91%, the first meeting of the second session was 94%, the second meeting of the first session was 92%, and the second meeting of the second session was 95% by meeting the excellent category. The implementation of learning with these two sessions is because of the time the research was carried out and the performance of limited face-to-face meetings. The implementation of the learning process is intended to determine the ability of teachers to manage PBL learning in additive material which refers to the suitability of the performance of the learning process using the planned learning process plan. Table 5 shows that the implementation of learning means that the learning activities and student activities during learning are running very well. It is because there is a phase or syntax of the problem-based learning model in each meeting that has increased [21]. Using the PBL model makes students active in the classroom because students are directly involved in each stage to solve the problems presented [16]. These results are strengthened by research that the PBL learning model is very well used in learning and can improve students' problem-solving skills [27]. Furthermore, to determine the improvement of problem-solving skills through the normalized gain (N-gain) score, the classical assumption test was carried out with the Kolmogorov-Smirnov normality test type with the SPSS 16, which can be seen in Table 6.

Table 5. Average implementation of learning

Meeting To	Session To	Average percentage (%)	Category
1	1	91	Excellent
	2	94	Excellent
2	1	92	Excellent
	2	95	Excellent

Table 6. Results of the Kolmogorov-Smirnov Normity Test Kolmogorov

Kolmogorv-Smirnov	
Asymp. Sig. (2-tailed)	.650

Based on Table 6, it was found that the significance value of the normality test using the Kolmogorov-Smirnov was 0.650, where the score was > 0.05, which means that it can be concluded that the data is normally distributed [28]. The results of further research for improving problem-solving skills for each problem-solving indicator through a normalized gain (N-gain) score can be seen in Table 7.

Table 7. Results of Improving Problem-Solving Skills for Each Problem-Solving

Indicator Problem-Solving Indicators	Pretest	Post-test	N- gain	Category
Identifying problem	58.87	91.33	0.78	High
Formulating questions	39.53	79.85	0.67	Keep
Formulating hypotheses	33.87	71.77	0.57	Keep
Determining solutions	56.45	92.74	0.83	High
Checking the results obtained	41.74	90.32	0.83	High

The analysis results of each problem-solving indicator have been presented in Table 7, where the initial stage, namely with the indicator of identifying the problem, obtained an n-gain of 0.78. In this early stage, students are instructed to identify problems of additive abuse in food and beverages that are closely related to daily life. Following the character of the PBL, which is based on actual problems designed to

help teachers provide information in the form of a lot of material and help students develop thinking, problem-solving skills, intellectual abilities, and become independent learners [12].

The next stage is to formulate questions and formulate hypotheses. Students get an average of 0.67 and 0.57, respectively which fall into the medium category. During the previous learning, students have never been invited to practice formulating questions and hypotheses. In addition, students also do not understand the components of formulating questions and hypotheses that include variables and have not previously been taught to students. The teacher must direct the students and multiply the exercises, in this case, repeatedly. Repetition plays an essential role in the learning process[29]. Because without repetition, the learning material will last in working memory for approximately only 30 seconds. Working memory has limited capacity. Considering that the information taught during learning is not only one topic but many and fast, which will make it inefficient, overcoming new details with practice methods in students is necessary so that the information conveyed enters into long-term memory. Through group discussions on the PBL model, students can express their opinions and ideas [30]. It makes students more excited about the learning process, learning is more meaningful, generates interest, and can increase learning motivation so that the knowledge gained by students will be stored in long-term memory. Furthermore, according to Vygotsky's theory, learning can be done on information that has never been taught to students if new data is still within reach of students or the so-called "zone of proximal development" [31]. The PBL model implementation presents real-life problems directly related to student life [27].

The next stage determines the solution sequentially by 0.83 and. In this stage, students are taught creatively to determine solutions to solving problems according to the experiments carried out. Following observations during the implementation of learning, students are more active in learning. Most students are very enthusiastic about the teaching carried out by trying to ask about problems through the given phenomenon, which is still not understood. In addition, students are excited about trying new things, namely when solving problems through experiments that have never been taught before, because the Covid-19 pandemic hinders them. Piaget's view is that children's activeness influences their cognitive development in constructing knowledge based on experience and interaction with their environment [32]. So that students can determine solutions based on the results of the experiments that have been obtained. It is related to the constructivist theory, which shows that students can better understand and think to solve problems by finding ideas and making decisions because they learn directly through acquiring new knowledge [33].

The stage of checking the results obtained an n-gain score of 0.83 with a high category. At this stage, the student should strive to double-check the results obtained. Students can interpret the results obtained at this stage by drawing the right conclusions. PBL learning students do not sit down and listen to the teacher explaining and taking notes. Still, students are always expected to be active and participate in thinking activities, communicate with their group friends, find information from available sources, and process the data obtained to conclude [15].

Students' responses to learning through the PBL model can be seen in the questionnaires distributed to all students who have done posttest questions. The questionnaire distributed to students consists of 10 questions that students then put a checkmark in the column that has been provided with a range of "Yes" and "No" scores. The results of the response questionnaire percentage of each indicator are presented in Figure 1.

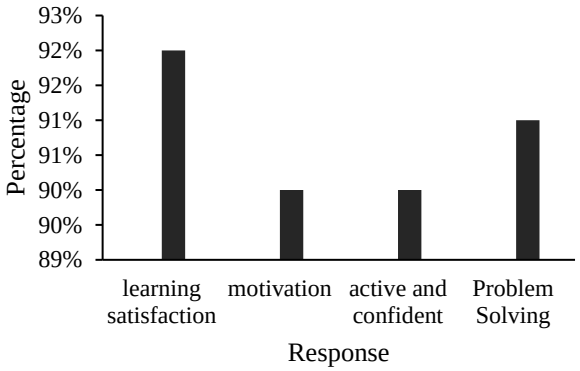

Figure 1. Student response questionnaire results

Based on the graph in Figure 1, it is known that the response results given to all students vary from 90% to 92%. The results obtained showed a very good response from learners regarding the PBL model that had been applied. In the indicators of learning satisfaction, including feelings of pleasure and interest and understanding of topics related to daily life, a percentage result of 92% with an excellent category was obtained. It is proven that when learning takes place, students are happy and understand learning because the learning that takes place is related to students' daily life, namely additives in food and drinks. The criteria of the PBL are authentic, problems originating from the real world, clear and easy to understand, broad and useful for life [12].

The motivation indicator obtained a percentage of 90% with an excellent category. During learning, students of each meeting experience an increase in passive, lack of self-confidence, responsibility for group work is still less enthusiasm, activeness, confidence, and accountability in group activities. Motivation arises from a person but is still driven by external factors [34]. Some forms of motivation given by teachers during learning are: giving grades to student assignments, providing feedback in the form of praise to students, and creating a comfortable

learning atmosphere. Furthermore, the characteristics of the problems posed in the PBL are authentic problems to investigate and find causes students to be challenged to find solutions to these problems [12]. Great curiosity encourages students to try to find answers to problems by discussing them with the group. It can be said that learning motivation is excellent if students participate in learning well to the end, by being proven to carry textbooks, work on the tasks assigned by the teacher, listen carefully to the solutions of the teacher, sit quietly and interact actively [34]. The results of category percentage are very good on this motivation indicator with problem-based learning models [19].

Furthermore, Active and confident indicators result in a yield percentage of 90%. During the learning process, at the beginning of the meeting, participants are still passive in learning and are still busy talking to their classmates because they may not know the learning model applied. However, in the next meeting began to show a positive attitude that is active and confident. It is evidenced during the group presentation, where students present the results of their group work in front of the class and discuss and exchange ideas if there are differences of opinion between groups. The results obtained follow research [35], which states that the learning process with the PBL model can increase student activities, students dare to express ideas and ideas, and students are active and creative in participating in the process of teaching and learning activities [36]. Other research results state that problem-based learning can improve students' enthusiastic attitudes, self-confidence, and communication [17].

The problem-solving indicator gets a percentage of 91% with an excellent category [37]. When given a pretest, students find it difficult to do because they are unfamiliar with the test questions given. However, after the PBL learning took place, students began to understand the stages of problem-solving. Although not all students had the same level of understanding, there were differences after PBL learning. PBL can improve problem-solving skills. Following the Theory of Constructivism, PBL is student-centered that allows students to be active participants in problem-solving, be confident, answer questions, work in teams to solve problems and cultivate awareness that learning is the responsibility of each student [14]. The results of the percentage with excellent categories on problem-solving indicators, which states that the application of problem-based learning can improve the problem-solving skills of junior high school students [18]. These results are strengthened by research that the PBL learning model is very well used in learning and can improve students' problem-solving skills [27].

Based on the results, the response indicators obtained have not reached a percentage of 100% for each indicator. However, students' response at the end of problem-based learning gets very good results. The positive response from the student is in line with the theory of behaviouristic learning. According to behaviouristic theory, learning requires a stimulus. Different stimuli will generate different responses [37]. So this study, students responded positively to learning, and the context provided showed that the stimulus provided was positive.

CONCLUSION

Based on the results, it can be concluded that learning with the PBL model in additives in food and beverages can improve students' problem-solving skills. The statement is supported by the results of the n-gain test of students' problem-solving skills. This improvement is supported by using problem-solving indicators that enable learners' problem-solving skills. The results of the implementation of learning obtained in the category are very good as a trigger for improving problem-solving skills and positive responses from students.

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