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# SCIENTIFIC LITERACY SKILLS PROFILES OF ELEVEN GRADE STUDENTS ON REACTION RATES TOPIC

**Alvin Jahwarotul Khumairoh[1], Ivan Ashif Ardhana[2]**

[12]Universitas Islam Negeri Sayyid Ali Rahmatullah, Jl. Mayor Sujadi No. 46, Tulungagung, 66221, Indonesia

[1]**Corresponding author: alvinjahwarotul2001@gmail.com*

**Abstract:**
The literacy skills of Indonesian students, according to the results of the PISA (*Program for International Student Assessment*) report, show a low level. This is caused by assessment activities that have not promoted scientific literacy in the form of understanding reading, text, or science data. This study aims to describe the profile of high school students' scientific literacy skills on reaction rate material. The method used was descriptive quantitative. The research subjects were high school students who had received reaction rate material. The instrument used was 8 essay questions that had been validated and empirically tested with a reliability coefficient of 0.605 in the moderately reliable category. Based on the results of the study, students' scientific literacy skills obtained an average percentage value of 30.92% in the poor category. Students who have scientific literacy skills in the good category are 6%, 19% are sufficient, 45% are deficient, and 29% are very deficient. Indicator achievement of interpreting data and evidence scientifically obtained a percentage of 30%, and explaining phenomena scientifically obtained a percentage of 9%. Scientific literacy skills in chemistry, especially reaction rate material, are not only to achieve learning objectives, but also to train students in solving problems related to phenomena in everyday life.

**Keywords:** scientific literacy; assessment; reaction rate

## INTRODUCTION

In this era, the development and changes of the times demand to create qualified and competent human resources in various fields in order to give birth to superior generations in all fields, including scientific literacy (Palennari et al., 2022). Indonesia's scientific literacy skills are still relatively low, as evidenced by the 2018 PISA (*Program for International Student Assessment*) results which ranked 70th out of 79 countries with a score of 389 out of 489 overall. (Anjeli Valentin Zandroto & Kelly Sinaga, 2022). Assessment with a scientific literacy component is one way to improve students' scientific literacy skills. PISA (*Program for International Student Assessment)* defines scientific literacy as the ability to apply scientific knowledge, identify questions, and reach conclusions based on empirical data to understand and make judgments about nature and the changes it undergoes as a result of human activities (Heuston, 2022). Scientific literacy is the ability to apply science to solve problems in everyday life and understand ideas and procedures (Hasasiyah et al., 2019). Scientific literacy indicators include three aspects of competence, namely explaining scientific phenomena scientifically, designing and evaluating scientific investigations, and interpreting data and evidence scientifically in three types of knowledge (content, procedural, and epistemic) (Wasis, 2020).

Changes in the independent curriculum make scientific literacy as one of the reasoning skills that is the focus to be targeted and evaluated. In implementing the independent curriculum, the Minimum Competency Assessment aims to measure students' thinking or reasoning competencies

with literacy and numeracy as well as strengthening student character. (Meriana & Murniati, 2021). In assessing students' literacy and numeracy skills, the Minimum Competency Assessment (MCA) still has difficulties. This is especially true when creating content and context-based questions because students are still unable to reason and provide explanations for their answers to questions expected under the minimum competency assessment. This is indicated by the low average results that continue to be obtained from literacy and numeracy skills (Ahmad et al., 2021).

Chemistry is a natural science subject taught in high school which is defined as a process of a scientist in developing knowledge such as chemical principles, facts, and concepts (Chang, 2005). One of the chemistry materials that require in-depth student understanding is the reaction rate. The reaction rate includes a discussion of the concept of reaction rate, reaction rate equation and reaction order, collision theory, and factors that affect the reaction rate. In the reaction rate there are macroscopic, sub-microscopic, and symbolic aspects that show that this material is abstract. Examples of macroscopic aspects in reaction rate material are the occurrence of a chemical reaction in a solution where the reaction can be seen using the five senses through observations such as the formation of gas bubbles, sediment, and color changes in the solution. Sub-microscopic aspects, for example, regarding the collision process that occurs in a reaction where the collision process that occurs will be influenced by several factors that can affect the reaction rate, while in symbolic aspects such as the reaction rate equation, reaction order, and the use of formulas in calculating the reaction rate.

Reaction rate has a connection with scientific literacy, because reaction rate has a fairly broad concept, and can be related to problems in everyday life. For example, in everyday life we must have cooked water. When cooking water, we will use fire. Fire has an influence on the speed of water maturity. When using a small fire, the water will boil slowly or long, while when using a large fire, the water will boil quickly. This is caused by temperature, the increase in temperature will make the movement of water particles faster so that the water boils quickly. The effect of temperature in the reaction rate material is included in the factors that affect the reaction rate. Therefore, reaction rate material requires students' ability to understand problems related to interpreting, calculating, and explaining to solve problems that are related to everyday life. The goal of student understanding is to transform knowledge from all that is real into a useful tool for creating mental models of chemical processes. In addition, students are able to use at least three representations to describe chemical phenomena in their understanding of chemical ideas. (Ijtihadah & Ardhana, 2024). According to research conducted at MAN 2 Lamongan states that students have difficulty understanding the concept of the effect of temperature and catalysts on reaction rates. (Siti Ririn, 2022). Another study on electrolyte and non-electrolyte solution materials found that students had a sufficient level of scientific literacy skills (Trianah, 2020).

Based on the results of interviews conducted with chemistry teachers at An-Nur Bululawang High School, information was obtained that the chemistry questions that have been used by teachers for learning evaluations have not contained scientific literacy and the questions given are only limited to knowing the level of students' understanding of chemistry material. In the learning process, the teacher also has not included scientific literacy. In addition, the school has not developed a scientific literacy instrument to measure the profile of students' scientific literacy skills in reaction rate material. Based on the description that has been presented above, the researcher aims to find out and describe the profile of scientific literacy skills of grade XI high school students on reaction rate material, so it is hoped that the results of this study can be valid information in the world of education related to efforts to improve students' scientific literacy skills.

## METHOD

This research uses descriptive quantitative, which is research that aims to describe the achievement of the profile of scientific literacy skills possessed by SMA An-Nur Bululawang students. This

study involved 31 students of class XI SMA An-Nur Bululawang. The technique of taking research subjects was carried out by *purposive sampling* or selection of study subjects based on the assessment of chemistry teachers. This consideration is based on the ability of students and has received reaction rate material. The data collection technique used an instrument of essay questions as many as 8 questions covering 2 indicators of scientific literacy, namely explaining phenomena scientifically and interpreting data and evidence scientifically. The questions used are in the form of essays because they can find out the level of students' scientific literacy skills more deeply, and can determine the extent to which students can fulfill the indicators of scientific literacy. The question instrument used is an instrument that has been developed by researchers with content validation of 80.78% with a decent category and empirically tested with *Cronbach alpha* 0.605 with a fairly reliable category.

Score interpretation is assessed by entering the scores received into the literacy score calculation in the following way:

$$\text{Literacy level} = \frac{\text{Student score}}{\text{Maximum score}} \text{ x } 100$$

In addition, the scores that have been obtained from students will be grouped into categories of scientific literacy skills with the following formula:

$$\text{Students' scientific literacy skill level} = \frac{\text{Number of students in a particular category}}{\text{Total students}} \text{ x } 100\%$$

The achievement of scientific literacy indicators according to PISA has three indicators categorized by the following formula:

$$\text{Indicator level} = \frac{\text{Student indicator score}}{\text{Indicator maximum score}} \text{ x } 100\%$$

Data were analyzed descriptively by modifying students' responses according to predetermined evaluation criteria and allocating them to categories of understanding in students' learning process as follows:

**Table 1**. Level of Understanding in the Learning Process

| Student's Final Score | Category |
|---|---|
| 81-100 | Very good |
| 61-80 | Good |
| 41-60 | Simply |
| 21-40 | Less |
| < 20 | Very Less |

Source: Arikunto (2015)

## RESULTS AND DISCUSSION

### Research Results

The results of the research in the form of answers to scientific literacy tests in the form of essays that have been conducted to 31 students of An-Nur Bululawang High School obtained data such as the following table:

**Table 2.** Average Score on Each Problem

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 2,09 | 2,06 | 2,48 | 1,48 | 3,41 | 3,09 | 2,22 | 2,61 |

Table 2. shows the results of the average value of the total score obtained from 31 students of SMA An-Nur Bululawang with different maximum scores each question, namely the maximum

score of questions number 1, 2, 5, and 6 is 10, the maximum score of question number 7 is 8, while the maximum score of questions number 3, 4, and 8 is 5. In question number 5 obtained the highest average score among the other questions which was 3.41, while question number 4 obtained an average score of 1.41. These two average scores only have a small difference in value, so from the data in table 2. it can be seen that students have a low average score. To find out the scientific literacy skills possessed by students can be seen in Table 3.

**Table 3.** Students' Scientific Literacy Ability Based on Score

| Student Total Score | Maximum Score | Average Score | Percentage | Category |
|---|---|---|---|---|
| **604** | 1953 | 19,48 | 30,92% | Less |

From the data in Table 3, it was found that the level of scientific literacy skills in general obtained an average score of 30.92% in the poor category. This result, in accordance with the diverse understanding as presented in Table 1, where 6% of students have good scientific literacy skills with an average test score of 62.69. 19% of students had sufficient scientific literacy skills with an average test score of 42,17. 45% of students had poor scientific literacy skills with an average test score of 30.04 and 29% of students had very poor scientific literacy skills with an average test score of 13.05. This can be seen in Table 4.

**Table 4.** Students' Scientific Literacy Skills Based on Frequency and Average Score Achievement

| No. | Frequency | Percentage | Average Test Score | Category |
|---|---|---|---|---|
| **1.** | 0 | 0% | 0 | Very good |
| **2.** | 2 | 6% | 62,69 | Good |
| **3.** | 6 | 19% | 42,17 | Simply |
| **4.** | 14 | 45% | 30,04 | Less |
| **5.** | 9 | 29% | 13,05 | Very Less |

As can be seen from Table 4. shows that scientific literacy skills need to be improved again. Because the table above shows the largest percentage value of 45% which shows that most students lack scientific literacy skills. The level of achievement of students' scientific literacy can be seen in each indicator.

**Table 5.** Students' Scientific Literacy Skills based on Scientific Literacy Indicators

| No. | Scientific Literacy Indicators | Percentage | Categories per Indicator |
|---|---|---|---|
| **1.** | Explaining phenomena scientifically | 9% | Very Less |
| **2.** | Interpret data and evidence scientifically | 30% | Less |

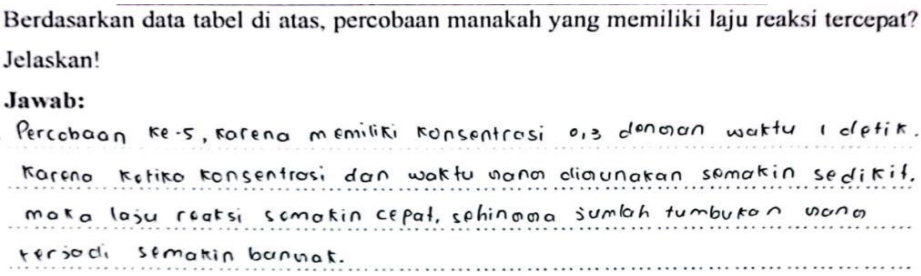
Based on the data in Table 5. obtained the level of students' scientific literacy skills in terms of their scientific literacy indicators. As in the indicator of explaining phenomena scientifically with a percentage of 9% classified as very less, while the indicator of interpreting data and evidence scientifically with a percentage of 30% is classified as less. Indicators of evaluating and designing scientific investigations are not used because researchers focus on the cognitive abilities of students, while this indicator is included in psychomotor abilities.

## Discussion

In general, students' scientific literacy skills obtained a percentage value of 30.83% in the category of less. These results are in accordance with interviews conducted with chemistry teachers that students have never received questions that contain scientific literacy and in the learning process also do not contain scientific literacy. During the process of working on the questions, students experienced difficulties because the questions given were in the form of essays accompanied by discourse and some data and graphs, so that students had even more difficulty in answering these questions because in addition to students being asked to analyze data, students were also asked to relate data to existing concepts in reaction rate material. Based on each indicator, the ability of scientific literacy seen from each indicator, students in explaining phenomena scientifically have a

percentage value and using scientific evidence has been fulfilled and is classified as a good category (Ning et al., 2020).

There are 2 students who have good scientific literacy skills with a percentage of 7%. Students who fall into this category have an average score of 62.69. Students in this good category, in general, have answered questions in accordance with scientific literacy indicators. Based on the answers given, students are able to interpret experimental data in the form of a table that shows there are several experiments related to the use of carbide in helping the ripening process of bananas. From interpreting the data from several experiments, students are able to understand the data and produce an answer that the 5th experiment has the fastest reaction rate among other experiments. In addition, students are also able to provide an explanation for the answer that to accelerate the reaction rate, the concentration used is getting bigger with less time. Therefore, this student answer has fulfilled the indicator of interpreting data and evidence scientifically.

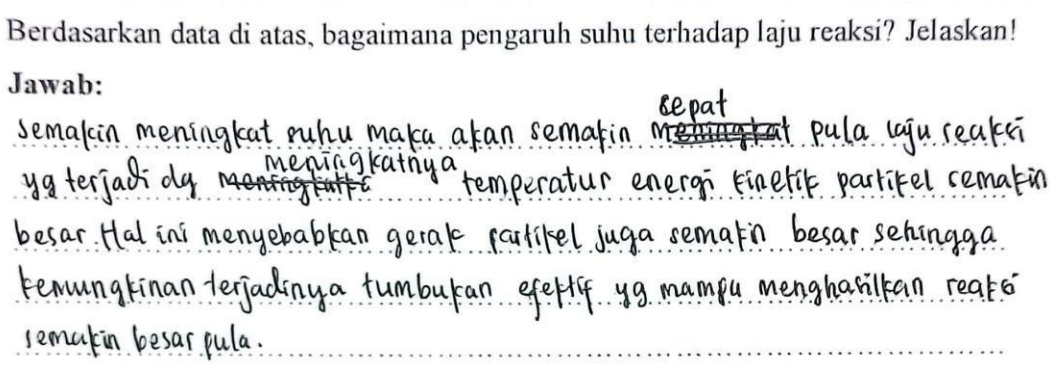

Berdasarkan data tabel di atas, percobaan manakah yang memiliki laju reaksi tercepat? Jelaskan!

**Jawab:**

Percobaan ke-5, karena memiliki konsentrasi 0,3 dengan waktu 1 detik. Karena ketika konsentrasi dan waktu nana digunakan semakin sedikit, maka laju reaksi semakin cepat, sehingga jumlah tumbukan nana terjadi semakin banyak.

**Image 1.** Student Answers Good Scientific Literacy

There are 6 students with a percentage of 19% who have sufficient scientific literacy skills. Students who fall into this category have an average score of 49.2. Students in this good category, in general, have answered questions in accordance with scientific literacy indicators. The answers of students who have good scientific literacy skills can be seen in Figure 2. Based on the answers given, students are less able to interpret data in the form of graphs that show the more concentration used, the higher the reaction rate. From the results of student answers, it shows that students are quite able to read data in the form of graphs and students are able to explain the effect of temperature on the reaction rate. This shows that the indicator of interpreting data and evidence scientifically in the form of graphical data is quite fulfilled.


Berdasarkan data di atas, bagaimana pengaruh suhu terhadap laju reaksi? Jelaskan!

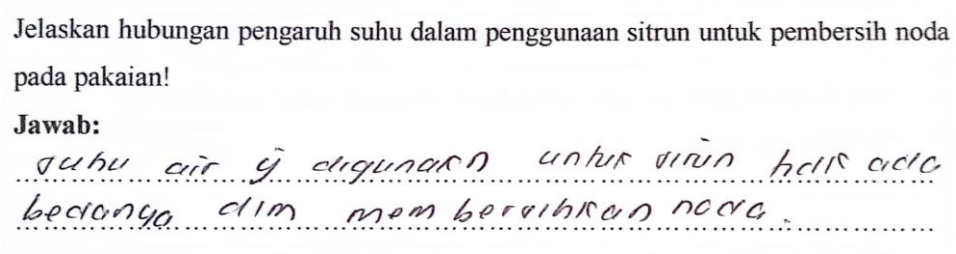
**Jawab:**

Semakin meningkat suhu maka akan semakin cepat pula laju reaksi yg terjadi dg meningkatnya temperatur energi kinetik partikel semakin besar. Hal ini menyebabkan gerak partikel juga semakin besar sehingga kemungkinan terjadinya tumbukan efektif yg mampu menghasilkan reaksi semakin besar pula.

**Image 2.** Students' Answers of Adequate Scientific Literacy

The scientific literacy skills of students who have less are 14 students with a percentage of 45%. Students who fall into this category have an average score of 30.04. Students in this good category, in general, have answered questions in accordance with scientific literacy indicators. The answers of students who have good scientific literacy skills can be seen in Figure 3. Based on the answers given, students are less able to explain phenomena scientifically. As in the question, a reading is given in the form of using citronella in cleaning clothes stains. From the students' answers, it can be seen that students do not understand the concept of the effect of temperature on the reaction

rate, so students answer that temperature has no effect on the use of citron in cleaning clothes stains. This shows that students do not fulfill the indicator of explaining phenomena scientifically.

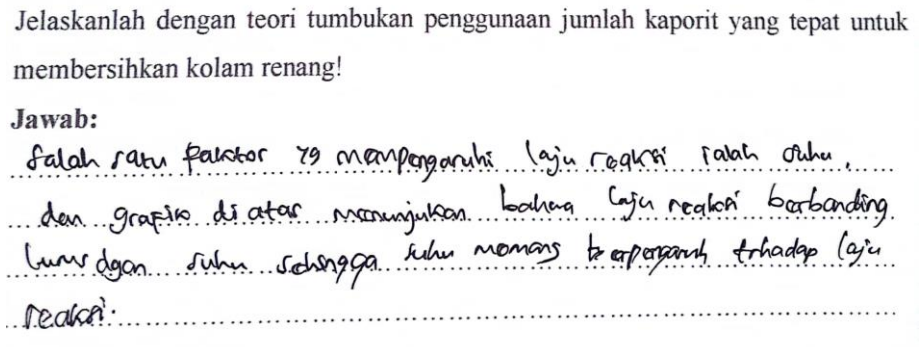

Jelaskan hubungan pengaruh suhu dalam penggunaan sitrun untuk pembersih noda pada pakaian!

**Jawab:**

suhu air yg digunakan untuk sirun hall cido bedanya dlm membersihkan noda

**Image 3.** Students' Answers of Lack of Scientific Literacy

The scientific literacy skills of students who have a very poor classification are 9 students with a percentage of 29%. Students who fall into this category have an average score of 13.05. Students in this good category, in general, have answered questions in accordance with scientific literacy indicators. The answers of students who have good scientific literacy skills can be seen in Figure 4. Based on the answers given, students have not been able to explain phenomena scientifically. As in this question, a reading is given about the use of chlorine in cleaning swimming pools. From the students' answers, it shows that students answer carelessly, because the reading does not mention temperature at all but the concentration of chlorine used to accelerate the reaction rate, so that it can quickly clean the swimming pool. In addition, the graph data contained in the reading only includes the concentration of CaOCl with the reaction rate. This shows that the indicator of explaining scientific phenomena has not been met.


Jelaskanlah dengan teori tumbukan penggunaan jumlah kaporit yang tepat untuk membersihkan kolam renang!

**Jawab:**

salah satu faktor yg mempengaruhi laju reaksi ialah suhu, dan grafik di atas menunjukan bahwa laju reaksi berbanding lurus dgn suhu sehingga suhu memang berpengaruh thdap laju reaksi.

**Figure 4.** Students' answers are very poor in scientific literacy

The average indicator of scientific literacy ability in explaining phenomena has a lower percentage value than interpreting data and evidence scientifically. In interpreting data and evidence scientifically obtained a percentage of 30% with a category of less. The lack of average in this indicator is because most students cannot read and cannot understand the data in the form of tables or graphs contained in the questions. This causes students to answer randomly and there are some student answers that are out of the context of the discussion. In addition, the indicator of explaining phenomena scientifically has a percentage value of 9% with a very poor category. This is since during the learning process the material has never been linked to everyday phenomena, so students have difficulty in working on problems that link concepts with everyday phenomena.

Based on the data obtained, in general, the scientific literacy skills of grade XI high school students on reaction rate material are included in the insufficient category. This is evidenced by the average student score obtained 19.48 with a percentage of 30.92%. When comparing with previous research in solving scientific literacy questions on reaction rate material, the level of scientific literacy of 26 students in class XI IPA 2 SMA Negeri 9 Bengkulu City obtained 3.8% for high scientific literacy level, 7.6% for medium scientific literacy level and 88.5% for low scientific literacy level, so that the ability possessed by students is at the nominal scientific literacy level (Tari Nurfadillah et al., 2023). In addition, students' lack of understanding of scientific literacy questions

and the memory-based learning patterns used by students so far have led to low literacy skills in students as a whole, which limits students' cognitive capacity to remember only (Maulida & Sunarti, 2022).

The low level of scientific literacy skills possessed by students is caused by several factors, namely that students have never been given questions based on scientific literacy, so students experience many difficulties because the form of the questions given is very unfamiliar. The questions that teachers make for learning evaluations and daily tests are taken from questions in chemistry textbooks. Another factor is students' lack of understanding of the material, so there are students who are wrong about the concept of reaction rate in answering questions. In addition, low scientific literacy skills can also be caused by the use of inappropriate learning models, lack of commitment in completing assignments and exams, teacher-centered learning, lack of student motivation in learning, and low initial understanding of learning materials (Palennari et al., 2022). Therefore, teachers should provide assessments that contain scientific literacy in chemistry subjects, especially reaction rate material. This is done to improve students' scientific literacy skills that can make education more qualified.

## CONCLUSIONS

Based on the results and discussion, it can be concluded that the ability of scientific literacy owned by high school students in class XI on the reaction rate material at SMA An-Nur Bululawang in general obtained a percentage value of 30.83% in the category of less. As students who have good category scientific literacy skills are 2 students with a percentage of 6%, 6 students are sufficient with a percentage of 19%, 14 students are less with a percentage of 45%, and 9 students are very lacking with a percentage of 29%. Judging from the indicators, students can explain phenomena scientifically with a percentage of 9%, and students are able to interpret data and evidence scientifically with a percentage of 30%.

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