

Analysis of Science Literacy Skills of Students in X Class at High Schools in Yogyakarta City on the Competency Aspect in Biology Learning

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ABSTRACT

This research aims to determine the level of science literacy skills of students in X class at high schools in Yogyakarta City in the subject of biology based on PISA science literacy indicators. This research is a quantitative descriptive study using the survey method. The data collection technique used tests in the form of questions based on science literacy indicators in the competency aspect. The data analysis technique is inferential statistics with non-parametric statistics using the Kruskal-Wallis test to determine whether there are significant differences in each school. The research results show that the science literacy skills of public high school students in Yogyakarta City are in the low category with an average score of 57,88%. Further tests indicate significant differences among each school.

INTRODUCTION

21st-century learning demands that students are able to think critically, communicate effectively, collaborate, and solve problems creatively. In Canada, the United States, and England, curriculum formulation in schools has been carried out to encompass 21st-century learning. Based on research conducted by Howard et al., (2019) reviewing national and international efforts to support 21st-century learning education, such as creating living schools through a shared vision and transformative governance in schools located in Canada. Various reform efforts in the field of education demonstrate the potential to bring about new and radical perspectives on the meaning of learning in education, as well as the best ways to achieve the established goals (Abidin et al., 2018). One of the goals in the 21st-century learning process is to enhance higher-order thinking skills in order to achieve scientific literacy.

Science literacy is a skill that students must possess in order to understand how scientists obtain data and propose explanations, know the key features of scientific investigations conducted, and be able to provide the expected answers and conclusions from science (Basam, 2021). Science literacy is actually not a new concept in the world of education. However, in the last two decades, science literacy has become the main focus in every discussion regarding learning objectives in science education in schools (Pratiwi et al., 2019). Therefore, every three years, an assessment of students' science literacy will be conducted through the Programme for International Student Assessment (PISA).

The results of the PISA assessment organized by the Organisation for Economic Cooperation and Development (OECD) regarding the science literacy skills of 15-year-old students, where Indonesia ranks low, indicate that the science literacy skills are still low. Indonesia in 2018 ranked 73rd with an average score of 396, then in 2022 Indonesia rose to 70th place with a score of 383 (OECD, 2023). The assessment results indicate that Indonesia is still among the bottom 10 countries. This indicates that students' science literacy skills are still relatively low.

The low science literacy skills of students can be seen based on previous research conducted by Fitriani et al., (2018) which showed that the science literacy skills of high school students in the Aceh Tamiang district were classified as low with a score of 40.61%. The same finding was reported by F. Rahmadani et al., (2022) where only 34% of students had moderate science literacy skills, while the remaining 66% were classified as low. Moreover, it is still often found that science education practices in various countries also neglect the social dimension related to science education and the encouragement to develop the skills needed for students to actively participate in society (Pratiwi et al., 2019).

Factors that contribute to the low science literacy skills of students include the low motivation to learn among students. Learning motivation is not only important for students but also very important for teachers (Hikmah et al., 2018). Affective factors and motivation that influence include students' interest in science and the value of science perceived through interest, self-efficacy, as well as beliefs and truths considered worthy of acceptance, referred to as

epistemic beliefs (Hofverberg et al., 2022). The low level of science literacy among students in Indonesia, if not addressed promptly, will result in a decline in the quality of human resources, which will hinder the advancement of science and technology.

Therefore, it is important to conduct research related to measuring students' science literacy abilities to identify the issues causing low science literacy in Indonesia so that it can develop learning with teaching methods, learning models, approaches, and teaching materials used in the biology learning process that can enhance students' science literacy abilities in schools. As previously mentioned, this research aims to determine the level of science literacy abilities of 10th-grade students at public high schools in Yogyakarta City in the subject of biology.

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THEORETICAL REVIEW

Science Literacy

Science literacy comes from the Latin word 'litteratus' which means lettered, literate, or can be called educated, and 'scientia' which means having knowledge. Literally, literacy comes from the word 'literacy' which means literate, while science comes from the word 'science' which means knowledge. Science literacy first appeared in education in America, as expressed in a paper by Paul de Hart Hurd and Richard McCurdy in 1958. Human behavior in utilizing knowledge in human affairs for social progress and the adaptability of living beings is the foundation of scientific literacy (Ahsani et al., 2024).

Science literacy is one of the skills of scientific knowledge through facts to identify and draw conclusions in the process of understanding (R. Rahmadani & Jefriyanto, 2021). Therefore, students must be literate in science and directly engage with science and technology. Consequently, competencies are needed to support these abilities, meaning students require competencies to explain phenomena scientifically, evaluate and design scientific investigations, and interpret data and evidence scientifically (Bellová et al., 2018). These three indicators are what students must possess to have scientific literacy capabilities, particularly in the aspect of competence.

Biology Learning

Biology has study objects with distinct characteristics in each of its aspects and has different methods and strategies to achieve learning objectives. Biology learning ideally should be based on science process skills so that students gain direct experience and involve cognitive abilities (mind on),

psychomotor skills (hand on), and affective skills (hearts on) (Aprizanti, 2023). Biology learning must involve various technologies and cultivate scientific thinking critically, innovatively, creatively, and independently through the scientific inquiry process (Husna et al., 2023).

The Relationship of Science Literacy in Biology Learning

Literacy learning implemented in the 21st century has four goals: first, to shape students into readers, writers, and strategic communicators. The second goal is to enhance thinking skills and develop thinking habits in students. The third goal is to increase and deepen students' motivation to learn. The fourth goal is to develop students' independence in learning as creative, innovative, productive, and character-driven individuals (Education, 2006). Therefore, science literacy skills are essential in biology education so that students can possess abilities in accordance with the aspects of science literacy competence. Students are capable of critical thinking and higher-order thinking regarding the problems occurring around them, able to process, read, and interpret data, as well as conduct scientific observations or investigations

METHODOLOGY

This analysis research uses a type of quantitative descriptive research with a survey method. This research involves 5 schools with a sample size of 165 students in the city of Yogyakarta. The population in this study consists of X MIPA students at high schools in Yogyakarta City. The sample in this study is X MIPA students at SMA Negeri 1 Yogyakarta, SMA Negeri 3 Yogyakarta, SMA Negeri 4 Yogyakarta, SMA Negeri 10 Yogyakarta, and SMA Negeri 11 Yogyakarta. The data collected is quantitative data from the results of the science literacy test instrument based on indicators in the aspect of science literacy competence. The question development indicators in the competence aspect refer to the scientific competence indicators of PISA 2015.

The test instruments provided include multiple-choice questions and essays. Multiple-choice questions were chosen because they can objectively measure learning achievements based on factual knowledge and mastery of the material, while essay questions can enhance higher-order thinking skills. Research conducted by Putri et al., (2023) indicates that essay questions can detect students' abilities to analyze questions for higher-order thinking, make decisions, and broadly identify the problems encountered.

The data analysis technique used in this study is descriptive statistics by calculating the correct scores obtained by students on each question based on the indicators of science literacy competence aspects, as well as inferential statistics through the non-parametric statistical test, the Kruskal-Wallis test, using SPSS (Statistical Package for the Social Sciences), to determine whether there are significant differences between the average literacy ability scores of students in public schools in Yogyakarta City. The results obtained will subsequently be interpreted based on the criteria table for the level of students' science literacy in each school according to (Djaali & Muljono, 2008), presented in Table 1 below.

Table 1. Scoring Criteria for Student Science Literacy Proficiency Levels

INTERVAL	CRITERIA
86% ≤ 100%	Very Good
72% ≤ 85%	Good
58% ≤ 71%	Enough
43% ≤ 57%	Low
N ≤ 43%	Very Low

RESULTS

The results of the analysis conducted to measure the level of students' science literacy among 165 students from five schools showed a score of 57.88, categorized as low. The measurement results for all students can be seen in the following table 2.

Table 2. Results of the Science Literacy Ability Test of student in X class at high schools in Yogyakarta City in the subject of biology

Science Literacy Score							
	N	Range	Min	Max	\bar{y}	s	Score category
Student LS Score	165	72	15	87	57.88	15.548	Low

The measurements conducted at each school regarding the science literacy skills in biology subjects were carried out using multiple-choice and essay test questions based on science literacy indicators in the competency aspect. School A obtained an average score of 66.61, categorized as sufficient. School B obtained an average score of 71.88, indicating that the science literacy ability is in the sufficient category. School C obtained an average score of 46.52, categorized as low, as did School D, which obtained an average score of 47.58, also categorized as low. The fifth school, School E, obtained an average score of 56.82, indicating that the science literacy ability is in the low category. The results of the science literacy test for each school in the biology subject can be seen in the following table 3.

Table 3. Results of Science Literacy Test Scores of Students from Each Public High School in Yogyakarta City

School	N	Range	Min	Max	\bar{y}	s	Score Category
SMA_A	33	41	46	87	66.61	13.766	Enough
SMA_B	33	52	33	85	71.88	11.277	Enough
SMA_C	33	33	29	62	46.52	9.715	Low

SMA_D	33	48	15	63	47.58	14.921	Low
SMA_E	33	39	35	74	56.82	8.984	Low

The results of the science literacy test obtained show that the science literacy skills of students in Yogyakarta City are categorized as low in biology subjects. Furthermore, the low science literacy skills of students are examined based on the achievement of each science literacy question indicator in the competency aspect. The results show that on indicator 1, which is explaining scientific phenomena, the data indicate that SMA B has better capability than other schools with a score of 79.33%, followed by school A with a score of 68.15%. School C obtained a score of 52.63, school D obtained a score of 53.27, and school E obtained a score of 56. The score results for indicator 1 can be seen in the following figure 1.

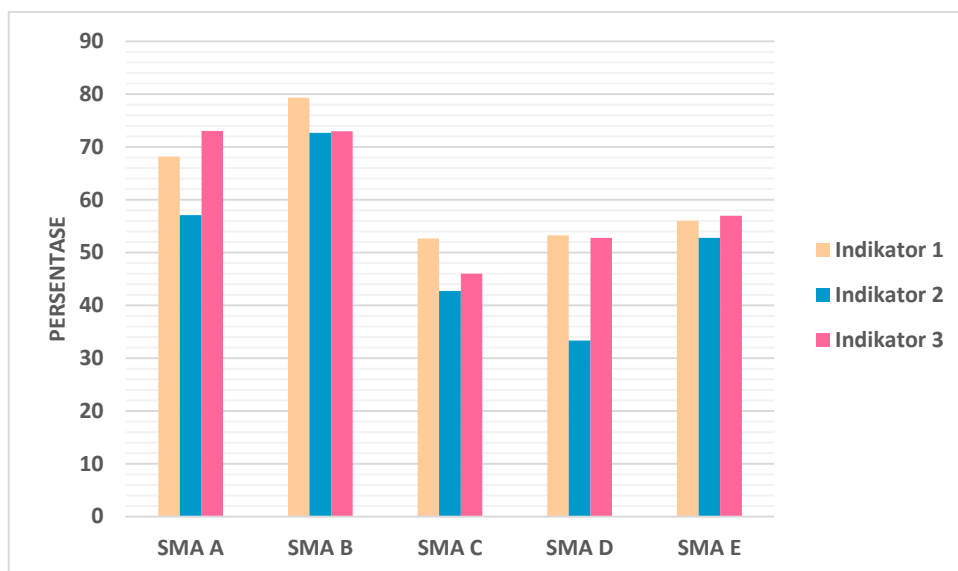


Figure 1. Comparison of Student Percentage in each aspect of science literacy competency indicators

Explanation:

Indicator 1: Explaining scientific phenomena

Indicator 2: Evaluating and designing scientific investigations

Indicator 3: Interpreting data and providing scientific evidence

The next result on indicator 2, which is evaluating and designing scientific investigations based on figure 2, shows that school B has better capabilities than the other four schools with a score of 72.63%. School A obtained a score of 57.05%, school C obtained a score of 42.68%, school D obtained a score of 33.33%, and school E obtained a score of 52.78%. Indicator 3, which is interpreting data and providing scientific evidence based on the score graph, shows that school A has better capabilities than the other four schools with a score of 73%. School B obtained a score of 72.93%, school E obtained a score of 56.93%, school D obtained a score of 52.74%, and school C obtained a score of 45.99%.

Table 4. Kruskal Wallis Test Statistics: Results of the Analysis of Science Literacy Skills of student in X class at high schools in Yogyakarta City in the subject of biology

	Nilai LS Siswa
Kruskal-Wallis H	69.741
df	4
Asymp. Sig.	.000

The average results for each indicator show that indicator 1 has the highest score compared to indicator 2 and indicator 3. The students' ability on indicator 1 received a score of 61.87, on indicator 2 received a score of 51.69, and on indicator 3 received a score of 60.31. The results of the Kruskal-Wallis test on students' science literacy skills showed an Asymp. Sig value of 0.000, which is less than the significance level of 0.05..

DISCUSSION

Based on the research results, it shows that the science literacy skills of students in public schools in Yogyakarta are in the low category, as indicated in Table 1, with an average score of 57.88 out of a maximum score of 100. The low science literacy skills of the students are due to several factors, including the fact that the students do not yet understand the basic science concepts taught by the teacher. This is in line with the research conducted by Yusmar & Fadilah, (2023) which found that students do not understand the biology material presented but are reluctant to ask questions. Furthermore, the results obtained from each school indicate that schools A and B fall into the sufficient category, meaning that biology teaching in these schools has adequately involved the process of students' science literacy skills. However, schools C, D, and E show results in the low category. This indicates that biology teaching in the school is still lacking in the application of science literacy skills due to the limitations possessed by the teachers. According to Cordon & Polong, (2020) teachers should be reflective, collaborative learners and effective teachers.

The students' science literacy skills were measured using a test based on science literacy indicators in the competency aspect with three indicators, the first being the aspect of explaining scientific phenomena. Based on the results obtained, students have a fairly good ability to explain scientific phenomena with a score of 61.87, making this indicator have a higher achievement than the others. However, the results show that schools C, D, and E have lower scores than the other schools. The students' answers indicate that their level of understanding is still relatively low, as shown in the research conducted by Fadilah et al., (2020) which revealed that students' science literacy skills are also low, with a score of 40.5. The low science literacy skills in this indicator are caused by students only mastering concepts through memorization, similar to the research conducted by Muhdhar et al., (2024) on students' science literacy skills in Malang, which scored 56.45 in the aspect of explaining phenomena scientifically, categorized as low.

Indicator 2 is the indicator with the lowest overall score, which is 51.69. Based on the results obtained, students still do not have the ability to evaluate and design investigations. This is due to the lack of innovative teaching materials to support the science literacy-based learning process. Science literacy-based learning should also involve technology. The use of teaching materials can maximize students' learning potential and allocate time effectively in studying (Palines & Cruz, 2021). The results of the research conducted by Bórquez-Sánchez, (2024) indicate that the low science literacy skills of students are also due to misconceptions among students caused by a lack of knowledge in both the affective and cognitive domains. Therefore, the more complex and numerous the concepts that students possess, the better their understanding of a scientific problem will be.

Indicator 3 received an average score of 60.31, indicating that students have a fairly good ability to interpret data and provide scientific evidence or are in the moderate category. However, of course, this is still very lacking and needs to be improved further. It is evident from the answers provided by the students when filling out the given test questions that the students still lack the ability to apply and interpret data. The same occurrence was found in the research conducted by Suroso et al., (2021) in East Java, where the low scientific literacy skills of students were evident in expressing the content of the discourse provided and interpreting data in the form of tables, diagrams, or other forms. The students' lack of ability to interpret data is partly because, in the learning process, they are only accustomed to completing the tables provided by the teacher, resulting in limited data interpretation skills (Rohmah & Hidayati, 2021).

The existence of a significant difference in the science literacy abilities of public high school students in Yogyakarta City using a non-parametric statistical test, namely the Kruskal-Wallis test. This test is used to examine whether there are significant differences between variable groups, allowing for the identification of significant differences between groups (Jamco & Balami, 2022). The comparative analysis conducted involves more than 2 population groups; thus, this test is used with data in the form of rankings (Quraisy & Hasni, 2021). In the conducted research, an Asymp. Sig value of 0.000 was obtained, so the basis for the decision-making is that there is a difference in the science literacy abilities of high school students in Yogyakarta City because the Asymp. Sig value is < 0.05 .

The ability of science literacy can be improved through engaging learning models, as demonstrated by Mahanal et al., (2021) in their research, where students' science literacy increased to 72.64% after using the RICOSRE learning model. The application of several learning models can enhance students' science literacy because it requires students to learn to express opinions, use knowledge to formulate problems, solve problems, and adopt a scientific attitude in conducting experiments (Latifah et al., 2022). In addition to the learning model, science literacy skills can also be improved by using innovative teaching materials and utilizing technology to support learning. This is in accordance with the research conducted by Irhasyuarna & Putri, (2022) which found that there

was an increase in science literacy learning outcomes in classes that were treated with teaching materials compared to classes that did not use teaching materials.

CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis of students' science literacy skills at high schools in Yogyakarta City, it can be concluded that the science literacy skills of student in X class at high schools in Yogyakarta City in Biology lessons obtained an average score of 57.88. This result indicates that the students' science literacy skills are in the low category. Further results on each science literacy indicator show that the ability to explain scientific phenomena is the most mastered by students, with the highest average score of 61.87. Meanwhile, the competencies that students have less mastery over are the ability to evaluate and design scientific investigations. The students' science literacy abilities vary significantly between each school. School B and A have better scores than the other schools.

FURTHER STUDY

Advice for future researchers is to conduct studies on science literacy by testing the application of engaging teaching materials and learning models, as well as analyzing other aspects of science literacy to achieve optimal results.

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