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Analysis of the Science Literacy Competency Profile of High School Students on Limited Energy Sources

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Abstract: Learning in the 21st century requires students to have the ability to face the times. One of the essential skills that must be possessed is scientific literacy. Scientific literacy is using scientific knowledge to identify questions, acquire new knowledge, explain scientific phenomena, and draw conclusions based on scientific evidence. This research aims to describe the scientific literacy profile of high school students in the subject matter of limited energy sources. Three competency indicators refer to PISA 2018: a) Explaining phenomena scientifically, b) Evaluating and designing scientific investigations, and c) Interpreting data and evidence scientifically. This research uses a quantitative approach with a descriptive analysis method. The study was conducted in June 2023 in the Even Semester of the 2022/2023 Academic Year at a public high school in Surabaya. The population in this study was 60 students. The instrument used is a scientific literacy test developed with a valid category and a reliability value of 0.811. The results of this study were that students' scientific literacy competency profiles were obtained at 37% low, 33% sufficient, 18% high, and 12% very high. As for the results of the percentage of students' scientific literacy abilities based on scientific literacy competencies, the highest category in the first competency of 63%, namely explaining phenomena scientifically, while the second competency of 62%, namely evaluating and designing scientific investigations obtains a lower percentage than the first competence, and 56%, namely interpreting data and evidence scientifically, has the lowest result among the three scientific literacy competencies.

Keywords: Students' profile; scientific literacy; limited energy sources.

Introduction

21st-century skills specifically emerge due to the reality of global education, which has not fully accommodated the output needs of education in Indonesia. The categories of requirements are grouped globally and described in four ways, namely: (a) Ways of thinking: creativity and innovation, critical thinking, solving problems, making decisions, and learning to learn; (b) Ways to work: communicate and collaborate; (c) Tools for work: general knowledge and skills of information and communication technology; (d) Ways to live: career, personal and social responsibility including cultural awareness and competence (Adawiyah, 2017). One of the abilities that students are

required to have is life skills. This ability is crucial to help students face the progress of the times. One of the life skills that must be possessed is scientific literacy. Scientific literacy is defined as an individual's ability to use scientific knowledge, identify problems, and build conclusions based on scientific evidence regarding scientific issues to understand and make decisions regarding nature and human interaction with nature. The level of scientific literacy among Indonesian students is relatively low and continues to decline yearly. Based on the results of the PISA (Program for International Student Assessment) assessment carried out in 2012, the average score of students in Indonesia was 382 from the overall average score of participating

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countries, namely 501. Furthermore, in 2015, Indonesian students obtained a score of 403 from the overall average score of participating countries, namely 493. Then, in 2018, students in Indonesia only managed to get a score of 396 from the overall average score from participating countries, which was 489 (OECD, 2018). It shows that between 2012 and 2015, Indonesia experienced an increase. However, between 2015 and 2018, Indonesia experienced a very significant decline. Overall, students' scientific literacy achievements in Indonesia are below the average of other countries (Bagasta *et al.*, 2018).

Based on the 2018 OECD, PISA has three aspects of scientific literacy competency explained in Table 1.

Table 1: Scientific Literacy Competencies

Scientific Literacy Competencies	Explanation
Explain phenomena scientifically	The ability to explain phenomena scientifically requires students to remember the content of information that is appropriate in a particular situation and use it to interpret and explain phenomena of interest. This competency includes describing or analyzing phenomena and anticipating possible changes.
Evaluate and design investigations scientifically.	Evaluating and designing scientific investigations is required to critically evaluate research results and reports. This qualification requires knowledge of the basics of scientific research, such as what to measure, what variables to change or control, and what steps to take to collect accurate and precise data.
Interpret data and evidence scientifically.	Interpreting data and evidence can convey the meaning of scientific evidence and its impact on a particular audience in the individual's own words, using diagrams or other appropriate presentations. This qualification requires using mathematical skills to analyze or summarize data and using standard methods to transform data into different representations.

Several factors can influence students' scientific literacy itself. Internal and external factors influence the level of students' scientific literacy abilities. Internal factors arise within the child, such as health, mindset, intelligence, motivation, and participation. The external factors include family, community, friends, teachers, media, learning media facilities, and infrastructure (Jufri *et al.*, 2019). According to research by Rusilowati (2018), learning materials, learning models, learning

environments, homework assignments, and scientific literacy-based assessment instruments can influence students' scientific literacy. In addition, teacher instructions are often ineffective in fostering scientific literacy, contributing to Indonesian students' low scientific literacy (Sutrisna, 2021). It can be caused by the fact that most science learning in schools is still conventional. Teachers often ignore the importance of reading and writing skills in science as competencies that students must have (Hidayah *et al.*, 2019). The current Indonesian curriculum supports one of the education goals: helping students achieve their full intellectual and personal potential (Apriyani *et al.*, 2020). Various related studies have also found that the absence of application, analysis, and evaluation of concepts is the main reason for students' low scientific literacy, especially in physics studies.

As a follow-up to the low PISA score, the Ministry of Education and Culture publication "Education in Indonesia Learns from the 2018 PISA Results" suggests that educators provide scientific literacy test instruments that can train students in solving scientific literacy problems. It is supported by Setiawan (2019), who emphasized that there is a need to improve the implementation of scientific literacy-oriented learning to improve student profiles, especially in physics. Likewise, the results of observations and needs analysis obtained through interviews with physics teachers at SMA Negeri 12 Surabaya show that there has been no implementation of the use of scientific literacy assessment instruments in that school. The application of scientific literacy instruments can use the topic of energy. Energy is closely related to nature and technology. It is from nature that energy is produced and can be used optimally with technology. Currently, energy needs are increasing significantly. The increase influences population growth and human activities. Man. The imbalance in energy supply and demand, driven by the rapid rate of population growth and world industrial development, has resulted in the depletion of energy reserves. Hence, providing more insight into energy is essential. Therefore, it is necessary to develop a physics assessment instrument based on scientific literacy on limited energy sources for high school students.

Method

This research is research that uses a quantitative approach with descriptive analysis methods. The study was conducted in June 2023 in the Even Semester of the 2022/2023 Academic Year at one of the State High Schools in the City of Surabaya. The population in this study was 60 students. The research instrument used was a test of students' scientific literacy questions. Students' scientific literacy abilities were measured

using test questions from preparing a scientific literacy assessment instrument on limited energy sources with 14 questions in the form of descriptions tested for validity and reliability. The 14 questions were declared valid based on testing with a reliability level of 0.811. The data analysis technique uses quantitative descriptive analysis by calculating students' scientific literacy levels using Equation 1:

$$\text{Literacy Level} = \frac{\text{Total Score}}{\text{Highest Total Score}} \times 100 \quad (1)$$

The category details of students' capability are in Table 2.

Table 2. Categories of students' scientific literacy abilities.

Literacy Level	Categories
30-39	Very Low
40-55	Low
56-65	Enough
66-79	High
80-100	Very High

(Arikunto, 2015)

then, the data obtained from the students' scientific literacy test results were analyzed based on the scientific literacy competencies tested in the questions.

Result and Discussion

The scientific literacy test uses three indicators in the scientific literacy competency aspect of PISA 2018. Of the 14 questions, there are five questions with the first indicator, 4 with the second indicator, and 5 with the third indicator. The following are the results of the student scientific literacy tests that have been carried out

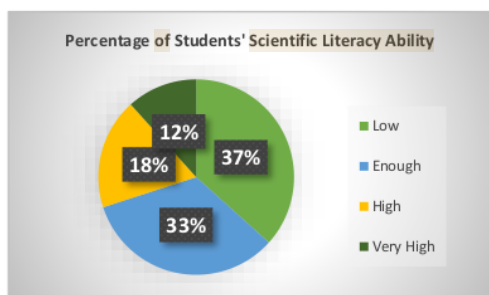


Figure 1. Percentage of Students' Scientific Literacy Ability.

The results of measuring students' scientific literacy profiles using the scientific literacy assessment instrument on limited energy sources obtained a percentage in the low category of 37%, the moderate category of 33%, the high category of 18%, and the very high category of 12%. So, it can be concluded that most

students have relatively low-profile abilities, and a few students have high and very high literacy abilities. Nofiana & Julianto (2018) stated that students' low scientific literacy abilities result in students being less responsive to developments and problems in the surrounding environment.

The percentage of students' scientific literacy profile results based on scientific literacy competency indicators is presented in graphical data as follows:

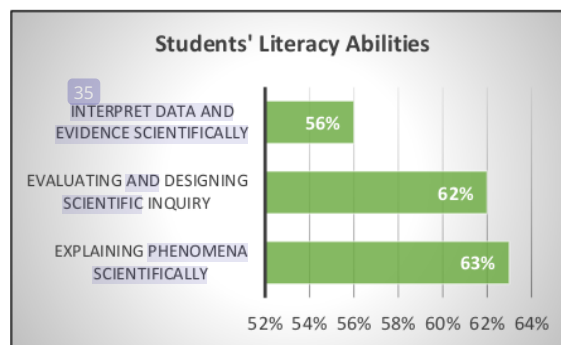


Figure 2. Students' literacy abilities are based on scientific literacy competency indicators.

Figure 2 shows that the average percentage of students with the competency to explain phenomena scientifically is 63%. In the competency to evaluate and design scientific investigations, it is 62%, and in the competency to interpret data and evidence scientifically, it is 56%. Based on these results, it can be concluded that, on average, students can explain phenomena scientifically well. Competence in evaluating and designing scientific investigations also gets a percentage that is not far off, namely 62%, which means that students have quite good evaluation skills on average. Meanwhile, scientific competence in interpreting data and evidence ranks lowest at 56%. Based on the graphic data in Figure 2, it can be concluded that the first competency has the highest results, the second competency is lower than the first competency, and the third competency is the lowest.

The first competency has the highest average score because students are only required to remember and recognize a scientific phenomenon. Most of the learning carried out by teachers is focused on theory and memorization (Afina et al., 2021). Meanwhile, the second competency has a lower average score than the first. This is because most science learning in Indonesia only emphasizes content, even though 90% of science learning should contain practicum (Diana et al., 2015). Students have the lowest ability in the third competency. It can happen because students cannot yet draw

appropriate conclusions from data in tables or graphs. According to research conducted by Mawardini et al. (2015), one of the factors behind the low level of students' scientific literacy is that students cannot yet interpret the data and information provided in tables or graphs.

In general, students' low levels of scientific literacy are caused by students' inability to work on questions based on scientific literacy that require analysis and understanding of the questions. According to Sutrisna (2021), students are still not used to working on scientific literacy questions because the questions in learning activities given by teachers, such as daily tests, midterm assessments, and final assessments, only require memory of theory or formulas. Research conducted by Huryah et al. (2017) explained that one of the factors causing students' low level of scientific literacy is that students are not used to working on questions that require analytical skills. Apart from that, the low level of students' scientific literacy is also caused by students' lack of interest in reading (Susiati et al., 2018). This low level of scientific literacy reflects that students in Indonesia are still unable to apply concepts to solve problems. Students tend to only memorize concepts without knowing the application of these concepts (Sugiyanto et al., 2017). Learning that remembers concepts, theories, and laws alone causes students to have difficulty applying the knowledge gained in everyday life (Fitriani et al., 2014).

Below is an example of a student answer sheet for each scientific literacy competency indicator:

1. Peningkatan akses air minum layak dan aman masih perlu terus dioptimalkan. Pernyataan ini menunjukkan bahwa akses air minum yang layak dan aman belum mencapai tingkat yang memuaskan, mengindikasikan bahwa ketersediaan air masih menjadi masalah di Indonesia. 2. Akses air minum yang layak di Indonesia baru mencapai 87,75% dari populasi. Meskipun telah ada kemajuan dalam mencapai akses air minum yang layak, persentase tersebut menunjukkan bahwa sebagian besar populasi Indonesia masih belum memiliki akses yang memadai terhadap air minum yang layak. 3. Hanya sekitar 20,14% populasi yang menikmati akses perpipaan. Angka ini menunjukkan bahwa sebagian besar masyarakat Indonesia masih menghadapi kendala dalam mengakses air melalui jaringan perpipaan, yang dapat menjadi indikator terjadinya krisis ketersediaan air. 4. Hanya sekitar 6,8% rumah tangga yang memiliki akses air minum aman. Persentase yang rendah ini menunjukkan bahwa masih terdapat kesenjangan dalam mencapai akses air minum aman yang sesuai dengan standar kesehatan.

Figure 3. Student work results in competency in explaining phenomena scientifically.

Figure 3 presents an example of one student's answer in solving a problem with the indicator of explaining the phenomenon scientifically. In the questions, students are given initial information in the form of text or reading related to the condition of clean water in Indonesia. Presents examples of student

answers on the competency to explain phenomena scientifically. Students are asked to mention and demonstrate the facts in the reading.

Sangat tepat, karena dengan bekerja sama dengan pihak PLTsa sampah industri yang dihasilkannya tidak akan terbuang sia-sia, melainkan akan dimanfaatkan kembali untuk kebutuhan listrik dan tidak akan mengganggu ekosistem di lingkungan sekitar tersebut

Figure 4. Student work results for the competency to evaluate and design scientific investigations.

Figure 4 presents an example of one student's answer in solving a problem with indicators of evaluating and designing scientific investigations. The question shows an illustration of the problem and the actions taken. Students provide an evaluation of the actions taken along with reasons. In Figure 4, students provide appropriate opinions accompanied by relevant reasons.

1. Ketersediaan air dari 2010- 2035 selalu mengalami penurunan 2. Di setiap tahun Maluku dan Papua lah yang mempunyai lebih banyak ketersediaan air dibandingkan pulau yg lain 3. Pulau yg mempunyai ketersediaan air paling kecil/ paling sedikit yaitu pulau Jawa pada tahun 2035 dengan 1118 4. Perbandingan ketersediaan air di daerah Maluku dan Papua dengan Jawa sangatlah jauh.

Figure 5. Student work results in competency in interpreting data and evidence scientifically.

Figure 5 presents an example of one student's answer in solving a problem with indicators of interpreting data and evidence scientifically. In the question, data is provided in the form of a graph of water availability in several regions in Indonesia. Students are asked to convert graphic data into relevant information based on the data presented. In Figure 5, students have provided information that matches the data presented in the question.

Conclusion

Based on the research that has been carried out, it was concluded that the results of the scientific literacy competency profile of students in one of the high schools in the city of Surabaya were 37% low, 33% fair, 18% high, and 12% very high. Meanwhile, the percentage of students' abilities based on scientific literacy competency is an average of 63% for the ability to explain phenomena scientifically, 62% for the ability to evaluate and design scientific investigations, and 56% for the ability to interpret data and evidence scientifically so that students' literacy skills Based on

scientific literacy competency, the highest results were obtained in the competency to explain phenomena scientifically. The lowest results were in the competency to interpret data and evidence scientifically.

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