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A Classroom Action Research: How to Improving Students' Science Process Skill using Problem-Based Learning Models

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Abstract: The 21st century requires science process skills, yet class 7-B students at UPT SMPN 10 Gresik have not engaged in learning activities that enhance these skills. This is a classroom research study that aims to improve students' science process skills, especially observing, predicting, interpreting, concluding, and communicating, by applying a problem-based learning model. We identified the classroom problem and the plan for the research, collected data by implementing a problem-based learning model, and analyzed and interpreted the data. If the students' science process skills have not reached the expected level, we must reflect and revise the plan. Student worksheets to facilitate problem-based learning in the study. The research sample comprised 32 students in class 7-B UPT SMPN 10 Gresik. We collect data using pretest and posttest science process skills. We analyzed and classified the obtained data using the guidelines for categorizing science process skills. The results showed that the average percentage of students' science process skills in the pre-cycle was 16.0 in the very poor category. In cycle II, the average percentage of science process skills rose to 39.1 in the poor category. Then, in cycle II, the average percentage of students' science process skills was 77.8 in the good category. These findings indicated that the problem-based learning model can improve science process skills. So, science learning activities should use a problem-based learning model so teachers can practice their students' science process skills.

Keywords: Increased; Problem-Based Learning; Science Process Skills; Student Worksheet.

Introduction

Rapid advances in technology and globalization require students to adapt and develop in a constantly changing world [1]. Students need skills to be successful in their lives and society. 21st-century skills can be defined as skills that include knowledge and skills. We must develop these high-level skills to ensure students' success in the information age[2]. Some of the skills required include scientific process skills[3].

Science process skills (SPS) are essential for solving problems in students' lives. Science process skills arise in our minds spontaneously and naturally, are used to divide our ideas into logical steps to find answers to how the world around us works, and are not only used for science but are also used for all situations that require critical thinking activities and make students competitive in global competition in their lives[4]. Science process skills are divided into two categories: essential skills and integrated skills. The basic skills consist of observing, concluding, measuring, communicating, classifying, and predicting using place-time relationships and numbers. Integrated skills include controlling variables, defining operationally, formulating hypotheses, modeling, interpreting, and conducting experiments[5].

In Indonesia, the COVID-19 pandemic led to online and hybrid science learning implementation. Online learning, where students receive only assignments and learn concepts without practice, may reduce their science process skills[6]. Based on the results of interviews and observations of learning activities carried out directly by teachers, students are less able to process and present information from their investigations. Students are also less able to apply what they obtain after conducting investigations to predict related phenomena. According to their investigations, students rarely engage in problem-solving activities.

The teacher, acting as a learning center, typically conducts learning activities using direct instruction. Meanwhile, students can practice process skills in science learning through direct experience, which can deepen their understanding of the material. Students can practice process skills through direct experience because they will better understand the processes or activities they are carrying out[8]. A student-centered learning approach can help students apply their knowledge through direct experience. A student-centered approach to learning (student-centered learning) seeks to increase the freedom and independence of students by involving responsibility and learning flow in the hands of students. Approach-centered learning can encourage students to be more interested in group collaborative activities and connecting ideas[9].

Problem-based learning (PBL) is one model that allows for direct experience during learning activities. PBL is a learning model that facilitates students' learning activities by using problems as a starting point for learning. Based on the learning model PBL, students work together

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and develop ways to gain knowledge through inquiry, information search, and problem-solving[10]. The syntax of PBL, such as problem orientation, organizing the students, individual and group research guides, developing and presenting the work, and analyzing and evaluating the problem-solving process, can train students' science process skills. The problems at the center of the learning process are real-life problems that are unstructured, complex, and open-ended.

Students receive an unstructured problem to start PBL. Then, they illustrate the problem and generate hypotheses for possible solutions. At this phase, students can practice their predicting skills. Students seek more information through investigation and various sources, such as the internet, books, or asking experts. During the investigation, students can practice their observing and interpreting skills. Then, students will give ideas and solutions to the given problems. The last phase is when students evaluate the problem and learning process and share solutions resulting from group discussions with other groups[7]. At this phase, students can practice their communication and concluding skills. The role of the teacher is to guide students, who are responsible for their learning during the problem-solving process[11].

We will train skills such as observing, predicting, interpreting, concluding, and communicating in science. We chose this approach to address the deficiency of these skills among students in VIIB. The learning model, known as problem-based learning, guided the learning process. It is hoped that students will be able to train and improve their science process skills to use them in their daily activities and continuously develop their education at the next level. We conducted this research by implementing a model problem-based learning approach in class VII science material, focusing on ecology and biodiversity. Problem-based learning in science material on the topics of ecology and biodiversity, apart from being able to practice science process skills, can also increase students' attention to problems that occur in the environment[11].

Research Methods

We refer to this type of research as classroom action research. We conduct classroom action research in two cycles, each consisting of two face-to-face meetings. Activities begin with identifying the classroom problem and the plan for the research, collecting data by implementing a problem-based learning model and analyzing and interpreting the data regarding the students' science process skills. If the students' science process skills have not reached the expected level, we must reflect and revise the plan.

The population and research sample used were UPT SMP Negeri 10 Gresik students. As research samples, we selected 32 students from class 7-B UPT SMP Negeri 10 Gresik participating in science lessons on ecology and biodiversity topics. The research instrument in this study is a written test on science process skills, consisting of 10 multiple-choice questions covering the aspects of science process skills indicators: observation, prediction, interpretation, conclusion, and communication. The students' worksheet incorporates work procedures and enrichment to bolster problem-solving activities and enhance students' science process skills. We prepare the content in the students' worksheets using a scientific approach, which involves observing, asking, gathering information (trying), reasoning (associating), and communicating.

We collected the data through tests and observations. The pre-research stage involves interviewing teachers about the implemented learning activities and students' science process skills and observing these activities to ascertain the students' initial abilities. We administer the science process skills test at the start and end of each cycle to gauge the progress in science process skills. We calculate the data from both the pretest and posttest students using the following formula[12]:

$$\text{SPS Score} = \left(\frac{\text{The score obtained}}{\text{Maximum score}}\right) \text{x } 100$$

The following table categorizes the results of the science process skills score[12].

Table 1. Categories for assessing students' science process skills

Score (SPS)	Category
$81 \leq \text{SPS} \leq 100$	Very good
$61 \leq \text{SPS} \leq 80$	Good
$41 \leq \text{SPS} \leq 60$	Enough
$21 \leq \text{SPS} \leq 40$	Poor
$0 \leq \text{SPS} \leq 20$	Very Poor

Results and Discussion

Based on the interview this study began by interviewing the science teacher about the learning activities in class VII B. The tutor teacher clarified that the teacher was at the center of the learning activities, a practice known as teacher-centered learning. The teacher instructs the students first to study the science textbook, after which they present their findings to the class for discussion. The teacher distributes notes to the students, instructing them to commit them to memory. Students rarely carry out investigative activities based on scientific methods and never learn tasks based on problem-solving (Problem-based Learning).

Observation activities are also carried out in class by implementing learning activities that provide students with the opportunity to carry out tasks based on scientific methods with the help of student worksheets) The results show that students do not know or have never used worksheets. Students also have difficulty carrying out scientific activities according to worksheets, so they need teacher guidance.

Next, we conduct a pre-cycle test. The table below describes the results of students' pre-cycle science process skills (SPS) before applying the problem-based learning model.

Table 2. Results of Pre-Cycle Students' Science Process Skills

No	SPS Indicators	Pre Cycle	
		SPS Score Percentage	Category
1	Observing	31.3	Poor
2	Predicting	3.1	Very poor
3	Interpreting	6.3	Very poor
4	Concluding	34.4	Poor
5	Communicating	4.7	Very Poor
	Total	79.8	Very poor
	Average	16.0	

The pre-cycle test results show that 3 of the students' SPS indicators were very poor, while 2 others were poor, and the average student's SPS was poor. To overcome the lack of KPS, it is necessary to apply a problem-based learning model (problem-based learning), in which students carry out problem-solving activities according to scientific methods. In problem-based learning, students investigate and discuss activities based on the provided worksheets. We then apply a scientific approach to train students' SPS.

The first cycle took place over two meetings. During learning activities, students carry out problem-solving activities in their surroundings. Students participate in problem-solving exercises in groups and engage in discussions. The teacher aids the students in their problem-solving activities by using their worksheets. We designed the students' worksheets following the syntax of the problem-based learning model. Learning activities begin with the problem orientation stage, where the teacher reinforces students to analyze the problems provided on the students' worksheets. Next, the teacher organizes students to learn by explaining the activities that pupils must do. Then, students carry out investigative activities in the surrounding environment and look for information in various literature. At this stage, the teacher guides students individually and in groups. After presenting the problem-solving results to the class, all members analyze and evaluate the solutions during class discussions.

Cycle I concludes with students taking a science process skills test. Students take the test in writing, answering 10 multiple-choice questions. The following table displays the results of scientific process skills over a single cycle.

Table 3. Results of Science Process Skills for Each Indicator In Cycle I

No	SPS Indicators	Pre Cycle		Cycle I	
		SPS Score Percentage	Category	SPS Score Percentage	Category
1	Observing	31.3	Poor	54.7	Enough
2	Predicting	3.1	Very poor	34.4	Poor
3	Interpreting	6.3	Very poor	25.0	Poor
4	Concluding	34.4	Poor	46.9	Enough
5	Communicating	4.7	Very poor	34.4	Poor
	Total	79.8	Very poor	195.3	Poor
	Average	16.0		39.1	

The data on the results of the science process skills above is depicted in a bar diagram of the increase in science process skills for each indicator in Figure 1 and the average increase in students' skills in Figure 2.

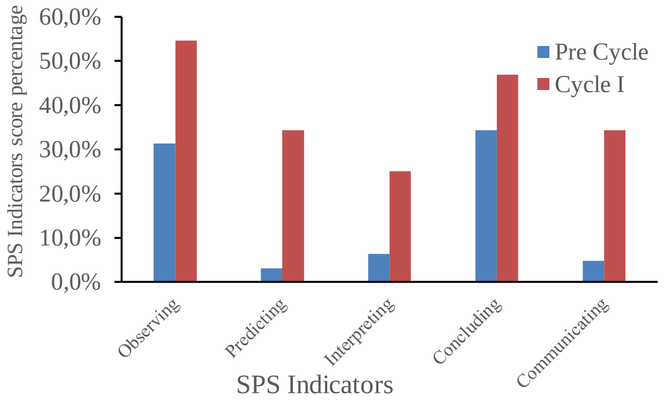

Figure 1. Improvement of Science Process Skills for Each Indicator

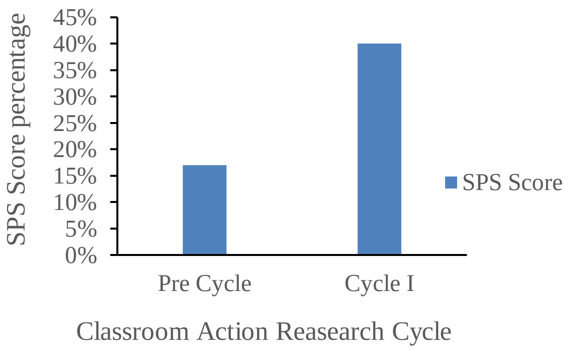

Figure 2. Average increase in science process skills

The above table and bar diagram images show an increase in each student's science process skills indicators. However, it is still in the sufficient and insufficient categories. Students' average science process skills also increased. However, it is still in the very poor category. Problem-based learning provides students with contextual learning to understand the problems presented and construct new knowledge more easily [13]. Students also practice their science process skills to solve the issues presented during investigation activities. Students search for information through observations and literature. In this activity, students can practice their observing skills. After that, students will analyze their data. The group members will share their observation results. With this new information, they will explore the stated problem and come to an understanding of and solution to the identified problem. The next activity is for students to demonstrate the results of their investigations by proposing solutions to previous issues presented [10]. Students communicate the results of their investigations and discussions in front of the class and conduct evaluation and reflection activities through class discussion activities. In this part, students can show and practice their communication and concluding skills[14].

The results of science process skills show that the average is in the poor category because new students are introduced to and carry out problem-solving activities based on scientific methods, so those activities are continued in the next cycle. The goal is to enhance students' science process skills across all indicators. Before continuing to the next cycle, the researcher pays attention to the reflection results to develop a follow-up plan so that learning in the next cycle runs smoothly and can improve students' science process skills to the maximum. Table 4 presents the results of reflection and follow-up plans.

Table 4. Reflection and Next cycle follow-up

No.	Cycle I reflection	Follow-up plan
1.	Students' unfamiliarity with problem-based learning models	The teacher guides students during problem analysis and solution presentation.
2.	Students are not accustomed to carrying out collaborative activities in groups that are heterogeneous in gender.	The teacher tries to form groups that are homogeneous in gender.
3.	Students can apply their knowledge and skills to other cases or problems.	The teacher provides enrichment on the students' worksheets.

Cycle II was carried out over two meetings. The process began with creating a learning plan and worksheets for the students to support the learning activities optimally. At the end of the students' worksheets, the teacher provides additional enrichment so that students can practice their knowledge and skills on other cases or problems. Teachers plan experimental activities in groups to improve students' learning experiences. Direct experimental activities can train students' science process skills and enhance their understanding of concepts.

Learning activities in cycle II begin with the problem orientation stage, where the teacher provides an introduction to students to analyze the problems provided on their worksheets. Next, the teacher organizes students to learn by dividing pupils homogeneously by gender and then explaining the activities that pupils must carry out. Students carry out experimental activities using tools and materials provided by the teacher. At this stage, the teacher guides students individually and in groups, enabling them to conduct experimental activities and utilize the data from their experiments to address the problems analyzed at the start of the lesson. Students present the results of their investigations in the form of problem-solving solutions and the reasons. Students then enrich their worksheets by applying the results of experiments and discussions. After presenting the problem-solving results to the class, all members will analyze and evaluate the solutions.

Cycle II ends with the teacher giving a science process skills test with 10 multiple-choice questions. Table 5 displays the results for each indicator during the pre-cycle, cycle I, and cycle II and the average score.

Table 5. Results of Science Process Skills of Each Indicator

No	SPS indicators	Pre Cycle		Cycle I		Cycle II	
		SPS Score Percentage	Category	SPS Score Percentage	Category	SPS Score Percentage	Category
1	Observing	31.3	Poor	54.7	Enough	78.1	Good
2	Predicting	3.1	Very Poor	34.4	Poor	71.8	Good
3	Interpreting	6.3	Very Poor	25.0	Poor	81.2	Very good
4	Concluding	34.4	Poor	46.9	Enough	71.8	Good
5	Communicating	4.7	Very Poor	34.4	Poor	85.9	Very good
6	Total	79.8	Very Poor	195.3	Poor	388.9	Good
	Average	16.0					

The results in the table above show an increase in students' science process skills for each indicator in Figure 3. Figure 4 illustrates the average increase in students' science process skills.

Based on the data on the results of the science process skills above, students' science process skills for each indicator aspect have increased, including 2 indicators in the very good category and 3 other indicators in the very good category. All indicators are in the excellent category at minimum. The average student's science process skills score is also good. During cycle II learning activities, students were able to be actively involved in investigation activities and group discussions. However, experimental activities require teacher guidance because students rarely do experiments. We halted the research in cycle II because it had reached the good category.

The scientific approach places students at the center of learning, allowing them to participate more actively in learning activities[15]. The teacher acts as a facilitator and guide during learning activities. Problem-based learning also allows students to practice their science process skills through investigative activities to solve the problems they face[16]. Students also improve their communication skills through discussion and presentation[17]. Using real issues in students' daily activities allows them to construct new knowledge by combining it with their experiences[14].

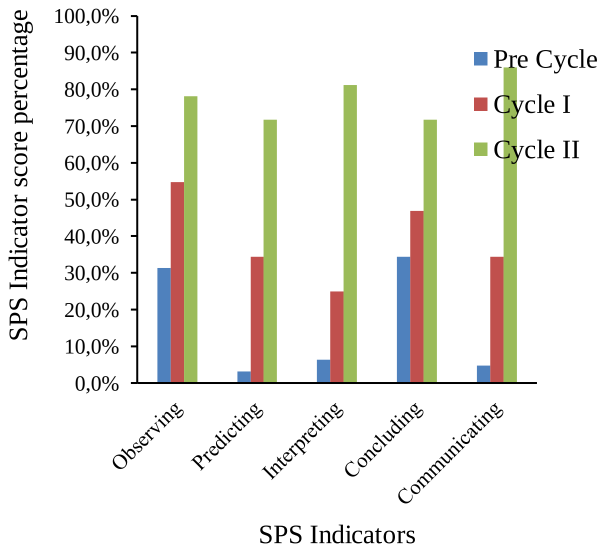

Figure 3. Improvement of Science Process Skills for Each Indicator

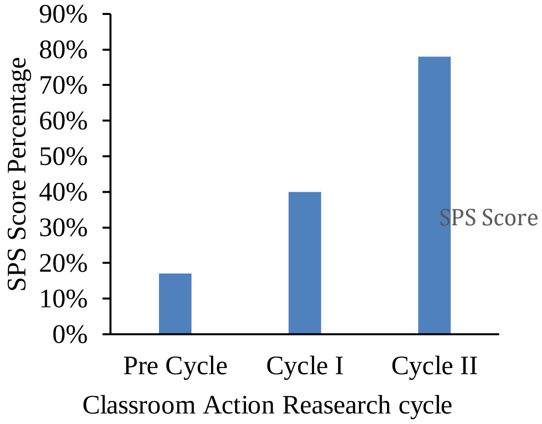

Figure 4. Average increase in science process skills

In cycle II, besides applying problem-based learning and a scientific approach that can train students' science process skills, teachers also provide experiential learning through direct experimental activities and add enrichment to the students' worksheets to maximize learning activities[18]. Based on the results of science process skills in cycle II, this learning can improve students' science process skills in the excellent category. Experimental activities allow students to utilize their senses, honing their observation skills. Experimental activities also enable students to practice predicting and interpreting skills through data analysis activities to determine relationships between variables. Students then conclude the experimental results and convey them in written or oral form[19]. Teachers also provide enrichment on students' worksheets so that students can apply the knowledge and skills gained to different cases or problems. Providing enrichment can influence students' work performance[20].

Some research that supports this result, such as those by Kasuga et al., has shown an increase in performance in developing students' science process skills compared to the traditional teaching methods. During the implementation of PBL, students are given some activities in which each student actively participates to solve the identified problem[10]. Pouzuelo-Muños et al. also researched how to develop science process skills with 16-year-old students in Spain using a problem-based learning approach. The result is that students can develop science skills, including identifying problems, formulating researchable questions, formulating hypotheses and predictions, designing and carrying out experiments, observing, measuring, collecting data, interpreting results, and communicating conclusions through completing the phases of the PBL process[21]. Zainy also found that using problem-based learning in Saadallah Wannous School significantly influences the students' science process skills compared to conventional learning[22].

Conclusion

Science process skills can improved in class 7-B students at UPT SMPN 10 Gresik by implementing problem-based learning models bolstered by student worksheets tailored to the syntax of problem-based learning and student needs. The students' science process skills were very poor during the pre-cycle, but they improved to a poor level in cycle II and then improved to a good level.

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