ANALYSIS OF STUDENTS' SCIENCE LITERACY ON BUFFER SOLUTION MATERIAL IN PUBLIC HIGH SCHOOL 2 MUARA BADAK

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Abstract. *Scientific literacy can be understood as students' capacity to apply scientific knowledge, recognize problems, and formulate conclusions based on evidence. This study was conducted to examine the level of scientific literacy among students at SMA Negeri 2 Muara Badak. A descriptive quantitative research design was selected because the purpose was to portray a single variable independently without linking it to other variables. The research population comprised all eleventh-grade science students at SMA Negeri 2 Muara Badak. Using a saturated sampling technique, all students from three classes XI IPA 1, XI IPA 2, and XI IPA 3, were included, totaling 77 participants. Data were gathered through literacy test instruments as well as non-test methods, including observation sheets, student response questionnaires, and interviews. The results indicated that students' scientific literacy was still within the moderate category, with an achievement percentage of 67.45%. Several factors contributed to this outcome, such as students' limited reading habits related to science, their relatively weak comprehension of subject matter, and instructional processes that tended to be teacher-centered rather than promoting independent inquiry and conceptual engagement.*

Keywords: *analysis, science literacy, quantitative descriptive method*

INTRODUCTION

The 21st century has made global development faster and more complex. No one can avoid the changes of the times today; everyone knows that the 21st century has brought thorough changes in terms of society, environment, and daily life. These transformations aim to improve the quality of life in contemporary society and must therefore be embedded within educational practices [1]. 21st-century skills are at the core of today's education, especially science learning. These abilities are fundamental needs for learning the scientific method and are taught in schools. Science literacy is among the most essential competencies students must possess [2]. It holds a vital role because it enables individuals to apply scientific knowledge, formulate questions, and make evidence-based conclusions, serving as essential preparation for students in navigating the advancements of the Industrial Revolution 4.0 era [3, 4]. Science literacy originates from Latin, derived from the words *"literatus"*, meaning literate, and *"scienta"*, meaning to know [5]. According to OECD (2015), scientific literacy refers to the ability to apply scientific knowledge, formulate questions, and draw evidence-based conclusions to understand natural phenomena and make informed decisions regarding environmental changes resulting from human activities [6]. Assessing science literacy is crucial to determine how well students understand scientific knowledge, their awareness of scientific process skills, and their capacity to use both in real-world contexts [7].

Based on periodic research conducted every three years by the *Organization for Economic Co-operation and Development* (OECD), Indonesia consistently scores below the established international standards and has even shown a downward trend. The 2018 PISA results show that Indonesia obtained a science literacy score of 396, placing the country 71st out of 79 participating nations. Data from the PISA assessments between 2000 and 2022 further indicate that

Indonesian students' science literacy levels remain comparatively low [8, 9, 17].

Table 1 Indonesian science literacy results data 2000-2018

Year	Score obtained	Rating
2000	393	38 out of 41 countries
2003	395	38 out of 41 countries
2006	393	50 out of 57 countries
2009	383	57 out of 65 countries
2012	382	64 out of 65 countries
2015	403	62 out of 72 countries
2018	396	70 out of 78 countries
2022	383	67 out of 81 countries

Students' low science literacy levels are shaped by various factors, such as the learning environment and overall school climate, which contribute to differences in literacy scores. In addition, the quality of school facilities, human resources, and organizational management also plays a significant role in determining students' literacy levels [10]. Consistent with Sumarni (2016), several underlying theories related to low science literacy suggest that students' limited literacy skills may stem from conventional science learning practices that overlook the significance of reading and writing in science as core competencies that students must acquire [11].

According to interviews with XI-grade chemistry teachers at SMA Negeri 2 Muara Badak, located in Marang Kayu Village, students struggle to relate the scientific concepts they acquire to real-world situations, especially those related to chemistry. This is because students tend to memorize concepts and theories without a deep understanding of the chemistry material. Teachers do use methods in explaining buffer solution material, among others, the discussion method, which involves student interaction and roles in the learning process, but this method limits students in developing material that is only on the material in the teaching materials [10]. The type of assessment suitable for evaluating students' chemical literacy skills is one that is specifically designed to measure chemical literacy. Chemical literacy-oriented assessment can be applied to the concept of buffer solutions because they play a role in everyday life, helping students understand chemical literacy [12].

Based on the explanations above, the researcher considers it important to analyze students' science literacy on buffer solution material at SMA Negeri 2 Muara Badak. Students of SMA Negeri 2 Muara Badak are a small social group that is the future of the development of a city and a country. Therefore, the researchers consider it necessary to first identify students' science literacy skills in Marang Kayu Village, Muara Badak District, before offering concrete solutions to the problems encountered.

METHOD

This study utilized a descriptive research design, which aims to describe and address issues surrounding a current phenomenon or event, whether involving a single variable, correlational patterns, or comparative aspects. This type of research aims to provide an accurate description of a situation without applying any specific treatment or intervention. In this study, researchers did not give special treatment to the samples used, so they did not use control classes or experimental classes [13]. The objective of this study is to analyze the science literacy competence of students in relation to buffer solution material at SMA Negeri 2 Muara Badak.

The population of this study consisted of all grade XI IPA students at SMA Negeri 2 Muara Badak during the 2022/2023 even semester, totaling 77 students. A saturated sampling technique was applied, in which all population members were taken as the sample, yielding a total of 77 participants. Data were gathered using two types of instruments, namely test and non-test tools. The test instrument comprised 10 essay

questions, while the non-test instruments consisted of student response questionnaires and interviews. The data analysis procedures in this study were conducted through several stages, including:

a. Scoring and evaluating students' responses on their answer sheets according to the scoring guidelines that have been made, namely, the correct answer is given a maximum score of 4, and no answer 0.
b. Converting scores into values with the following formula:

$$\text{The student score} = \frac{\sum \text{the score obtained}}{\sum \text{max} \, score} \text{ x } 100$$

c. Calculating the overall average score obtained by students for students' science literacy skills..

$$Average\ score = \frac{\text{total correct answers}}{\text{number of students}}\ x\ 100\%$$

d. Determining the percentage value of each student in the aspects of scientific literacy skills, namely aspects, content, competence, context and attitude.

$$Percentage\ value = \frac{\sum score\ obtained}{\sum maximum\ score}\ x\ 100\%$$

e. Determine the average percentage value obtained by students for all aspects of scientific literacy skills, namely content, competency, context and attitude aspects.

$$Average\ NP\ Content\ aspect\ = \frac{the\ score\ obtained}{\text{student count}}$$

f. After being percented, the data were described in general based on knowledge, competence, context and attitude of science literacy with categories in Table 2 [14].

Table 2 Criteria for Percentage Assessment of Students' Science Literacy Skills

No	Interval Skor	Kriteria
1	86 – 100%	Very high
2	76 – 85,99%	High
3	60 – 75,99%	Medium
4	55 – 59,99%	Low
5	≤ 54%	Very low

RESULT AND DISCUSSION

The process of compiling this research instrument was carried out by referring to the objective of measuring students' scientific literacy skills. The first instrument was a test consisting of 10 descriptive or essay questions, designed based on scientific literacy [15]. These questions cover aspects of content, competence, context, and attitude in the buffer solution material. This test aims to measure the extent to which students can understand concepts, apply knowledge, relate buffer solution material to the context of everyday life, and demonstrate scientific attitudes in solving problems. The second instrument was an interview and a student response questionnaire. Interviews were conducted to explore students' in-depth understanding of scientific literacy, while questionnaires were used to obtain an overview of students' perceptions of the test and the material taught. These two instruments are used as supporting data to complement the test results and provide a more comprehensive picture of students' scientific literacy skills.

This research involved three sample classes: XI IPA 1 with 25 students, XI IPA 2 with 27 students, and XI IPA 3 with 25 students, resulting in a total sample size of 77 students. The interview results with the XI-grade chemistry teacher at SMA Negeri 2 Muara Badak indicate that students commonly face challenges in applying the scientific concepts learned at school to daily-life situations, particularly in chemical contexts. Students tend to memorize concepts and theories without understanding their meaning in depth. This condition leads to weak scientific literacy performance, specifically in the domains of contextual application and scientific attitudes. The teacher said that in learning buffer solutions, a discussion method involving interaction between students had been used. Although this method is participatory, the discussion is still limited to the material available in the teaching materials. Students have not been given enough space to explore and develop their understanding beyond standard material, so that skills in linking chemical concepts to real-world situations have not developed optimally. In addition, students' initial abilities are also reflected in the results of previous daily tests, which show that their understanding of the buffer solution material still varies, with most not yet achieving conceptual or applicative completion. This finding reinforces the importance of measuring scientific literacy comprehensively through test instruments and other supporting data in this study.

Data were obtained from several sources, including science literacy test questions, student response questionnaires, and interviews. The following is the process of presenting data based on science literacy test data, response questionnaires, and interviews. The data analysis produced the following findings:

Table 3 Students' Science Literacy Skills

Aspek	Nilai siswa	Kategori
Knowledge	69,70 %	Moderate
Competency	55,28%	Low
Context	88,96%	Very high
Attitude	55,84%	Low
Average	67,45%	Moderate

The data show that the mean score for students' science literacy is 67.45%, categorized as moderate. This finding implies that the science literacy proficiency of Grade XI students at SMA Negeri 2 Muara Badak is still classified as moderate. This is in line with the results reported by Usman et al. (2018), the science literacy level of class X MIPA students at SMA Negeri 2 Samarinda reached 66.5%, falling within the moderate category [16]. The suboptimal level of students' science literacy skills stems from their difficulty in answering literacy-based questions that demand comprehension and analytical thinking. This issue arises because the evaluation items provided by teachers typically focus only on recalling previously learned material. This is reinforced by Pantiwati (2017), who argued that science assessments must extend beyond evaluating content knowledge to also develop students' higher-order thinking and their ability to implement scientific processes in everyday life [18]. This finding is also supported by interview results, which reveal that students generally prefer listening to teacher explanations rather than repeatedly reading textbooks to understand chemistry content. Excerpts of student interviews can be seen as follows:

Student A "No, because I prefer to be given example problems rather than reading too much."

Student B "I rarely read books because I prefer to listen to the teacher's explanation rather than reading, and there are no books that I read for a month miss."

These factors contribute to the classification of science literacy skills at SMA Negeri 2 Muara Badak as moderate. This is consistent with the findings of Jufrida et al. (2019), who explained that the weak science literacy performance of students in Indonesia is shaped by multiple determinants, such as the curriculum and educational system, teachers' selection of instructional approaches, the adequacy of learning facilities and resources, availability of teaching materials, students' reading habits, and several other contributing factors [19].

a. Science literacy skills in the knowledge aspect

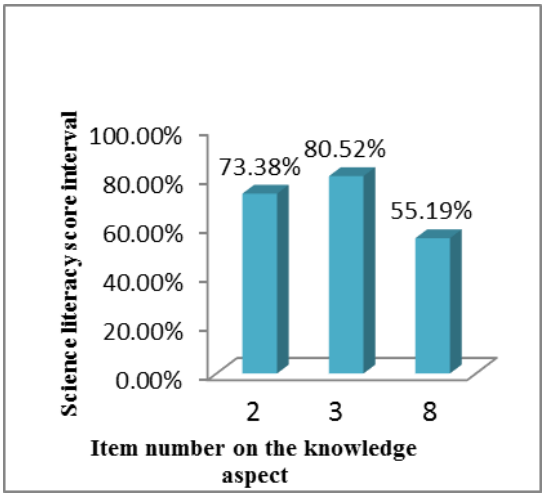

Figure 1. Percentage of LS Ability in Knowledge Aspect

Description:

2 and 8 = Content knowledge indicators

3 = Indicator of procedural knowledge

Figure 1 indicates that the average percentage score for all knowledge aspects is 69.70%, which falls into the moderate category. The performance of students' scientific literacy on content indicators is presented in Figure 1, where items 2 and 8 scored 73.38% and 55.19% respectively, categorized as moderate and low, respectively. Item 2 demonstrates that students are fairly capable of responding to the question presented. The enhancement of scientific literacy competencies is influenced by multiple factors, including the instructional approaches or methods employed by teachers to build conceptual understanding. Learning

strategies that stimulate students' curiosity about the topic and motivate them to engage in problem-solving activities are believed to enhance science process skills, which form an essential component of science literacy competencies. Connected to the results of student questionnaires, 74% agreed, and 24% strongly agreed that the literacy questions can make students interested in finding out new information, and students try to work on science literacy questions.

Whereas question item number 8 obtained a percentage value of 55.19% in the low category, this finding means that students are less able to answer questions on the indicators of the knowledge aspects spread in the questions given. The results of the analysis of these questions it is known that some students have not been able to calculate the pH value of eye drops properly and correctly. Students only rewrite the questions given, and even students just write the results of the pH value without knowing where the results come from. The low level of students' science literacy in this knowledge indicator is attributed to their limited conceptual understanding when responding to questions [20].

The results for the procedural knowledge indicator are presented in Figure 1. For this indicator, class XI students at SMA Negeri 2 Muara Badak achieved a score of 80.52% on item number 3, placing it in the high category. This shows that students were able to answer the question successfully. Analysis of student work and interview findings revealed that several students could solve the problem well, including identifying the buffer properties present in carbonated beverages. These findings are consistent with Sari et al., who reported a 77% achievement rate in the knowledge aspect, which also falls into the high category [21].

b. Science literacy competency aspects

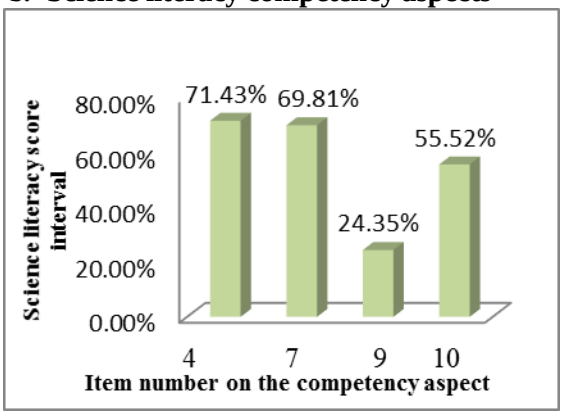

Figure 2 Percentage of LS Ability in Competency Aspect

Description:

4 and 7 = Competence in explaining phenomena scientifically

9 and 10 = Competence in researching, evaluating and using scientific information to make decisions

Based on the evaluation of students' responses, it is known that students are quite capable of mentioning the equilibrium system contained in the mixture of citric acid and sodium citrate in question number 4. As for question number 7, some students wereable to solve the problem. However, they answered the question incorrectly. This finding aligns with Rusilowati (2014), who noted that students tend to excel more in memorization than in science process skills. This tendency reflects students' preference for mastering knowledge through rote learning rather than through analytical thinking. Another contributing factor is the common practice in schools where science learning prioritizes cognitive mastery over the development of students' thinking skills [23].

Furthermore, the competency indicator of researching, evaluating, and using scientific information to make decisions obtained a percentage value of 24.35% and 55.32%, with a very low category for item number 9 and a low category for item number 10. In this competency indicator, students were unable to use scientific explanations, evaluate arguments, or draw conclusions based on scientific evidence. Analysis of the students' answers revealed that the majority were unable to respond accurately. This finding may be attributed to their lack of experience with science-literacy-based items and their

tendency to avoid thoroughly reading the accompanying passages.

c. Science literacy skills in the context aspect

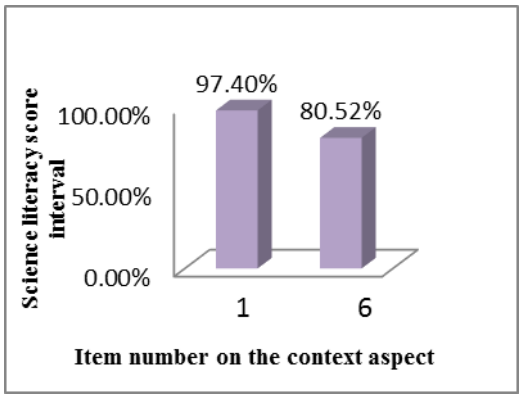

Figure 3 Percentage of LS Ability in the Context Aspect

Description:

1 = Health and illness (personal)

6 = Natural (local) resources

Referring to Figure 3, the context aspect shows the highest percentage among all assessed components, with a score of 88.96%, categorized as very high. This finding means that students can answer questions on context aspects that are scattered in the questions given. The context aspect in this instrument is a discourse followed by a description question given to students to provide alternative solutions. This result aligns with the opinion of [22], which states that context-based learning links chemistry with real-life issues and problems. This approach does not merely stimulate critical thinking about scientific phenomena, but also promotes inquiry skills and strengthens communication in the classroom, offering meaningful and enriching experiences in science learning [23].

d. Science literacy skills in the attitudinal aspect

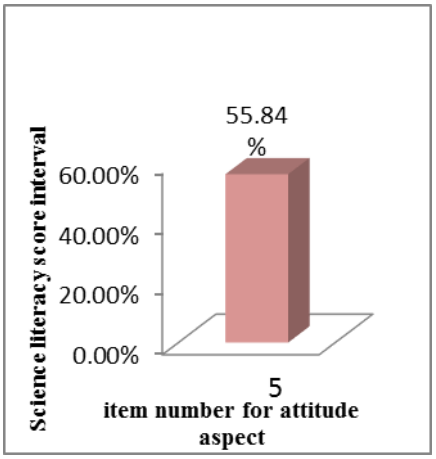

Figure 4 Percentage of LS Ability in Attitude Aspect

Figure 4 shows that the attitude aspect reached 55.84%, categorized as low. This suggests that the low level of students' science literacy in this dimension stems from unfamiliarity with science literacy items, limited reading competence, and instructional practices that do not sufficiently foster student expression or active engagement. This interpretation is consistent with insights gained from student interview data, illustrated as follows:

Student A: "I rarely read books, this is because I prefer to be given examples directly by the teacher, and for the past month I have not read any books".

This indicates that students' inadequate science literacy is partly attributed to their limited reading habits, as they tend to rely solely on teacher explanations rather than engaging with learning resources independently.

CONCLUSIONS AND SUGGESTIONS

The results of this study indicate that students' science literacy skills regarding buffer solution concepts at SMA Negeri 2 Muara Badak are categorized as moderate. It is recommended that teachers design and implement contextual learning activities that integrate real-world phenomena. Such practices can foster students' ability to relate chemical concepts to everyday life and strengthen their science literacy. Further

studies are recommended to explore strategies, learning methods, and media that are effective in improving students' science literacy skills.

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