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Application of the Problem-Based Learning Model to Improve Students' Scientific Literacy Abilities

Willyam Santos Alfrado[1)], Y Yennita[✉2)], N Nelwisman[3)], Ina Lestari[4)]
[1)] *Physics Teacher, SMA Plus Bina Bangsa, Indonesian*
[2,4)] *Department of Mathematics and Science Education, Universitas Riau, Indonesian*
[3)] *Physics Teacher, SMA Plus Pekanbaru, Indonesian*

e-mail: [1)] willyamhutauruk@gmail.com
[✉2)] yennita@lecturer.unri.ac.id

Abstract: *Big changes have occurred in the 21st century due to technological advances and rapid developments in various fields. The key to success in facing the challenges of the 21st century is scientific literacy, namely the ability to understand, communicate, and apply scientific concepts in real life. However, in reality, practicing 21st-century skills is still rarely done because learning is teacher-centered. This research aims to improve students' scientific literacy skills through a problem-based learning model. The research was conducted in class X MS 4 with 28 students. The research was carried out in two cycles, each consisting of 4 stages: planning, implementation, observation for evaluation, and reflection. From the comparative analysis of scientific literacy abilities in cycles 1 and cycle 2, it was found that scientific literacy abilities in cycle 1 with an average score of 67 in the middle category experienced an increase in cycle 2 with an average score of 77 in the high categories. Based on the research results, it can be concluded that applying the problem-based learning model can improve students' scientific literacy abilities in physics materials.*

Keywords: *21st-century skills, science literacy, problem-based learning, science learning*

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Penerapan Model Pembelajaran Berbasis Masalah untuk Meningkatan Kemampuan Literasi Sains Peserta Didik

Abstract: Perubahan besar terjadi dalam abad ke-21 karena adanya kemajuan teknologi dan perkembangan cepat di berbagai bidang. kunci sukses menghadapi tantangan abad 21 adalah melek sains (*science literacy*) yaitu kemampuan dalam memahami, mengkomunikasikan, serta mengaplikasikan konsep sains dalam kehidupan nyata. Namun pada kenyataannya untuk melatih keterampilan abad 21 masih jarang dilakukan karena pembelajaran berpusat pada guru. Tujuan dari penelitian ini adalah untuk meningkatkan kemampuan lirerasi sains peserta didik melalui

✉ *Correspondent Author*

model problem based learning. Penelitian dilakukan di kelas X MS 4 dengan 28 peserta didik. Penelitian dilakukan sebanyak dua siklus dengan masing-masing siklus terdiri dari 4 tahap, yaitu perencanaan, pelaksanaan, observasi/evaluasi, dan refleksi. Analsis perbandingan kemampuan literasi sains pada siklus 1 dan siklus 2 didapatkan hasil bahwa kemampuan literasi sains pada siklus 1 dengan nilai rata-rata 67 pada kategori sedang mengalami peningkatan pada siklus 2 dengan nilai rata-rata 77 dengan kategori tinggi. Berdasarkan hasil penelitian dapat disimpulkan bahwa penerapan model *problem based learning* dapat meningkatkan kemamampuan literasi sains peserta didik pada materi fisika.

Keywords: keterampilan abad 21, literasi sains, *problem based learning*, pembelajaran sains

Introduction

Education in the 21st century requires a paradigm shift in the learning process, where skills that suit the needs of the times become the main priority to prepare students to have relevant competitiveness. Big changes have occurred in the 21st century due to technological advances and rapid developments in various fields (Hanipah et al., 2023). To ensure the smooth implementation of learning, students must have several key competencies, such as learning and innovation skills, mastery of media and information, and the ability to manage life and career (Lendeon & Poluakan, 2022).

Efforts to improve the expected quality of Human Resources (HR), this aspect is reflected in the essence of the educational philosophy which aims to realize the three most fundamental dimensions of humanity. (1) The affective dimension is reflected in the level of faith and piety, ethical norms and beauty, as well as high morality and good character; (2) The cognitive dimension is reflected in the ability to think and intellectual intelligence to explore knowledge and develop and master technology; and (3) The psychomotor dimension is reflected in the ability to develop technical skills and practical expertise. All of this aims to prepare students to be ready to face life (Majid, 2023).

Physics is a scientific discipline in the field of Natural Sciences which studies the physical properties of objects in nature. Knowledge in physics is represented mathematically so that it can be understood and utilized by humans to improve human welfare (Harefa & Gumay, 2021). Learning physics is closely related to everyday life. Students already have the daily experience that is relevant to physics (Astalini et al., 2019). Thus, learning physics cannot be separated from mastering concepts, applications, solving physics problems, and working scientifically. However, much physics learning is only oriented towards mathematical concepts and practice questions.

The 2022 Program for International Student Assessment (PISA) research results were just announced on December 5, 2023. Indonesia is ranked 68th with the following scores: Mathematics (379), Science (398), and Reading (371) (Kemendikbudristek, 2023). Data from the PISA survey shows that students' scientific literacy abilities in Indonesia are in the low category. Several factors that cause low student scientific

literacy in Indonesia include students' low understanding of the essence of science, lack of application of scientific concepts in everyday life, understanding of science which is limited to theory only, difficulty in reading and interpreting visual data such as pictures, diagrams, and tables, as well as students' lack of ability to think critically, reason scientifically, think creatively, and solve problems effectively (Sopandi, 2019).

In line with this, the factors that cause low scientific literacy can be seen from several studies that have been conducted. The decline in scientific literacy skills among Indonesian students is caused by factors such as the curriculum and education system, the teaching strategies chosen by teachers, the availability of learning tools and facilities, and the quality of the teaching materials used (Sutrisna, 2021). Apart from that, according to research conducted by Fuadi et al., (2020) factors causing the low scientific literacy abilities of Indonesian students put forward by researchers related to the results of PISA Indonesia include the choice of textbooks, misconceptions, non-contextual learning, low reading abilities, and a learning environment and climate that is not conducive.

Based on observations in one of the schools in Riau Province, most physics learning takes place with a teacher-centered approach. Learning activities are mostly carried out by teachers, such as lectures and explaining in front of the class. Students listen more and do practice questions. This causes students to lack 21st-century skills. When the author gives questions with long discourse and contains various information about the movement of satellites around the earth, students are less interested in reading the question discourse. Most students ask the author about some information that should be found in the discourse. Thus, students lack literacy skills. This is because the learning models that are often used in class are mostly teacher-centered. So students' science literacy becomes low.

Scientific literacy is one of the most important skills that students have because it is related to the use of science (Yustina, 2020). Scientific literacy according to PISA is defined as the ability to use scientific knowledge, identify questions, and draw conclusions based on evidence, to understand and make decisions regarding nature and changes made to nature through human activities (Widiawati et al., 2019). One of the keys to success in facing the challenges of the 21st century is scientific literacy, namely the ability to understand, communicate, and apply scientific concepts in real-life (Utami et al., 2022).

Increasing students' scientific literacy abilities and understanding can be achieved through implementing appropriate learning models and utilizing technology as a support (Fitriyana et al., 2020). To improve students' scientific literacy skills, it is necessary to improve the quality of educators and integrate the necessary literature into the curriculum as mandatory reading (Kristyowati & Purwanto, 2019).

Therefore, educators are advised to apply learning models that can activate the role of students during the learning process. One learning model that can increase student involvement is Problem-Based Learning (PBL). PBL is a way of learning by exposing students to a problem/issue to be solved or conceptually resolved open problems in learning (Hotimah, 2020). Problem-based learning aims to help students

develop investigation and problem-solving skills, provide opportunities for students to learn the experiences and roles of adults, and enable students to improve their thinking abilities and become independent students (Junaidi, 2020). Apart from that, PBL is also related to learning that covers wider aspects of life (life-wide learning), the ability to understand and apply information, work together in teams, as well as reflective and evaluative thinking skills (Maulana Arafat Lubis & Azizan, 2019). PBL can also include character values in learning to prepare students for life and career skills, such as diversity, curiosity, communication skills, creativity, discipline, environmental awareness, and responsibility. Based on this background, this research aims to improve students' scientific literacy skills by using the PBL learning model.

Research Methods

The research carried out was classroom action research. The research was carried out in two cycles with stages of planning, implementation, observation/ evaluation, and reflection. Stage method according to Arikunto (2010) carried out in this research are as follows:

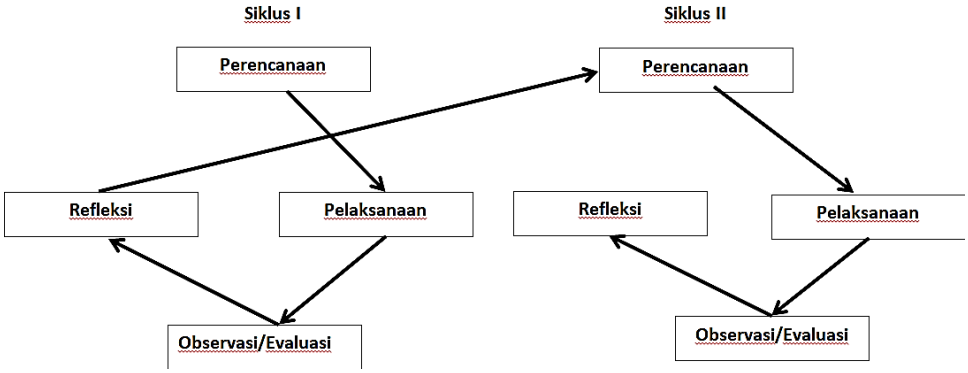

Figure 1. Arikunto method classroom action research cycle.

This research is qualitative research to describe students' scientific literacy abilities. The research was conducted at SMA Negeri Plus Riau Province, Pekanbaru City, Riau Province, Indonesia. The research instrument used was a written test of 9 questions given to 28 class X MS 4 students.

Table 1. Competency and context of scientific literacy ability

Competence	Context
Explain phenomena scientifically	Physical Systems
Evaluate and design scientific investigations	Earth and Space Systems
Interpret data and evidence scientifically	Living Systems

Source: (OECD, 2019).

This research was carried out over two continuous cycles to get better results so that indicators of success were achieved. The instruments used are problem-based learning worksheets designed to develop students' scientific literacy abilities and scientific literacy ability test sheets. The improved scientific literacy competencies can be seen in Table 1. The data analysis technique used is descriptive analysis with the assessment criteria shown in Table 2.

Table 2. Criteria for Assessment of Scientific Literacy Ability

Presentation	Predicate
86-100	Very high
76-85	High
60-75	Middle
55-59	Low
≤54	Very low

Source: (Purwanto, 2009).

Results and Discussion

Students' scientific literacy abilities are seen in three competencies, namely explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically. In cycle 1, students' scientific literacy skills are trained using learning models and LKPD based on problem-based learning models. In terms of the ability to explain phenomena scientifically, students are trained in the problem of pacing culture on impulse and momentum material. Students are expected to be able to explain the concept of impulse, namely the force of the paddle on the water and the momentum of a line that is moving at a certain speed. In the competency to evaluate and design investigations, students are asked to evaluate the influence of the direction of the dancer's jump on changes in line speed. To know this, students must first understand the concept of the law of conservation of momentum. In the competency to interpret data and design scientific investigations, students are trained by interpreting impulse and momentum graphs. After being trained in the three scientific literacy competencies, students were tested and got the results as shown in Table 3.

Table 3. Cycle I literacy ability profile

Competence	Average value	Category
Explain phenomena scientifically	79	High
Evaluate and design scientific investigations	52	Very low
Interpret data and evidence scientifically	71	Middle
Total Average Value	67	Middle

After seeing the results of literacy skills in cycle 1 in the middle category, in cycle 2 students' literacy skills were retrained with the same competencies: explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically. Cycle 2 trained on simple harmonic movement material using problem-based learning models and LKPD. The ability to explain phenomena scientifically is trained with the problem of two people riding a swing with identical swings and different masses of people. Students are asked to explain how the two people move. Does it include simple harmonic motion and will their movements be simultaneous if they start from the same position? The ability to evaluate and design scientific investigations is trained by carrying out mathematical pendulum experiments in Phet Simulation to evaluate and investigate whether there is an influence of the length of the swing rope and the mass of the load on the swing motion according to the problem. The ability to interpret data and scientific evidence is trained by presenting mathematical pendulum experimental data into graphs of the relationship between the squared period and the length of the rope and the relationship between the squared period and the load period. After being trained in scientific literacy skills, students were then tested and got the results in Table 4.

Table 4. Cycle 2 literacy ability profile

Competence	Average Value	Category
Explain phenomena scientifically	79	High
Evaluate and design scientific investigations	77	High
Interpret data and evidence scientifically	74	Middle
Total Average Value	77	High

Based on Table 4, it can be seen that there is an increase in scientific literacy skills from cycle 1, namely with a score of 77. The highest average score is in the competency to explain phenomena scientifically with a score of 79, followed by the competency to evaluate and design scientific investigations with a score of 77, and interpret data and scientific evidence with a score of 74. The profile of scientific literacy abilities in both cycles based on each competency can be seen in Figure 2.

Based on Figure 2, it can be seen that the competency to explain phenomena scientifically has not increased from cycle 1 and cycle 2. The competency to evaluate and design scientific investigations has increased significantly from an average score of 52 in the very low category in cycle 1 to an average score of 52. average 77 with a high category in cycle 2. According to Rahmadani et al., (2022) the low ability of students to evaluate and carry out investigations is due to the quality of students' memory affecting their ability to carry out evaluations and scientific research. Furthermore, according to the National Research Council, the skills of evaluating and designing scientific investigations are students' skills in identifying, distinguishing, proposing, evaluating,

describing, and judging scientific knowledge in a complex manner (Cleeton, 2011). The skills of evaluating and designing scientific investigations are very difficult skills to teach. The increase occurred because in cycle 1 students evaluated and carried out investigations not through experiments, but only using the mathematical equation for the law of conservation of momentum. Meanwhile, in cycle 2, students carry out experiments through PhET Simulation simulations to evaluate and investigate temporary answers based on the problems presented.

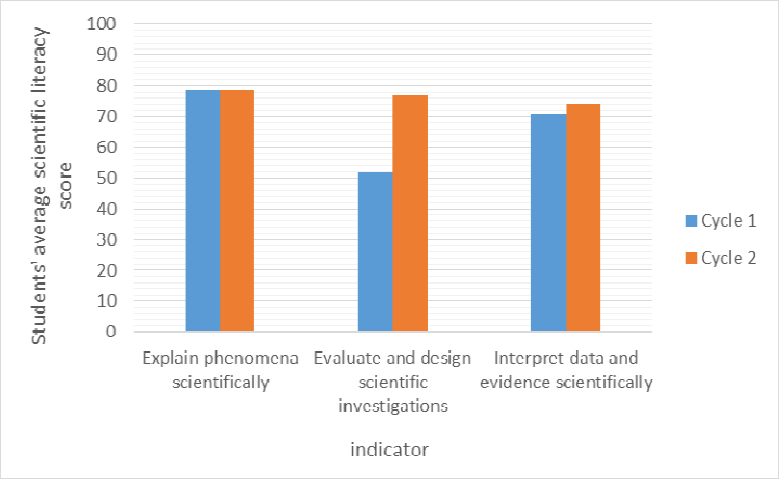

Figure 2. Comparison of students' scientific literacy abilities.

In competency to interpret data and evidence scientifically, there was an increase from an average score of 71 in the middle category in cycle 1 to an average score of 74 in the middle category in cycle 2. This increase was because the data in cycle 1 was obtained through practice questions, while in cycle 2 data and graphs were obtained from Phet simulation web simulation experiments.

Based on the research results, it can be concluded that there is an increase in students' scientific literacy in learning using the problem-based learning model. The increase in students' scientific literacy results is due to the PBL model providing motivation and student learning activities, and helping students transfer knowledge to understand real-world problems. In line with these results, research conducted by Hestiana & Rosana (2020) stated that learning using SSI-based PBL can improve students' scientific literacy and critical thinking. The research conducted by Vitri et al., (2021) scientific activities in PBL support the development of students' scientific literacy. The research conducted by Aradia et al., (2023) the problem-based learning model can improve high school biology science literacy skills. The limitation of this research is that it uses a small sample so that in future research there will be more samples.

Conclusion

Based on the research that has been conducted, it can be concluded that students' scientific literacy abilities have increased from an average score of 67 in cycle 1 to an average score of 77 in cycle 2. Scientific literacy abilities have increased from the middle category in cycle 1 to the high category in cycle 2. 2. So it is proven that the problem-based learning model can increase students' scientific literacy in the three competencies, namely explaining phenomena scientifically, evaluating and designing scientific investigations, and interpreting data and evidence scientifically.

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