JURNAL PENDIDIKAN KIMIA
ISSN: 2085-3653| e-ISSN: 2549-3116
Vol. 14 | No. 1 |19 - 27| April | 2022
https://doi.org/10.24114/jpkim.v14i1.32665

Analysis of student scientific literacy using the socio-scientific issues (SSI) approach on reaction rate

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Received: 02 February 2022 **Revised:** 02 April 2022 **Accepted:** 03 April 2022

ARTICLE INFO

Keywords:
Reaction Rate
Socio-scientific Issues approach
Student scientific literacy

ABSTRACT

This research at analyzing and knowing student science literacy after using Socio-Scientific Issues (SSI) approach on Reaction Rate lesson at the eleventh grade of MIPA 1 of State Senior High School 4 North Tambusai, Rokan Hulu. This research was conducted in the first semester in the Academic Year of 2019/2020. It was quantitative descriptive research. A purposive sampling technique was used in this research, and the samples were 32 students. The instrument was an essay test and it was supported by an unstructured interview. The data obtained then were analyzed descriptively. The results of analyzing the data showed, based on the data of essay test results, mean percentages of scientific literacy indicators: implementing the appropriate knowledge was 66.01% (good), identifying was 69.21% (good), explaining the implications of scientific knowledge for society was 80.94% (good), proposing ways to investigate scientific questions was 54.68% (enough), and drawing the right conclusion was 75.78% (good). It could be concluded that the achievement of student scientific literacy skills on the aspects of science competencies of Reaction Rate lesson at the eleventh grade of MIPA 1 overall was on good category.

1. Introduction

Scientific knowledge in the current global era contributes to increasing the competitiveness and welfare of a nation in the international arena. This is because scientific knowledge is a determining factor in technological development (Choerunnisa et al. 2017). Technological developments that change so rapidly require the world of education to continuously improve the quality of education, in order to adapt to all aspects of life, one of which is the field of education.

Education is a program that seeks to improve the quality of human resources as well as a determining factor for a country to enter the superior category or not (Amin, 2017). Education is also able to produce students who excel in various fields including being able to form someone who is literate in science. Someone who is scientifically literate can also be called someone who is scientifically literate. Scientific literacy means that scientific knowledge can be applied to solve problems in everyday life. Someone who is scientifically literate will face problems by analyzing

problems based on scientific evidence and then concluding them scientifically (Adytia & Kusumawati, 2018).

Scientific literacy is very important for students to have as a provision to face the challenges of 21st century development. Where scientific literacy directly builds a new generation, in this case, students who have strong scientific thoughts and attitudes can effectively communicate knowledge to the general public. A student who has scientific literacy is a student who uses science concepts, has scientific process skills to assess in making everyday decisions when dealing with other people, society and the environment, and understands the interaction between science, technology and society (Toharudin et al. 2011).

Scientific literacy according to PISA (Program for international student assessment) in the OECD (2009) is a person's knowledge of science to identify questions and explain scientific phenomena, draw conclusions from science-related issues that can produce change (problem-solving) in everyday life. This can make students use scientific knowledge and apply it in solving everyday problems related to the material being studied (OECD, 2009).

In the last few decades, the level of scientific literacy of the world community has become an interesting topic in the study of the world of science education. One of the international assessment programs that use scientific literacy as its conceptual basis is PISA, which is organized by the OECD (Organization for Economic Cooperation and Development) (Pratiwi et al. 2016). PISA results from 2000 to 2018 placed Indonesia as one of the countries with low scientific competence. According to PISA, Indonesia's scientific competence data is ranked 62 out of 71 participating countries. In terms of the distribution of literacy itself, nationally only 25.38% of scientific literacy is considered sufficient, while 73.61% is stated to be lacking.

Indonesia's ranking from this PISA assessment (2000-2018) reflects the Indonesian education system that has not been able to facilitate the empowerment of scientific literacy of students (Narut & Supardi, 2019). Based on these data, it can be concluded that the scientific literacy skills (including chemistry) of students in Indonesia are still low, this indicates that learning science (chemistry) in schools has not been supported to improve students' scientific literacy skills (Imansari et al. 2018).

This is in accordance with the results of the researcher's interview with one of the teachers in the field of chemistry at SMA Negeri 4 Tambusai Utara, that the ability to use scientific knowledge to identify scientific problems, use facts, understand living systems and draw conclusions based on information related to everyday life is still lacking weak. Where, during the learning process the teacher has applied scientific literacy in explaining the material and relating it in everyday life so that students not only know concepts but students also know the application of chemistry in everyday life. As in giving a topic or problem in everyday life related to chemistry subject matter. Then the students were asked to explain as best they could and the teacher straightened the student's explanation. So that students are honed their scientific literacy skills in thinking, solving problems, analyzing and drawing conclusions related to the material in everyday life so that students better understand science.

One of the learning approaches that can be used to facilitate students is the socio-scientific issues (SSI) approach which requires students to play a more active role and is an effective learning method that supports the goals of scientific literacy and the development of students' moral character.

This is in accordance with the results of research conducted by Fowler et al (2009) which states that learning using the SSI context can increase students' moral sensitivity, thereby contributing to the overall moral development of students. According to them, through learning with the SSI context students are directed to explore and pay attention to the lives, health and welfare of others (Zeidler & Nicholas, 2009). Through this approach, it seeks to bring students closer to science problems contextually through issues that can be found in everyday life.

The material used in this research is the reaction rate material. The rate of reaction is closely related to everyday life. Based on the relevance of the topic of reaction rates with everyday life, relevant social science issues can be searched for as contexts for SSI.

2. Methods

This research is a descriptive research quantitative research design with one-shot case study conducted on one experiment without class comparison with the socio-scientific issues (SSI) learning approach. This research was conducted in October-November 2019 academic year 2019/2020 odd semester in class XI. In this study, 5 times face-to-face. The population in this study were all students of class XI odd semester SMA Negeri 4 Tambusai Utara in October-November 2019th academic year 2019/2020 school year, totaling 65 students. The sample of this study was class XI MIPA 1 as many as 33 students as the experimental class.

In this study presents the subject matter of reaction rates with a socio-scientific issues (SSI) approach, and conveys the steps that must be taken in learning by applying the learning approach: (a) Divide students into several groups; (b) Presenting a problem of social issues; (c) Guiding students to get questions about topics that include scientific perspectives as well as questions from individual and community domains; (d) Guiding students in clarifying the scientific background in relation to the level of student understanding and if possible given practical work or practicum; (e) Guiding students in expanding scientific information so that it can support individual or community decisions; (f) Guiding students in explaining, evaluating and comparing different points of view and perspectives on the problems presented; (g) Guiding students for metareflection (metacognition); (h) Provide opportunities for each group to present the results of their discussion; (i) Guiding students in making conclusions.

Table 1. Categorization of scores

Score interval	Category
81 – 100%	Very good
61 – 80 %	Good
41 – 60%	Enough
21 – 40%	Not enough
1 – 20%	Very less

Sampling using the purposive sampling technique is a sampling technique with certain considerations. Data collection techniques in this study used a test (posttest), and unstructured interviews. To obtain good test questions as a data collection tool in this study, a trial was held on students who had studied the reaction rate material, namely class XII MIPA 1. The questions tested were tested on students, then analyzed to determine the validity, reliability, level of problem difficulty, and distinguishing power. Then analyze the final data by using the following steps:

a. Provide a raw score for each student's answer to the essay test based on the standard answer made.
b. Calculate the total score of the essay test for each student based on each indicator.
c. Determine the percentage value of scientific literacy of each student, by converting the raw score into a percentage value based on the formula:

$$NP = \frac{R}{SM} \times 100$$

NP: Percentage value; R: Raw score obtained by students; SM: Maximum score of the test in question

d. Measuring the average score for each sub-indicator of scientific literacy:

$$\text{Average} = \frac{\Sigma \text{skor total}}{\text{Jumlah siswa}}$$

e. The categorization of scores is based on the data that has been obtained from the results of the essay test (Table 1).

The instruments used in this study were essay tests, interviews, and documentation. Where the essay test was piloted first to a class that had studied the reaction rate material after being validated by a material expert consisting of a chemistry lecturer at UIN Suska Riau and a chemistry teacher at SMA Negeri 4 Tambusai Utara. The calculation of the analysis of the test items was carried out using a computer with the ANATES software version 4.0.5. to determine the validity, reliability, level of difficulty of the questions and the discriminating power of the questions.

3. Results and Discussion

This research uses posttest questions in the form of essay. The test results were then analyzed to determine the validity, reliability, level of difficulty of the questions and the discriminating power of the questions.

3.1. Instrument Analysis

Questions used in study this shaped essay as much 10 about valid essay from 14 about essays. Has a reliability value of 0.78 with high criteria. After analyzing the level of difficulty of the questions, 10 questions were taken with a 3-5-2 comparison pattern, namely 30% questions with easy criteria, 50% questions with moderate criteria and 20% questions with difficult criteria (Sudjana, 2009). After analyzing the discriminatory power of the questions, 10 questions were taken, namely 7 questions with sufficient criteria, 3 questions with good criteria.

3.2. Final Data Analysis

Students' science literacy ability after being treated using a socio-scientific issues (SSI) learning approach. Based on data processing of students' science literacy essay test answers on 5 science literacy indicators consisting of 3 aspects of science competence which were measured and analyzed based on the results of essay tests and interviews among others, aspects of science literacy competence to explain science phenomena (with indicators of applying appropriate knowledge, identifying and explaining the implications of scientific knowledge for society), competence to evaluate and design investigations (with indicators proposing ways to investigate scientific questions), and competence to interpret scientific data and evidence (with indicators draw the right conclusions). The results of the analysis of the achievement of the scientific literacy test of 33 students are presented in Table 2.

Table 2. Results of Students' Science Literacy Achievement based on Tests

Scientific literacy indicators aspects of scientific competence	Percentage (%)	Category
Applying Knowledge Appropriate	66.01	Good
Identify	69.21	Good
Explaining the Implications of Scientific Knowledge for Society	80.94	Good
Propose Ways to Investigate Scientific Questions	54.68	Enough
Drawing the Right Conclusion	75.78	Good
Average	69.32	Good

Based on Table 2 above, it shows that the highest percentage value of student scientific literacy is found in the indicator explaining the implications of scientific knowledge for the community by 80.94% in the good category and the lowest percentage value of student science literacy is found in

the indicator proposing ways to investigate scientific questions of 54.68 % with sufficient category. The overall average achievement of science literacy based on the test is 69.32 % in the good category. To make it clearer the achievement of students' science literacy based on the data in Table 2. Each indicator can be seen in the diagram in Figure 1.

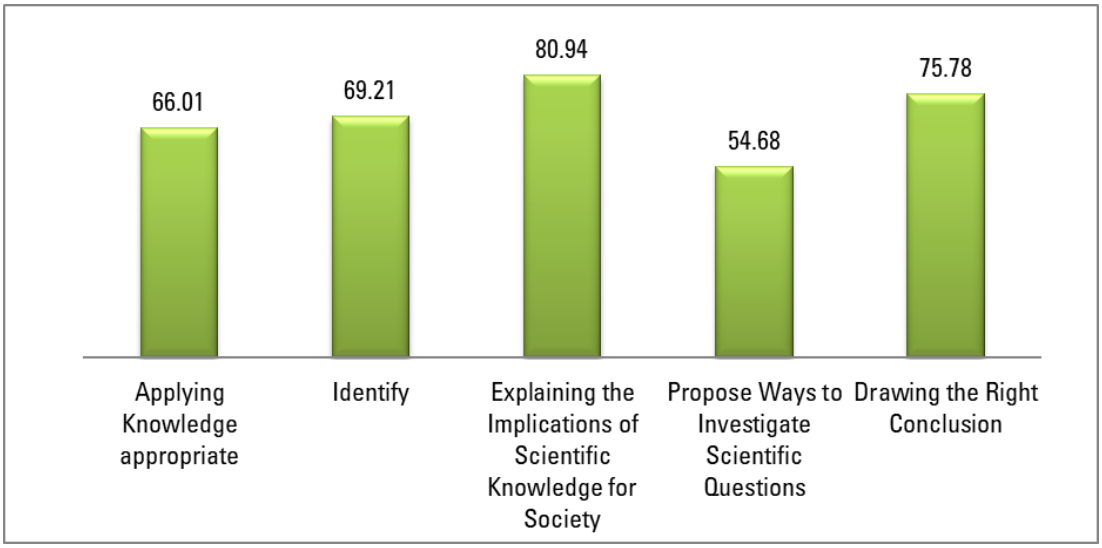

Figure 1. Percentage of Students' Science Literacy Achievement based on Tests

In the learning process in class XI MIPA 1 applied socio-scientific issues (SSI) approach with the aim of knowing how students' scientific literacy was after being treated by using the learning approach on the reaction rate material. Science literacy is a person's ability to understand science, communicate science (oral and written), and apply scientific knowledge to solve problems, so that they have a high attitude and sensitivity to themselves and their environment in making decisions based on scientific considerations (Toharudin et al. 2011).

Socio-scientific issues (SSI) learning approach applied in this research process consists of five stages, namely 1) problem solving and analysis, 2) problem clarification through practical activities, 3) continuing social issues, 4) discussion and evaluation, and 5) metareflection. The results showed that the average science literacy of students as a whole based on the results of the essay test got a percentage in the good category. This happens because during the learning process students communicate with each other and cooperate with their groups to carry out the SSI stages on the topic being studied.

3.3. Applying Appropriate Knowledge

With this indicator, students are required to apply appropriate knowledge to determine the reaction order and the equation of the reaction order from the experimental data presented and also the problem of catalytic converters in minimizing vehicle exhaust gases that are harmful to the environment. The ability of students to apply appropriate knowledge was obtained by 66.01% which was in the good category, this proves that students have good understanding and concepts of knowledge. Students are able to apply appropriate knowledge from the given problem, both from the theoretical concepts they have and from making hypotheses in solving problems from the experimental data provided. Students are given the opportunity to express their opinions based on their own knowledge.

The ability to apply appropriate knowledge is inseparable from the concepts that are built in students to understand what they are learning, through the socio-scientific issues (SSI) approach students play an active role in analyzing the problem or sub-topic of the reaction that is being studied so as to train students' scientific literacy. on indicators apply the appropriate knowledge. This is in

accordance with Ely Rohmawati's opinion that learning in the context of socio-scientific issues (SSI) can train students' scientific literacy and facilitate students to achieve scientific literacy competence (Rohmawati et al. 2018). Socio-scientific issues (SSI) also have several benefits, namely growing students' scientific literacy so that they can apply evidence-based scientific knowledge in everyday life.

3.4. Identify

The identifying indicator is observing from a given problem. For example, students are required to identify the factors that affect the reaction rate, namely the concentration factor in burning fossil fuels that causes acid rain. In this indicator, students need reasoning about an event presented in the problem so that they can construct their opinion and make the right answer.

The student's ability to identify was obtained by 69.21%. This shows that students' scientific literacy on identifying indicators can be said to be good, where students are able to answer the questions given and explain the answers obtained from the results of the analysis of the questions given with theoretical concepts they understand related to reaction rates so that they can draw conclusions that are appropriate. appropriate. This is in accordance with the statement made by Nisa and Hayat which states that the ability of students to identify scientific issues from the questions given is certainly closely related to the knowledge they understand and the material being studied so that the concept of knowledge contained in students' memory affects students' ability to identify questions. given (Sumarni et al. 2021).

3.5. Explain the Implications of Scientific Knowledge for Society

In this indicator, for example, students are required to explain the implications of scientific knowledge for the community about the factors that affect the reaction rate on fruit ripening using carbide. The ability of students to explain the implications of scientific knowledge for society was obtained by 80.94% which was in the good category. When viewed with other indicators, this indicator is the indicator with the highest achievement, this proves that students can understand the questions given and also students master theoretical concepts during the learning process so that students are able to explain answers to questions well.

This shows that the socio-scientific issues (SSI) learning model can train students' scientific literacy on indicators explaining the implications of scientific knowledge for society well. This is in accordance with Rundgren's research that socio-scientific issues (SSI) is an appropriate context to help students transfer content knowledge and skills and think scientifically in making better decisions in answering questions (Rundgren & Rundgren, 2010).

3.6. Proposes Ways to Investigate Scientific Questions

In this indicator, for example, students are required to propose ways to prevent food spoilage in order to keep it fresh in accordance with the theme of reaction rate. The ability of students to propose ways to investigate scientific questions was obtained by 54.68% which was in the sufficient category. When viewed with other indicators, this indicator is the indicator with the lowest achievement. The low achievement of students on this indicator is because some students still have difficulty in working on questions related to proposing methods and students are also not accustomed to solving problems proposing ways. This is in accordance with Rohmi's opinion that one of the factors that influence student achievement in working on scientific literacy questions is that students are not accustomed to solving scientific literacy questions (Rohmi, 2017; Peranginangin et al. 2019).

3.7. Draw the Right Conclusion

In this indicator, students are required to draw the right conclusions, for example, given experimental data from two forms of iron powder and chips and HCl solutions with different

concentrations. From the data presented, students are asked to make an appropriate conclusion, namely which experiment runs the fastest. Through the SSI approach, students conduct sugar dissolution experiments to collect data in the learning process. Students are directed to make conclusions based on the results of experiments that have been carried out and also based on the literature/theory that has been obtained. These indicators are trained and developed through a meta-reflection stage on the SSI approach.

The ability of students to draw the right conclusions was obtained by 75.78% which was in the good category. The test results show that students are able to draw a conclusion on the given problem. This is influenced by the good understanding of students regarding the concept of the material being studied, if the concept is fully understood by students it will be easy to draw a conclusion. This will also affect students' scientific literacy on indicators of drawing the right conclusions. This is reinforced by the results of research conducted by Nisa and Hayat which states that the achievement of scientific literacy skills on this indicator is reflected in the students' ability to interpret scientific evidence and draw conclusions by interpreting the data contained in several tables on the scientific literacy test instrument used, by using the evidence and reasons behind the conclusions drawn in solving the reaction rate material (Silaban, 2017; Sumarni et al. 2021; Benek & Akcay, 2022; Kutlu et al. 2022).

The results of the analysis of students' scientific literacy on the five indicators in this study indicate that the socio-scientific issues (SSI) approach can train students' scientific literacy on the reaction rate material well. This is evidenced by the average value of the percentage of students' scientific literacy achievement which is included in the good criteria. The socio-scientific issues (SSI) learning approach provides opportunities for students to participate actively from the beginning to the end of the learning process. In addition, students also seek information from various learning sources in analyzing problems from the given discourse, so that students' curiosity through problem analysis activities, discussions, meta-reflection to draw conclusions.

The application of the socio-scientific issues (SSI) approach in the learning process will create a more meaningful learning atmosphere for students, motivate students to be more active in the learning process and be more creative in solving problems that may be found through group discussion activities and are more interested in learning science. because students are given real and active learning experiences, so that they acquire the skills to think and act scientifically or better known as scientific literacy which includes scientific literacy indicators, so that the application in learning will support student activities and learning outcomes. The socio-scientific issues (SSI) approach focuses on student learning and places the teacher only as a facilitator so that students are actively involved from the beginning to the end of the learning process.

This statement is supported by Zo'bi's findings which state that learning using SSI will improve students' ability to make decisions related to controversial social issues, this is because learning using socio-scientific issues (SSI) aims to involve students in the decision-making process, show students the importance of their decision to study a problem comprehensively, including problems related to their morals (Zo'bi, 2014). Where, in socio-scientific issues (SSI) it gives students the opportunity to be active in expressing their opinions and collecting information obtained so that they will bring up solutions for answers and student responses to a problem that is relative (Abd-El-Khalick, 2003; Gray & Bryce, 2006).

The results of the researcher's analysis after conducting research at the State High School 4 Tambusai Utara have an average value of science literacy in the aspect of competence of 69.32 % with a good category. This indicates that learning chemistry at SMA Negeri 4 Tambusai Utara has trained students' scientific literacy in the aspect of competence, this is also supported by the socio-scientific issues (SSI) learning approach in training students' scientific literacy skills. This is supported by interviews of researchers with several students who have carried out test questions

which indicate that students are able to connect the concept of reaction rate with phenomena that occur in everyday life.

Based on the results of interviews conducted by researchers with students, that students already know literacy and scientific literacy, students state that the questions are difficult, so that some can be understood and some are not understood, in working on the questions require a high understanding to solve them. Students also understand the basic concepts in the reaction rate material and explain the concepts that exist in the reaction rate material. Students can also explain the relationship between reaction rate material and everyday life, namely by mentioning examples of reaction rates and the factors that influence them in everyday life.

4. Conclusion

Based on the findings of research conducted in class XI MIPA 1 SMA Negeri 4 Tambusai Utara, Rokan Hulu for the 2019/2020 academic year on the reaction rate material, it was concluded that overall the five scientific literacy indicators in the aspect of scientific competence were measured and analyzed in this study. classified as good and can be developed optimally by students. This can be seen from the average value of students' scientific literacy indicators in the aspect of scientific competence obtained based on essay tests, namely applying appropriate knowledge of 66.01% (good), identifying 69.21% (good), explaining the implications of scientific knowledge for community by 80.94% (good), proposing ways to investigate scientific questions by 54.68% (enough), and drawing the right conclusions by 75.78% (good). The application of this SSI approach to teachers in teaching and learning activities in the classroom, requires the provision of supporting facilities for the development of students' scientific literacy, such as teaching materials and student reading resources, as well as applying students' insights to seek social issues that are currently developing. The next researcher, is to develop chemistry teaching materials and analyze aspects of knowledge related to social issues as an effort to obtain a complete scientific literacy aspect.

Acknowledgment

The author may wish to thank all educators and students involved and ready to add to this exam. The authors also thank the speakers and individual students of the undergraduate science education program at the Jambi University Postgraduate Program.

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