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IMPROVING SCIENTIFIC LITERACY SKILLS INTEGRATED WITH THE PROBLEM-BASED LEARNING MODEL

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ABSTRAK

Abstract: *This study aims to improve elementary school students' scientific literacy skills through the implementation of the* Problem Based Learning *(PBL) model. The research subjects were 28 fifth-grade students at SDN 26 Kota Sorong. The method used was classroom action research conducted in two cycles. Instruments included scientific literacy tests, observation sheets, and interviews. The results showed that the average scientific literacy score increased from 55.6 in the pretest to 79.2 in the posttest, with a total improvement of 42.4%. Improvements occurred across all aspects of scientific literacy, including explaining scientific phenomena, designing and evaluating scientific investigations, and interpreting data and evidence scientifically. The PBL model was proven to encourage active student engagement, foster critical thinking skills, and make the learning process more meaningful. Therefore, PBL is recommended as an effective instructional approach to enhance scientific literacy in elementary school science learning.*

Abstrak: Penelitian ini bertujuan untuk meningkatkan kemampuan literasi sains siswa sekolah dasar melalui penerapan model pembelajaran *Problem Based Learning* (PBL). Subjek penelitian adalah siswa kelas V SDN 26 Kota Sorong yang berjumlah 28 orang. Metode yang digunakan adalah penelitian tindakan kelas dengan dua siklus. Instrumen yang digunakan meliputi tes literasi sains, lembar observasi, dan wawancara. Hasil penelitian menunjukkan bahwa rata-rata kemampuan literasi sains siswa meningkat dari 55,6 pada pretest menjadi 79,2 pada posttest, dengan peningkatan sebesar 42,4%. Peningkatan terjadi pada seluruh aspek literasi sains, yaitu menjelaskan fenomena secara ilmiah, mendesain dan mengevaluasi penyelidikan ilmiah, serta menafsirkan data dan bukti secara ilmiah. Model PBL terbukti mendorong keterlibatan aktif siswa, mengembangkan kemampuan berpikir kritis, dan menjadikan proses pembelajaran lebih bermakna. Oleh karena itu, model PBL direkomendasikan sebagai pendekatan pembelajaran yang efektif dalam meningkatkan literasi sains di sekolah dasar.

A. INTRODUCTION

The Programme for International Student Assessment (PISA) is an international assessment that measures the abilities of 15-year-old students. PISA defines scientific literacy as the ability to use scientific knowledge, identify problems, and draw conclusions based on evidence, in order to understand and make decisions about the natural world and the changes that occur as a result of human activity (Aini, 2022). Literacy is the ability of individuals to read, write, and understand information. Scientific literacy refers to the ability to use scientific knowledge, identify questions, and explain scientific phenomena based on scientific evidence (Rafi'y et al., 2023). One of the goals of scientific literacy for students is to develop scientific knowledge and critical thinking in problem-solving to support students' holistic development in understanding and participating in a world increasingly influenced by technology and information (Tamam & Subrata, 2022). The right learning model can make learning more engaging, interactive, and able to develop students' cognitive and psychomotor skills (Sumarni et al., 2021). The Problem Based Learning (PBL) model is a problem-based learning model that involves students in problem-based activities to gain knowledge and the ability to solve problems (Pasiri, 2023).

The urgency of this research lies in the fact that Southwest Papua Province, which has 532 elementary schools, has very low literacy levels, especially in science. One such school is SD Negeri 26 Kota Sorong. It was found that the minimum mastery criterion (KKM) for Grade 4 Science is 70. Of the 15 students, 80% (12 students) completed their assignments, while 20% (3 students) did not submit theirs. Among those who submitted, 50% (6 students) had incorrect answers that did not align with the lesson concepts, while the other 50% (6 students) answered correctly. In this era of rapid technological advancement, students must have scientific knowledge to face misinformation on social media, provide accurate evidence, and contribute positively to society. Problem-based learning is a model that encourages active student involvement in discovering concepts through problems presented in class, aiming to train students' problem-solving abilities and engage their mental activity in understanding learning concepts (Gede Heri Pilawinata et al., 2024).

According to (Aradia & Anggiyani, 2024), the lack of scientific literacy among students is caused by textual and contextual teaching methods. Students are not yet able to communicate and connect various scientific topics, let alone apply complex and abstract concepts in real-life situations. Recognizing the results of the PISA assessment, there is a need for instructional methods that prepare students to be scientifically and technologically literate, think logically, critically, and creatively, express opinions appropriately, and collaborate effectively. Scientific literacy is the ability to understand science, communicate science (both orally and in writing), and apply science to solve problems with a high level of awareness and sensitivity to oneself and the environment (Dewanti et al., 2022). This is supported by (Kaniyah et al., 2022), who state that scientific literacy allows students to independently analyze concepts and directly experience examining and understanding the natural world scientifically. Teachers must foster scientific literacy so that students develop specific skills during learning, actively engage in their environment, and solve problems and make informed decisions (Mahmudah et al., 2022). Scientific literacy is a fundamental foundation for elementary students to understand the world around them and make appropriate decisions. However, many students struggle to grasp scientific concepts due to traditional and passive teaching methods. Integrating the PBL model can promote deeper understanding by involving students in real-world problems that stimulate curiosity and critical thinking (Mamusung et al., 2023). Therefore, this research is crucial to improving elementary students' scientific literacy through the application of an effective and meaningful PBL approach.

Teachers are vital in the learning process. Therefore, they must improve their teaching skills to maximize student learning, even though many still rely on traditional teaching models and rarely use learning media (Wijayanti et al., 2024), to present engaging learning concepts, it is important to initiate the process through innovative instructional models (Sumarni et al., 2021). Thus, the researcher believes that the Problem Based Learning model is suitable for enhancing students' scientific literacy in science subjects. Problem Based Learning involves presenting students with problems and assigning them to find solutions under the teacher's guidance. (Malikhatun & Artharina, 2023) explain that problem-based learning is an instructional approach that presents contextual problems to stimulate students to learn. This model can serve as a motivational trigger for students, increasing their curiosity.

Problem-based learning emphasizes student-centered activities, which are expected to improve their scientific literacy and academic performance. Many educators around the world have adopted this model to enhance classroom learning quality. It has positively impacted students' learning outcomes and various educational aspects. In facing the 21st century, learning paradigms and student competency demands are shifting towards critical thinking, making the PBL model highly promising for educators aiming to prepare students for modern challenges (Rorimpandey et al., 2023).

Relevant research by (Supriyanto et al., 2022) highlights PBL as a strategy requiring students to actively investigate and solve problems. The PBL model fosters critical thinking and encourages students to collaborate, ask questions, find answers, and articulate their learning. Similarly, (Syafaat et al., 2023) emphasize that problem-based learning is among several innovative teaching strategies. It engages students in active learning and problem-solving using scientific methods. This model helps students develop critical thinking, discipline, communication, tolerance, responsibility, motivation, and participation (Sonia & Miterianifa, 2024).

The PBL model is designed to help students develop intellectual, critical thinking, problem-solving, and teamwork skills. Problem-solving activities are grounded in real-life situations, with learning beginning from presenting students with problems. Dewey, Akinoglu, and Tandogan, cited in Abidin et al., (2018), emphasize learning through practice and experience, where students learn operational knowledge and work in groups to

address real-world issues. The steps of the PBL model start with presenting a problem aligned with students' real-life experiences. The second step is guiding students in learning. The teacher acts as a facilitator, motivating students to find their own solutions and answers, and fostering their responsibility in team participation.

Research results Novita (2023) that demonstrated through data analysis that the PBL model yields better results than expository teaching. This difference suggests that PBL significantly impacts students' scientific literacy. Another study by (Mulyani, 2020) confirmed that PBL is highly effective in improving scientific literacy.

This study introduces a new approach to enhancing scientific literacy among elementary school students in Southwest Papua by integrating the Problem Based Learning model tailored to the local context. Its novelty lies in implementing PBL to develop critical thinking and problem-solving skills while addressing real issues relevant to students' everyday lives. Few studies have explored the application of PBL in science education in remote, frontier, and underdeveloped regions, particularly Southwest Papua. Thus, this research contributes significantly to developing contextual instructional models in the area.

The objectives of this study are: 1) To improve students' attitudes toward scientific literacy through problem-based learning, and 2) To analyze the success level of students' scientific literacy within the problem-based learning model. Nonetheless, there are still misconceptions when students apply science concepts in answering questions. Students also struggle with literacy-based science problems that require strong reading comprehension. They are more comfortable with rote-based questions but find it challenging to use reasoning to connect scientific concepts. As a result, students do not achieve optimal scores. Based on these learning challenges, the research problem is formulated as follows: Can the use of the Problem Based Learning model improve scientific literacy skills in science subjects for Grade 4 students at SD 26 Kota Sorong, Southwest Papua.

B. RESEARCH METHOD

This is a quantitative study using a quasi-experimental research design. This approach was chosen to determine the effect of the Problem-Based Learning (PBL) model on improving elementary school students' scientific literacy skills (Nurulanningsih, 2023).. The design used is the Nonequivalent Control Group Design, which involves two groups: an experimental class and a control class. The research design is as follows:

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experimental	O_1	PBL Model	O_2
Control	O_1	Conventional Learning	O_2

The population and sample in this study are all fourth-grade students of SD 26 in Sorong City, Southwest Papua, totaling 30 students, consisting of 14 girls and 16 boys. The sample was selected using purposive sampling, considering the equivalence of academic characteristics between classes. The sample consists of two classes, each assigned as the experimental and control group.

The main instrument in this study is a science literacy test that includes three aspects: scientific knowledge, science process skills, and real-life application. The test consists of multiple-choice and open-ended questions, developed based on science literacy indicators and tailored to the learning theme. The instrument was validated by experts and tested to ensure its validity and reliability. Data were collected through (1) pretest and posttest to measure improvements in science literacy before and after the treatment, and (2) observation during the learning process to ensure the implementation of the PBL model.

Data analysis techniques the results of the pretest and posttest were analyzed using descriptive and inferential statistical techniques. The analysis steps included the normality test (e.g., Kolmogorov-Smirnov), homogeneity of variance test (Levene's Test), and independent samples t-test to determine the differences between the experimental and control classes (Sonia & Miterianifa, 2024).

C. RESULT DAN DISCUSSION

1. Research Result

Based on the findings of the study through observations of science literacy outcomes using the Problem-Based Learning (PBL) model, a significant result was obtained with an improvement percentage of **86.8%**. The students' conceptual understanding results are summarized in Table 2 below:

Table 2. Data on the Improvement of Science Literacy of SDN 26 Kota Sorong Students

Aspect of Science Literacy	Pretest (Average)	Posttest (Average)	Improvement (%)
Explaining phenomena scientifically	56.4	79.2	40.4
Designing and evaluating scientific investigations	52.1	75.8	45.5

Aspect of Science Literacy	Pretest (Average)	Posttest (Average)	Improvement (%)
Interpreting data and scientific evidence	58.3	82.6	41.6
Overall Average	55.6	79.2	42.4

Based on Table 2, it can be seen that there was a significant improvement in all aspects of students' science literacy after the implementation of the Problem-Based Learning (PBL) model.

a. Explaining Scientific Phenomena
   The average pretest score in this aspect was 56.4 and increased to 79.2 in the posttest, with an improvement percentage of 40.4%. This indicates that students became more capable of connecting scientific concepts with real-life phenomena. Through the PBL model, students were exposed to contextual problems that required them to understand and explain phenomena scientifically.
b. Designing and Evaluating Scientific Investigations
   This aspect showed the highest improvement, reaching 45.5%. This suggests that PBL is highly effective in encouraging students to think critically when designing, conducting, and evaluating scientific investigations. Problem-based learning activities encouraged students to develop skills in planning problem-solving steps and reflecting on experimental outcomes.
c. Interpreting Data and Scientific Evidence
   This aspect saw a 41.6% increase, from an average of 58.3 in the pretest to 82.6 in the posttest. This shows that students became more skilled in reading data, drawing conclusions based on evidence, and interpreting results logically. Group discussions and result presentations in the PBL model provided space for students to enhance their analytical skills.
d. Overall Science Literacy Average
   Overall, students' science literacy skills increased from an average of 55.6 to 79.2, or by 42.4%. This reflects the success of the PBL model in improving the quality of students' understanding and science literacy skills.

The improvement across all these aspects reinforces the view that the Problem-Based Learning model can create a more active, meaningful, and challenging learning environment. Problem-based learning not only encourages students to understand scientific concepts but also instills a systematic and critical scientific way of thinking. Thus, the implementation of the PBL model is a relevant strategy for developing elementary students' science literacy in facing the challenges of 21st-century learning.

D. CONCLUSION DAN SUGGESTION

Based on the results of the research conducted at SDN 26 Kota Sorong, it can be concluded that the implementation of the Problem-Based Learning (PBL) model has proven effective in improving students' science literacy skills. This is reflected in the increase in students' average scores on the science literacy test, from 55.6 in the pretest to 79.2 in the posttest, with an overall improvement of 42.4%. More specifically, all measured aspects of science literacy showed significant improvement. In the aspect of explaining scientific phenomena, students' scores increased by 40.4%. Meanwhile, the aspect of designing and evaluating scientific investigations showed the highest improvement, at 45.5%. The third aspect, interpreting data and scientific evidence, increased by 41.6%. This improvement indicates that students became more active, critical, and able to apply scientific concepts in real-life contexts through problem-solving-based learning. The results demonstrate that PBL is not only effective in enhancing content knowledge but also in developing essential scientific skills. Students were more engaged in exploring scientific problems, formulating hypotheses, conducting investigations, and reflecting on findings. This type of active learning environment allowed them to think more deeply, collaborate with peers, and express their ideas more confidently. These findings support the view that learning is most effective when students are given opportunities to explore and discover knowledge through authentic, meaningful tasks.

Given these positive outcomes, it is strongly recommended that the PBL model be adopted and consistently implemented in science education, particularly at the elementary school level. The development of science literacy from an early age is crucial in preparing students for future academic challenges and encouraging lifelong learning. Teachers, as key facilitators of this model, need continuous professional development to enhance their ability to design effective problem-based learning scenarios, manage classroom discussions, and guide students in their inquiry process. Moreover, institutional support is essential to the successful implementation of PBL. Schools and educational authorities should provide the necessary resources, such as teaching materials, laboratory tools, and adequate infrastructure. Policies should also be designed to encourage innovation in teaching practices and support teachers in experimenting with student-centered approaches. Professional learning communities and peer collaboration among

teachers can further strengthen the adoption of PBL. In addition, it is important to conduct follow-up research to further explore the impact of the PBL model in different educational settings. Future studies could investigate the effectiveness of PBL across various subjects, such as mathematics, social studies, or language learning, as well as at different grade levels. Longitudinal studies may also provide insights into the long-term effects of PBL on students' cognitive and affective development. In conclusion, the findings from this research contribute to the growing body of evidence that supports Problem-Based Learning as an effective pedagogical model. By fostering scientific literacy, critical thinking, and real-world problem-solving skills, PBL prepares students to face the dynamic challenges of the 21st century. Its consistent implementation in schools can create a more engaging, equitable, and future-oriented education system.

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