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Science Literacy Profile of Eleventh-Grade High School Students in Acid-Base

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Abstract:
The assessment conducted by PISA indicates that the science literacy rate of students in Indonesia occupies the lowest rank. One of the reasons is the lack of literacy-based assessments with multiple representations. This study aims to describe the profile of science literacy skills of eleventh-grade students on base acid material. The method used is descriptive quantitative, with the subject of the study being 62 students in XI grade who have acquired base acid matter. The instrument used is 10 elements of scientific literacy description with a multiple representation framework developed, with a high-reliability value of 0.795. The study results showed that the average literacy profile of science students reached 56.22%, which belongs to the middle category, with 5% of students entering the lower category, 27% in the high category, and 68% in the medium category. Students' access to indicators explaining scientific phenomena reached 52.29%, interpreting data and evidence scientifically reached 54.96%, and evaluating and designing scientific research reached 83.3%. Based on these data, eleventh-grade students have a moderate level of science literacy, with the highest access to the indicators to evaluate and design scientific research. This literacy of science needs to be enhanced through the provision of scientific literacy tools that apply multiple representations.

Keywords: Science literacy, acid-base, multiple representation

INTRODUCTION

The faster science grows in the 21st century, the faster the environmental, political, educational, and economic challenges human beings face. The Sustainable Development Goals (SDGs) are the United Nations agenda that covers 17 global goals and targets by 2030, aiming to improve human life quality (Bappenas, 2017). Through science literacy, students can think scientifically, it is one step towards achieving quality education. However, the results of a study conducted by the PISA (Programme for International Student Assessment) show that the average literacy of students in Indonesia is still low, even by 2022, Indonesia has experienced a drop in the average science literacy from 396 to 383 (PISA, 2023).

Chemistry is a subject of science close to everyday life, but it isn't easy to understand by students because of its abstract and complex nature. Students require science literacy to use the concept of chemistry in everyday life; besides, students need to understand the three levels of representation (Hidayah & Ardhana, 2024). The macroscopic level in chemistry refers to chemical phenomena that can be observed directly, such as changes in the color of a solution during dilution.

Acid-base is a chemistry substance requiring science literacy and multiple representations. Students often complain about basic acid material; for instance, students have difficulty interpreting data and evidence scientifically at a macroscopic level, such as explaining the causes of acid rain and its effects on the environment, because students do not know the pH of acid rain. Furthermore, on indicators describing scientific phenomena, students have difficulty explaining the mechanisms of antacid reactions to cope with gastric acid (Saputri et al., 2022). As for indicators evaluating and designing scientific research at a symbolic level, students find it challenging to plan and calculate experiments based on acid-neutralization reactions (Djatmiko & Mahbubah, 2022).

Assessment can be used to obtain information about students' access and abilities, as well as an excuse for improving their abilities (Rozhana & Sari, 2019). Science literacy assessments include assessment of indicators that explain phenomena scientifically, scientific interpretation of data and evidence, and evaluation and design of scientific research. Measurement of student science literacy on acid-base material has been done in previous studies. Still, few have combined it with multiple representation frameworks, while multiple representations can stimulate scientific literacy (Ulfana et al., 2023). The Nofiarti study analyzes science literacy on base acid at the conceptual and functional level with a moderate level of science literacy (Nofiarti, 2021). Furthermore, Djatmiko & Mahbubah (2022) research shows that students' scientific literacy skills in acid-base material are low. Lack of science literacy is due to textbook selection, misconceptions, poor reading skills, uncontextual learning, and learning environments (Winarni et al., 2020).

Based on the results of interviews with the chemistry teacher MAN 1 Tulungagung, showed that the school had implemented a literacy program before learning began, but to give literacy on science subjects is not running. The evaluation given by the teacher is only limited to description and double choice without any literacy being displayed. Besides, students are not used to working on science literacy, and they are still strangers to the form of multiple representation issues. The teaching done by the teacher has also not fully implemented contextual learning.

Under the above description, to improve the literacy of science and help the achievement of the SDGs program, a description of science literacy is needed, which can be used as a reference in improving science literature as well as the use of scientific literacy instruments that apply multiple representation frameworks to stimulate science literation. Therefore, research has been carried out to describe the profile of XI class sciences literacy capabilities on acid-base materials using scientific literation instruments equipped with multiple representation frameworks.

METHOD

The research in this article is a kind of quantitative research with a descriptive approach. The study subjects are students from class XI, with 62 students from MAN 1 Tulungagung. Study subject is taken based on specific criteria, namely students of grade XI who have almost the same ability and have obtained basic acid lessons. The data collection technique is carried out through question raising, with the instruments used in the form of 10 questions of science literacy representing three indicators of scientific literacy, namely, to explain phenomena scientifically, to interpret data and scientific evidence, and to evaluate and design scientific research as for the question form of a description that applies a multi-representation framework. The multiple representation framework used is a DAC framework (Definition, Algorithmic, Conceptual) developed by Smith et al. (2010). The question tool used is a question that has been developed by researchers with a content validation of 78% with a qualifying criterion and a reliability of 0.795 with a high reliability. Data analysis is carried out by calculating the scores obtained by the student according to the evaluation section and calculating science literacy skills based on the following formula:

$$Level\ of\ science\ literacy\ skills = \frac{scores\ earned\ by\ students}{Maximum\ score} \times 100$$

After obtaining each student's score, the students are then grouped into the science literacy category based on Table 1. Then, the percentage of students on the ability of a particular category is calculated with the formula as follows:

$$Percentage\ of\ students\ in\ each\ category = \frac{Number\ of\ students\ answered\ correctly\ each\ category}{Total\ student} \times 100\%$$

Access to PISA science literacy indicators on skill aspects consists of three indicators, which are subsequently calculated as the percentage of students who can answer for all indicators through the following formula:

$$Indicator\ access\ percentage\ = \frac{Student'sscore\ per\ indicator}{Maximum\ score\ per\ indicator} \times 100\%$$

Data analysis is done descriptively by grouping students' scores that have been calculated and matched to the science literacy category as follows:

Table 1. Science Literacy Level (Sutrisna, 2021)

Student end score	Category
67-100	High
34-66	Middle
<33	Low

RESULTS AND DISCUSSION

Research Results

The results of a study conducted on 62 students of XI class MAN 1 Tulungagung showed that the percentage of students responding to number 3 had the highest percentage, 90,86%. In contrast, the lowest percent score is at number 10 with 34.95%. The achievements of the percentage of students responding to each item can be seen in Table 2.

Table 2. Percentage score on each item

1	2	3	4	5	6	7	8	9	10
41,40%	36,56%	90,86%	44,35%	59,14%	65,32%	83,33%	86,29%	35,48%	34,95%

The difference in the percentage of students answering each item is due to the difference in difficulty levels; the higher the difficulty level, the less students can answer correctly (Hanifah et al., 2014).

Table 3. Percentage of student science literacy

Student's Score	Maximum Score	Percentage	Category
1464	2604	56,22%	Middle

Based on Table 3 it is known that the results of the literacy test of science students of class XI MAN 1 Tulungagung We have obtained that the average level of literacy of the science students obtaining category is 56.22%.

Table 4. Grouping of students by science literacy category

Number	Frequency	Percentage	Average value	Category
1.	17	27%	73,39	High
2.	42	68%	51,13	Middle
3.	3	5%	30,16	Low

Science literacy students based on each category based on Table 1. obtained 27% of students entering the high category with an average of 73.39, 68% of students entering the middle category with an average of 51.13, and 5% of students into the lower category with the average of 30.16.

Table 5. Percentage of students able to respond to each indicator

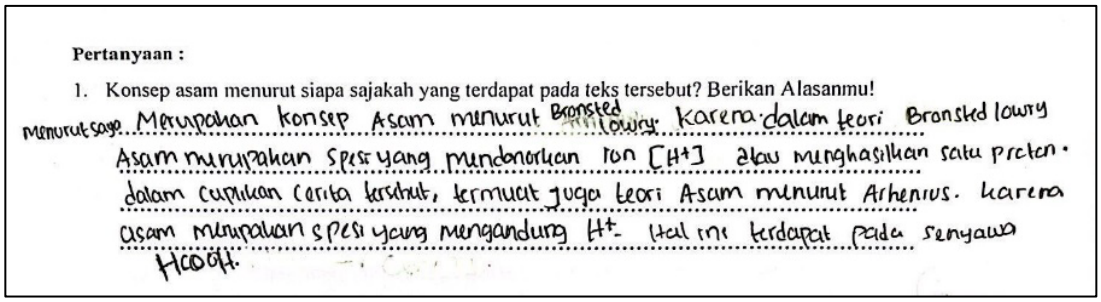
No	Indicator	Percentage	Category
1.	Explaining phenomena scientifically	52,29%	Middle
2.	Interpreting data and evidence scientifically	54,96%	Middle
3.	Evaluating and designing scientific inquiry	83,3%	High

According to the study results, the indicators explain the phenomenon scientifically and can answer by 52.29% of students, indicators interpret data and evidence scientifically answered by 52.96% of the students, and indicators evaluate and design scientific research answered by 83.3% of students.

Discussion

Science literacy of eleventh-grade students in general on base-acid material achieved a percentage of 56.22% with the average category, and it is in line with an interview conducted by the chemistry teacher that the school's students have implemented an independent curriculum and everyday students carry out literacy. However, the literacy that students do is limited to random reading books. Students are not used to finding literacy in science materials like chemistry. Uncontextual learning and low reading skills are reasons science literacy is still not maximized. (OECD, 2019).

The majority of students who entered the high category earned 27% or as much as 17 students. Students in this category can answer questions thoroughly and accurately, as in question number one, which uses a science literacy indicator to interpret data and scientific evidence that requires students to find information from the given literacy text. Question number one requires the student to answer more than one question marked with the phrase "by whom." This requires a student to understand the subject correctly.

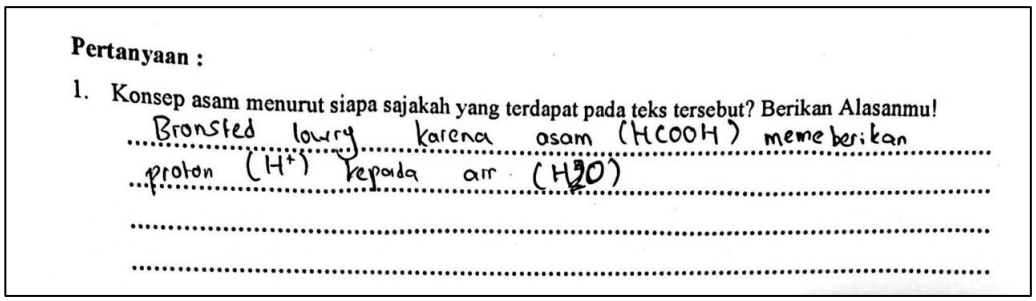

Pertanyaan :

1. Konsep asam menurut siapa sajakah yang terdapat pada teks tersebut? Berikan Alasanmu!

Menurut saya. Merupakan konsep Asam menurut Bronsted Lowry karena dalam teori Bronsted lowry Asam merupakan spesi yang mendonorkan ion [H+] atau menghasilkan satu proton. dalam cuplikan cerita tersbut, termuat juga teori Asam menurut Arhenius. karena asam merupakan spesi yang mengandung H+ Hal ini terdapat pada senyawa HCOOH.

Figure 1. Student answers with high science literacy abilities

Figure 1. is an example of the answers of students with science literacy skills in high. Students with high scientific literacy abilities can scientifically interpret scientific literature, i.e., data and evidence. The students can interpret information from literacy texts and transform such information into answers. Furthermore, students with science literacy in the middle have a percentage of 68%, with an average score of 51.13. Students at the middle level can answer questions, but the answers are not complete. Middle-skilled students, on the number one question, tend to answer one of the acid theories; they are not very thorough in understanding the given issue.


Pertanyaan :

1. Konsep asam menurut siapa sajakah yang terdapat pada teks tersebut? Berikan Alasanmu!

Bronsted lowry karena asam ($HCOOH$) memeberikan proton (H^+) kepada air (H_2O)

Figure 2. Student answers with middle science literacy abilities

Figure 2. shows one of the answers of students with middle science literacy. Students in this category have met the indicator of scientific literacy of interpreting data and evidence scientifically, but students are not careful in answering questions.

As for students with low science literacy, they earned a 5% percentage with an average score of 30.16. Students with a low level of ability cannot answer questions correctly. Students with the low category have not yet been capable of finding information from the text presented, nor can they understand the meaning of the subject properly.

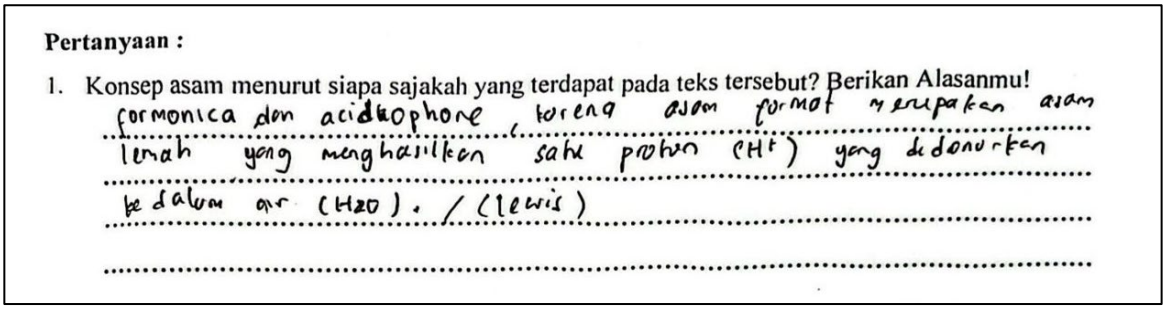


Figure 3. Student answers with lower science literacy abilities

Figure 3. also shows that low science literacy students tend to answer questions originally and cannot distinguish between Bronsted-Lowry acid theory and Lewis acid theories. Students in the low science literacy category have not been able to use the indicator of scientific literacy on item number one, which is to interpret data and evidence scientifically. The lack of maximum literacy in the student's science is due to several factors: the student is not accustomed to working on science literacy. The evaluation question given by the teacher is only about the form of description and double choice without the literacy text given. Learning that is not entirely contextual is also the cause of not maximizing students' science literacy level. (Fuadi et al., 2020).

CONCLUSIONS

Based on the results of research and discourse, it can be concluded that the literacy of science students of class XI MAN 1 Tulungagung on base acid matter generally obtained a percentage of 56.22% with a Medium Category. As for students with high science literacy skills, 17 students with 27 percent, 42 students with middle literacy with 68 percent, and 3 students with low literacy ability with 5 percent. Science literacy indicators achieved students among them, scientifically explained phenomena reached 52.29%, indicators interpreting data and evidence scientifically reached 54.96%, and indicators evaluating and designing scientific research reached 83.3%.

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