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Optimizing the Science Literacy Abilities of Elementary School Teacher Education Students Through Electrical Material Practicum

Gita Senja Sari[1*], Ali Mustadi[1], Ikhlasul Ardi Nugroho[1], Kintan Limiansih[2]

[1] Elementary Education, Faculty of Education and Psychology, Yogyakarta State University, Indonesia.
[2] Elementary School Teacher Education, Faculty of Teacher Training and Education, Sanata Dharma University, Indonesia.

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Corresponding Author:
Gita Senja Sari
gitasenja.2022@student.uny.ac.id

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Abstract: This research aims to determine the optimization of students' scientific literacy abilities through practical electricity material. The sample in this research was Elementary School Teacher Education students. This research uses a quantitative descriptive approach with a survey method. The research results show that students' scientific literacy is 64.49%, which is categorized as moderate. Based on the results of a review of research results, the competency that is classified as low is competency b with a score of 65.05 and the highest competency is competency c with a score of 73.45. In this research, the indicator that needs to be improved in scientific literacy is indicator 4 at 38.5%.

Keywords: Optimization; Physics; Scientific literacy

Introduction

Currently, education is entering an era of transformation in the 21st century. The era of educational transformation in the 21st century is a current of change where teachers and students both play an important role in learning activities (Anjarsari & Suyatna, 2023). The development of the 21st century is marked by the widespread use of technology, especially in communication and information, which has penetrated all aspects of life. Humans use this technology to communicate without borders. These technological advances have made human life easier, including the learning process. According to Daryanto et al. (2022), and Dhanil et al. (2023) there are several skills that must be mastered to face 21st century life, such as the ability to think critically, problem solving and collaboration. Therefore, students and students are expected to prepare themselves to face these developments.

There are various ways to prepare students to face these developments, one of which is through scientific literacy (Suparya et al., 2022). With scientific literacy, students can use their conceptual understanding to analyze, explain and act on phenomena in the surrounding environment (Sukmawati et al., 2022). The importance of scientific literacy in learning in the 21st century has brought changes in science education which functions as a science driver to provide a more useful direction for science learning. Science also helps students develop ways of thinking, creative, analytical, and critical, develop in solving problems systematically, and make decisions using various information in the form of verifiable evidence (Udompong & Wongwanich, 2014). Thus, mastery of scientific literacy is necessary for students, because through scientific literacy they can understand the environment and phenomena based on scientific evidence based on developments in science and technology. In line with the opinion of Udompong

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et al. (2014) that every student needs to develop scientific literacy to understand the nature and technology of human creation, be able to apply science fairly, creatively and morally. Scientific literacy will give birth to scientifically literate individuals in the future (Turiman et al., 2012).

Scientific literacy comes from two words, namely literatus which means letter, literacy, or education and scientia which means having knowledge. Scientific literacy is defined as participation in various scientific problems that influence a person's thinking, scientific literacy refers to an individual's understanding of science, its processes, and its application in everyday life in society (Mujahidin et al., 2023). Program for International Student Assessment (PISA) argues that scientific literacy is the ability to be involved in phenomena that are closely related to science and use scientific literacy as the ability to identify questions, obtain new knowledge, explain scientific phenomena and draw conclusions based on scientific evidence related to science.

According to Miller in Paristiowati et al. (2019) that scientific literacy is defined as the level of understanding of scientific and technological concepts used to act as members of modern society. Meanwhile, according to Techakosit et al. (2015), Anshar et al. (2023), and Seprianto et al. (2023) Scientific literacy is the ability to use scientific knowledge to identify questions, and draw conclusions based on evidence to understand and help make decisions about nature and changes caused by human-made activities. In contrast to the opinion expressed by Amin (2017), scientific literacy is a complex ability that a person has so that they will be able to solve the problems they face, especially in facing current global competition.

So it can be concluded that scientific literacy is the process of optimizing knowledge by identifying questions, explaining scientific phenomena and drawing conclusions based on scientific evidence. In developing scientific literacy, there are several aspects that need to be considered, namely identifying scientific issues, explaining scientific phenomena and using scientific evidence (Reiska et al., 2015).

In 1997, the OECD created a program whose aim was to monitor the results of the education system (PISA) related to the learning outcomes of 15 year old students (Oliver & Adkins, 2020). With this, the government is very helpful in increasing the effectiveness of the education system. Regarding the development of PISA results on scientific literacy, Indonesia is ranked 70th out of 78 countries (Fadlika et al., 2020). With this, it can be concluded that Indonesia's scientific literacy is still below average. Therefore, efforts need to be made to improve this. One of these efforts is to identify the factors that cause students' low scientific literacy, which will later become evaluation material that will give rise to ideas.

The problems faced by students in implementing scientific literacy are weaknesses in critical thinking in learning, then difficulties in communicating the ideas and information they receive (Merta et al., 2020). Apart from these problems, the lack of knowledge that students have regarding the material taught when integrating scientific literacy in the learning process, another factor is the occurrence of misconceptions about the material they receive (Aini et al., 2023). The level of scientific literacy is relatively low due to several factors, namely the environment and learning atmosphere which influence variations in scientific literacy scores (Asyhari, 2015). Other factors such as school infrastructure, human resources and school organization and management also greatly influence students' scientific literacy. Firman revealed that students' low scientific literacy is closely related to the mismatch between the teaching of science education material in schools and the demands of PISA (Ardianto & Rubini, 2016).

The development of scientific literacy needs to be carried out from an early age, starting at the elementary school level so that simultaneously students have complete abilities (Zahro et al., 2019). Scientific literacy is developed at the elementary school level with science learning content that is equipped with abilities in the realm of knowledge and skills (Limiansih & Susanti, 2021). The role of teachers and prospective teachers is very important in developing students' scientific literacy. Therefore, they must prepare themselves well. In addition, they must have a strong understanding of science and be up to date with technological advances affecting society every day (Altun-Yalçn et al., 2011). Teachers also have a key role in guiding students in understanding scientific concepts, developing critical thinking skills, and applying scientific methods in learning. In the learning process, teachers must also be careful in choosing a learning method or model so that later students are not limited to just memorizing when receiving learning materials (Rahmadani et al., 2017). The aspects of scientific literacy are context aspects, knowledge aspects and competency aspects. However, the central point in assessing scientific literacy is the competency aspect (Jamaluddin et al., 2019).

PISA assessed scientific literacy in 2018 with a score of 396 with a ranking of 70 out of 78 participating countries, this indicates that Indonesia's scientific literacy is still low (Fuadi et al., 2020). Findings related to scientific literacy have also been carried out at PGSD, Sanata Dharma University, as many as 43 students obtained scientific literacy results of 51.93% in the low

category (Limiansih & Susanti, 2021). Similar research was also conducted by Sakti et al. (2021) with results of the average percentage of students' scientific literacy abilities in 3 aspects, namely content aspects (53.80%), process aspects (44.038%) and context aspects (35.088%). Research on scientific literacy was also carried out by Juliani et al. (2017) with the result that the scientific literacy process was categorized as low in the aspect of procedural knowledge 43.12%, and epistemic knowledge 47.44% while in the aspect of competency evaluating and designing scientific research 42.32 % and competence in interpreting data and scientific evidence 56.76%.

Based on these findings, we can conclude that scientific literacy is very important to instill from an early age, namely from elementary school level. Understanding and skills in science provide a strong foundation for students in understanding natural phenomena, applying scientific methods, and making decisions based on scientific evidence. Improving students' scientific literacy can be done by making innovations in the learning process. One innovation that can be done to increase scientific literacy is to apply practicum methods during the learning process.

Practicum is a method for teachers to increase students' interest and attention (Adelia et al., 2023). With the practical method, students become trained in conducting experiments so that they will increase their scientific literacy (Munfaida et al., 2022). In line with the opinion of Lestari et al. (2021) that practicum is one of the factors that influences student learning outcomes which plays an important role in supporting the success of the science teaching and learning process.

The aim of this research is to optimize the scientific literacy abilities of elementary school teacher education students through electricity practicum.

Method

The type of approach in this research is descriptive quantitative using survey methods. The quantitative approach was taken with the aim of finding out whether students' scientific literacy can be optimal through practicum. This research will describe events that occur in a phenomenon and situation (Sudjana & Ibrahim, 2015). The population of this study was all 43 Class C second semester students. The sampling technique used in this research is voluntary sampling technique. This technique gives respondents the freedom to participate or not in the research process (Sugiyono, 2022). The instrument used is test questions developed based on scientific literacy indicators according to PISA.

The instrument used in this research was a 12-number test question instrument based on scientific literacy competency. The question instrument in this research was validated directly by the civil service lecturer by revising it twice until it was said to be suitable for use.

Student scientific literacy profile data with the highest score for each question, namely 3 points. The formula used to calculate the average gain of respondents is:

$$\text{LS Score for Each Responde} = \frac{\text{Scores obtained by respondents}}{\text{Maximum Score (36 scores)}} \text{ x } 100\%$$

The average acquisition is categorized based on the categories described in table 1 below:

Table 1. Categories of Scientific Literacy Achievements (Huryah et al., 2019)

Category	Percentage (%)
High	>75
Medium	60–75
Low	<60

Result and Discussion

Based on the results of data collection carried out on April 17 2023 and May 8 2023. By distributing test questions to students who were collected via the Google Form link that was shared. The number of respondents in the research was 28 students using voluntary sampling techniques or what is usually called a voluntary sample. The results that have been collected by students are then calculated to obtain the highest score, namely 3 scores.

Results of Analysis of Scientific Literacy Scores for Each Indicator

The analysis results are shown in the graphic table below:

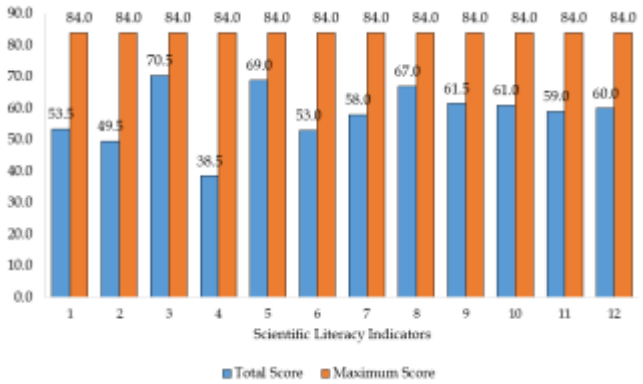

Figure 1. Graph of student LS scores for each indicator

Based on the results presented in the graph above, the highest score is in indicator 3, namely explaining the

application of science in everyday life. Meanwhile, the lowest score is in indicator 4, namely determining hypothetical questions. To examine more deeply the results of students' scientific literacy, below is an explanation of the results of the analysis of students' LS abilities in each indicator.

Indicators identify, use and formulate or create an explanation for a phenomenon. The ability of this indicator can be observed through presenting tests involving experiments on pictures. In this test, students must answer the factors that cause the phenomena that occur in the images displayed. Most students chose the cause of this phenomenon as the result of static electricity. There were 5 students who gave complete answers. Apart from that, there were students who answered that this phenomenon was caused by friction. Meanwhile, only a small number of students gave short answers.

Indicators make predictions about an event and provide an explanation/reason for a hypothesis, measured and tested through the question "what happens when the friction between the comb and hair gets longer? And what effect does this friction produce? Explain your reasons!" In this test, students are asked to predict what will happen when a comb is rubbed over their hair for a long period of time. Apart from that, students are also expected to be able to explain the effect of comb friction on hair. Most students predicted that the number of electrons moving to the hair would increase, while some students only answered that the longer the friction, the more electrically charged the comb would become. This shows that some students were able to predict and explain the effects of the experiment.

Explaining the application of science in everyday life was measured by the question "explain the application of static electricity in everyday life that you know about!" In this indicator, students are expected to provide examples of the application of static electricity in everyday life and provide explanations regarding the examples given. There were 3 students who gave complete answers, while the other students only gave examples without providing explanations.

Determining hypothetical questions, this indicator is measured by giving hypothetical questions. Hypothetical questions are questions with answers obtained from experimental results. Some of the questions in question are as follows: a) Why do the two straws repel each other? b) Does tissue have a repulsive force like two straws? c) What charge do the two straws have so that they can repel each other? d) How long does it take for two straws to rub together to produce static electricity? e) Can the electrons produced by the two straws be transferred back to the tissue as it was in its original state?

Hypothetical questions are found in point's b and d. Unfortunately, most students cannot understand these hypothetical questions. There was only 1 student who answered correctly, while 27 other students only answered by explaining the hypothetical content contained in the question.

Proposing a scientific way to answer a question measured through a test question that asks, "What experimental steps need to be taken to prove the existence of static electricity in each of these objects?". It is hoped that students can explain the experimental steps needed to test the presence of static electricity on specified objects. There were 11 students who gave answers by providing complete steps and explaining how to put together the objects mentioned in the question. Furthermore, there were 12 students who only provided experimental steps for the 2 objects mentioned in the question. A total of 5 students gave short answers, there were even students who did not give answers at all to the question.

Evaluating a scientific way to answer a question is measured through the use of test questions that say, "Do you think there were errors during the experiment carried out? Were there any wrong steps taken by Nadia?" In this problem, students are expected to evaluate the experiment carried out by Nadia.

There were 2 students who gave the correct answer, explaining the errors that occurred in the experiment and identifying the wrong steps taken by Nadia. However, there were also 12 students who gave various answers, such as simply answering "there were no errors" without explaining whether any errors had occurred. In addition, some students gave short answers such as "Yes" or "No" without providing adequate explanations.

Explain and evaluate the various methods used by scientists to ensure the reliability of data and the objectivity and generalization of explanations. This indicator is measured through the use of test questions that say, "Do you think Fatir's conclusion is correct?" In this question, there were 8 students who gave the correct answer. However, it is necessary that in this indicator there are also very varied student answers. Some students simply answered "true" without providing an explanation of the reasons why they thought the conclusion was correct.

Transferring data from one form to another is measured by transferring data from one form to another, by selecting a graph that suits the presentation of the data in the test questions given. There were 18 students who chose graphs that matched the data presented. Apart from that, there were also students who only drew graphs without providing adequate information. Apart from that, there were 7 students who gave various

answers. For example, there are students who only explain the contents of the data presentation given in the question, without specifically selecting or drawing an appropriate graph. In this case, it is important to note that choosing an appropriate graph and providing a clear explanation is an important element in evaluating this indicator.

Analyze and interpret the data to then make conclusions measured through test questions that say, "What charge does object B and object D have, why does this happen?" In this question, students are expected to be able to analyze the charge possessed by object B and object D. There were 14 students who gave the correct answer, correctly explained the charge possessed by object B and object D, and provided an explanation of why this could happen. However, there were 8 students who gave short answers, such as "the charge that object B and object D have is a positive charge", but did not provide further explanation as to why the two objects have the same charge. Apart from that, in this question there were also students who only repeating questions from the problem without providing adequate answers or explanations.

Identifying assumptions, facts and scientific explanations is measured by presenting phenomena related to static electricity, where students are expected to be able to identify static electricity phenomena that are in accordance with scientific explanations. In the measurement results, there were 4 people who answered according to scientific answers, namely they could explain. This phenomenon is correct and in accordance with scientific knowledge regarding static electricity.

However, most of the other students only answered "Yes", but did not provide an explanation as to why this phenomenon could be categorized as a static electricity phenomenon. In this indicator, it is important for students to be able to provide adequate explanations that are in accordance with scientific knowledge regarding static electricity, to be able to demonstrate a good understanding of this phenomenon.

Distinguishing between arguments based on facts and scientific explanations and theories or based on general is measured by giving two arguments, one of which is an argument based on scientific facts but there is also an argument in the form of a myth. In this indicator, there were 3 students who were able to differentiate between the two arguments and then provide explanations related to the arguments that were in accordance with scientific facts. However, some students answered with the answer "father's argument". This proves that students still lack access to information related to scientific facts related to the material.

Evaluating scientific opinions from different sources (newspapers, journals, internet) this indicator is measured by providing two arguments, where one argument is based on scientific facts, while the other is a myth or belief that is not supported by scientific evidence. In this indicator, it is hoped that students can differentiate between the two arguments and provide explanations related to the arguments that are in accordance with scientific facts. The measurement results show that there are 3 students who can differentiate between the two arguments and provide explanations that are in accordance with scientific facts. They are able to recognize arguments based on scientific facts and provide appropriate explanations related to these arguments.

However, some other students only answered with "father's argument" or similar answers. This indicates that students still lack access to information related to scientific facts related to the material. In this case, it is important for students to increase their understanding of reliable sources of information and to be able to differentiate between arguments supported by scientific evidence and myths that have no solid basis.

Science Literacy Scores for All Students for Each Competency

Scientific literacy has 3 scientific competencies that are measured. The following are the results of the analysis of students' scientific literacy abilities based on scientific literacy competencies.

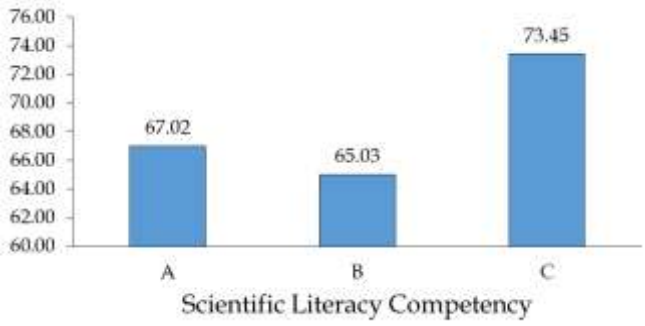

Figure 2. Graph of the total LS scores of all respondents for each competency

Based on the analysis, it was found that the highest scientific literacy ability was in competency C, where students were able to identify questions that could be answered, design investigations, and evaluate investigation plans. However, it should be noted that there are still students who provide simple or short answers related to questions, indicating that there is still room for improvement in this ability.

In competency A, students' abilities are higher than in competency B. This shows that students are able to identify, use, and formulate explanations of phenomena,

make predictions, provide hypothetical explanations, and explain the application of science in everyday life. However, there are some students who still give short answers without providing an explanation related to the phenomenon presented in the question. This shows that a lot of practice improves their ability to provide complete and appropriate answers.

The lowest competency is competency B. Most students experience difficulty in determining hypothetical questions. To overcome this, more training and learning needs to be done that focuses on these aspects in order to improve students' understanding and abilities in competency B.

Average Scientific Literacy Score of All Respondents

Based on the results of the analysis of scientific literacy data for each respondent, the results showed that the overall scientific literacy achievement of students was 69.49% in the medium category.

Scientific literacy cannot be optimized if it takes a short time. This is due to limited time to train students to read scientific issues and study natural phenomena around them (Thahir et al., 2021).

Students' scientific literacy abilities are also common because students are not yet trained in working on questions that require accuracy and understanding the content of the reading. For this reason, students need more accuracy in reading, understanding the content of the text and logical reasoning skills to be able to complete the scientific literacy test.

Developing students' scientific literacy can be done by providing science learning that is oriented towards scientific literacy. Science learning is carried out by integrating learning approaches and models that train students in analyzing and evaluating scientific phenomena and also utilizing the surrounding environment as a learning resource.

In order to increase students' scientific literacy, several corrective steps can be taken, namely to increase students' understanding of hypothetical questions: It is necessary to strengthen the concept of hypothetical questions in learning. Students can be invited to carry out trials or experiments directly related to the material to strengthen their understanding of hypothetical questions and how to choose the right hypothetical questions. Scientific literacy can also be improved by using a contextual learning model, which is a model that integrates real situations or contexts into learning. In the context of scientific literacy, this model can be used to strengthen content mastery and enable students to connect scientific concepts with real-world problems. In this way, students will be better able to explain scientific phenomena and solve problems related to science.

Apart from that, it is important to encourage students' interest in reading scientific issues and studying natural phenomena that occur around them. In the learning process, students need to be given the opportunity to practice reading skills, understanding text content, and logical reasoning so they can complete scientific literacy tests better. In developing students' scientific literacy, changes need to be made in learning activities that optimize scientific literacy. These steps include utilizing the surrounding facilities and environment to conduct hands-on experiments, implementing contextual learning models, and providing learning experiences related to the real world.

Conclusion

The findings obtained in this research were that the scientific literacy abilities of elementary school teacher education students were categorized as moderate with an achievement percentage of 69.49%. To improve students' scientific literacy skills, there are changes that can be made, namely by inviting students to carry out trials or experiments and applying contextual learning models. This can be done by utilizing campus facilities and also utilizing the surrounding environment as a learning resource. By going through experiments, students will also understand more about learning both in terms of concepts and practice. In implementing the contextual learning model, it is hoped that students can connect scientific concepts with real phenomena. In this way, students will find it easier to explain scientific phenomena and solve science-related problems.

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Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this manuscript.

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