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The Impact of Using a Problem-Based Learning Approach on Students' Science Literacy in Class XI Natural Sciences and Mathematics on Reaction Rate Factor Material

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Abstract
This study aims to determine the effect of applying a problem-based learning model on the science literacy skills of XI MIA 3 class of 31 students on reaction rate factor material. This study used a class action research method and was conducted in August-December 2020. This class action research applies the Stephen Kemmis and McTaggart model. In addition to observation and reflective journals for two cycles, the final test results showed an increase in results from cycle I of 84% to 86.86% in cycle II. This study concluded that this learning model can be used to improve students' science literacy skills if the teacher plans the learning appropriately. Based on the experience in conducting this classroom action research, the researcher provides several suggestions to teachers in applying this method.

1. Introduction

The Minimum Competency Assessment (MCA) is one of the substitutes for the national exam, which is planned to be implemented in the 2020-2021 academic year. This is done as a policy to realize the transformation of education management in Indonesia called independent learning. AKM is considered a more comprehensive assessment benchmark to measure students' minimum abilities, namely the basic competencies needed by students to be able to learn, whatever the material and whatever the subject.

There are two fundamental competencies measured in the IMR, namely reading literacy and math literacy (numeracy). According to PISA (2012), reading literacy is the level of ability to use written information in the situation faced in everyday life. This ability is expected to increase and develop students' knowledge and potential, as well as their role in society. Meanwhile, mathematical literacy is the capacity of individuals to formulate, use and interpret mathematics in various contexts. This includes mathematical reasoning and the use of mathematical concepts, procedures, facts and exercises to describe, explain and predict phenomena (Lastuti, F. A. O., Maharani, R. M., & Pratini, 2018).

This is a challenge for teachers to increasingly implement active learning that involves literacy, especially in science subjects that have many phenomena that are close to students' daily lives and can make students interested in asking questions. For example, in chemistry, with the same composition, a student can choose the better form of ulcer medicine, tablet or syrup, if the student applies the concept of reaction rate factor. This supports the creation of learning that not only increases understanding of material concepts but also trains students to make decisions in everyday life, which is in line with what is emphasized in science literacy (Ardiyanti et al., 2019).

Unfortunately, the questions or worksheets given by the teacher during learning are not varied. Students rarely get questions that contain phenomena and need an in-depth understanding of the questions before answering them. Teaching is often just transferring knowledge and does not provide opportunities for students to understand the context in depth to improve students' science literacy skills ((Nainggolan et al., 2021). This habit eventually makes students dislike questions that contain discourse because they are too lazy to read questions, while some materials in chemistry learning have characteristics that are close to everyday life so that they can be implemented to improve science literacy skills, such as reaction rate material. (Fauziah et al., 2019; Paristiowati et al., 2019).

Science literacy can be viewed from two sides, the first side views that the main component of literacy is understanding science material, namely basic science concepts. The other side has the view that science literacy is not limited to science concepts, science literacy must be owned by everyone because it also requires reasoning skills in a social context (Rahayu, 2017). It is at this point that education is expected to be able to bridge these two sides. Education, especially in the field of science, is expected to develop students' ability to use knowledge and skills that contain scientific concepts to solve problems in life responsibly (Holbrook & Rannikmae, 2009).

This motivates teachers to implement lessons that improve students' science literacy skills. The hope is that students become accustomed to understanding a context before solving it. In addition, the learning is expected to support students' preparation for the AKM program.

One of the learning models that can train students' literacy skills is problem-based learning. (Ardianto & Rubini, 2016; Hartati, 2016; Pamungkas et al., 2015). In PBL learning, the teacher acts as a facilitator who guides students to solve problems by starting to identify problems, make hypotheses, search for data, conduct experiments, formulate solutions and determine the best solution to the conditions of the problem. The syntax of the PBL (Problem Learning) learning model can make students more aware in understanding the concepts of science given at school and skilled in solving problems that exist related to chemistry which can develop students' science literacy skills. This happens because, with the problems given, students' critical thinking skills will be trained when solving problems (Gurses et al., 2015), and will provide a strong stimulus to improve students' science literacy to make decisions and solve problems according to the context of the problem. Increasing students' ability to solve problems will also increase students' science literacy skills.

Based on this background, teachers want to know the effect of PBL learning on student literacy through the classroom action research (PTK) method. Teachers realize that student change is not easy to happen, therefore with PTK, it is hoped that teachers can get student responses during learning and evaluate them to find better ways of teaching.

2. Literature Review

Science Literacy

PISA (International Program for Student Assessment) defines science literacy as the ability to use scientific knowledge, identify questions, conclude based on facts, and make decisions from changes that occur due to human activities in the environment or the universe (PISA, 2015). According to the assessment objectives, science literacy consists of three interrelated aspects as shown in Figure 2: context, knowledge, and competence (PISA, 2009).

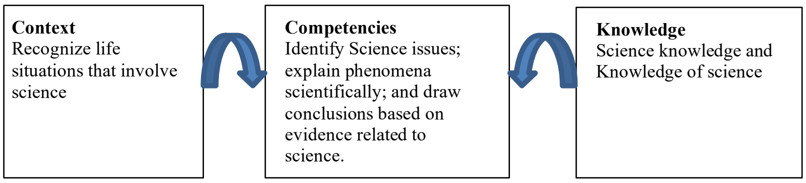

Figure 1. Aspects of Science Literacy

The assessment emphasized by PISA is scientific competence which includes identifying issues, explaining phenomena, and drawing conclusions based on evidence related to science (PISA, 2014) The scientific competence is presented in Table 2.

Table 2. Scientific competence in PISA ((PISA, 2009)

Kompetensi	Indikator
Identify science issues	• Identify issues that are possible to investigate scientifically • Identify keywords to search for scientific information • Recognize keywords or key points of scientific inquiry
Explaining phenomena scientifically	• Apply science knowledge in a variety of situations • Scientifically describe or explain phenomena and predict changes • Identify descriptions, explanations and predictions
Using scientific evidence	• Interpret scientific evidence to make and communicate conclusions • Identify the assumptions, evidence and reasoning behind a conclusion • Reflecting on the implications of science and technology developments in life

Problem-based Learning

The Problem-Based Learning (PBL) learning model is a problem-based learning model designed for students to gain important knowledge that makes them proficient in solving problems and have the skills to participate in teams (Jansson et al., 2015). The problems solved are characterized by real problems that train students to learn to think more critically, this critical thinking is expected to make students not easily fooled by hoax news (Fadiawati, N., Diawati, C., & Syamsuri, 2020).

The constructivist learning environment which is the foundation in designing the PBL learning model is what is needed to improve literacy. Wulandari & Sholihin (2015) in Adiwiguna, Dantes, & Gunamantha (2019) said that the learning steps in the PBL model can facilitate students to increase their interest in scientific issues that are possible to investigate through the steps of the scientific method, seek their information, increase curiosity to identify and formulate problems, be able to work effectively and build networks in groups and have high creativity. The meaningfulness of this learning process will make the cultivation of science concepts maximally absorbed.

Characteristics of Reaction Rate Material

The concept of reaction rate is a concept in chemistry that is close to students' daily lives but quite complex. In addition to containing theories and concepts, this material also requires counting and table reading skills. In the 2013 curriculum, the reaction rate material is in KD 3.6 and KD 3.7 with the basic competencies that must be achieved and their indicators in chemistry subjects on reaction rate material, namely:

3.6 Explain the factors that affect the reaction rate using collision theory.

3.6.1 Explain the meaning of reaction rate.

3.6.2 Conclude about the factors that affect the reaction rate

3.6.3 Explain about collision theory in chemical reactions

3.7 Determine the reaction order and reaction rate constant based on experimental data

3.7.1 Determine the reaction order from experimental data in the form of reactant concentration parameters and reaction time/reaction rate.

3.7.2 Determine the reaction rate constant from experimental data in the form of reactant concentration parameters and reaction time/reaction rate

Based on the indicators of the reaction rate material, it can be classified in the taxonomy which can be seen in Table 3.

Table 3. Characteristics of Reaction Rate Materials

Knowledge Dimention	**Cognitive Dimention**	
	Apply	Analysis
Conseptual	3.6.1 3.6.3 3.7.1 3.7.2	3.6.2

The basic competencies and indicators of reaction rate material in the knowledge aspect above show that reaction rate material has dominant concept application characteristics.

3. Research Methodology

This classroom action research (PTK) was conducted on students in class XI IPA 3 SMAK 7 PENABUR Jakarta, August-December 2020. The number of students in class XIA3 in the 2020/2021 academic year is 31 people. The factors studied are students' science literacy skills, how teachers plan lessons and how they are implemented in the classroom. This PTK uses the Stephen Kemmis and Mc Taggart model.

A spiral system of self-reflection starts from planning, action, observation, reflection, and re-planning which is the basis for a problem-solving design. Using a qualitative paradigm approach, this research starts from a problem in the classroom, namely, students are lazy to read questions that have discourse because they are not used to it, this is then followed up with the application of a learning action then reflected, analyzed and re-applied in the next cycle, after revision based on the findings during reflection.

The implementation of learning with a problem-based learning model in cycle I was carried out by first providing asynchronous videos about the concept of reaction rate and its factors to be studied at home and discussed during online learning. This is done because since PJJ the lesson hours have changed to 25 minutes/lesson hours so to streamline online lessons, it is hoped that students already have prior knowledge related to the material being taught.

In this lesson, the teacher divided students into 9 breakout room groups with 3-4 students. PBL implementation activities in this study are presented in Table 4 below.

Table 4. Learning Activities

Steps	Teacher Activity
Problem orientation	• Leads to questions or problems about reaction rates
Organizing students to learn	• Ask students in each group to record the discussion in the room. • Ask the group leader to lead the discussion and display the worksheet which contains problems using the concept of reaction rate and concentration factor. • Ask about difficulties or progress in working on the worksheet in the breakout room • Testing students' understanding of the concepts found.
Assisting independent or group inquiry	• Assist students in answering questions they are unsure of
Developing and presenting work	• Guiding students through the worksheet
Analyzing and evaluating the solution	• Asking student representatives from several groups to present the answers to the worksheet • Asking students from other groups to respond • Provide direction if there are different concepts, then the teacher will provide direction to a more appropriate answer • Giving the cycle I learning outcomes test

The evaluation results in cycle I were applied to cycle II which was carried out in as many as 2 meetings with a total of 5 lesson hours for 25 minutes with the topic of temperature, surface area and catalyst factors on the reaction rate.

Data collection techniques were carried out through interviews, learning outcomes test sheets developed by Fitriani et al. (2015) and Paristiowati et al. (2019), reflective journals and documentation. The data analysis technique used is coding which aims to simplify students' opinions on reflective journals and describe learning outcomes data that will be used to determine the effect of PBL application on students' science literacy skills.

4. Result and Discussion

This study consisted of two cycles to determine the effect of the application of the problem-based learning model on the science literacy skills of students in class XI MIA 3 on the material of reaction rate factors. Based on the calculation of the total score obtained by students on the assessment of learning outcomes for each cycle, it is known that students' science literacy skills have increased. This can be seen from the average percentage of student learning outcomes in cycle I of 84% while in cycle II of 86.86%, with a description of learning outcomes as presented in Figure 2.

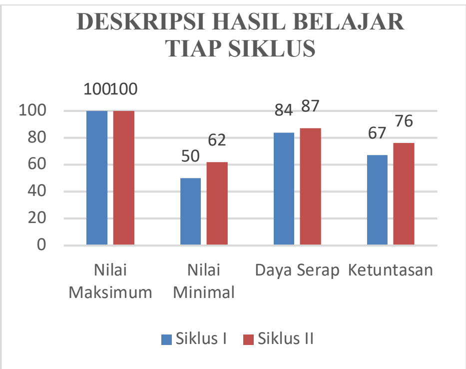

Figure 2. Description of Learning Results of Each Cycle

In the assessment of students' science literacy skills for each science literacy competency as can be seen in Diagram 2, it is also known that 2 out of 3 aspects of science literacy in students increased, namely in the competencies of explaining scientific phenomena and using scientific evidence, while the aspect of identifying science issues decreased by 7.76%.

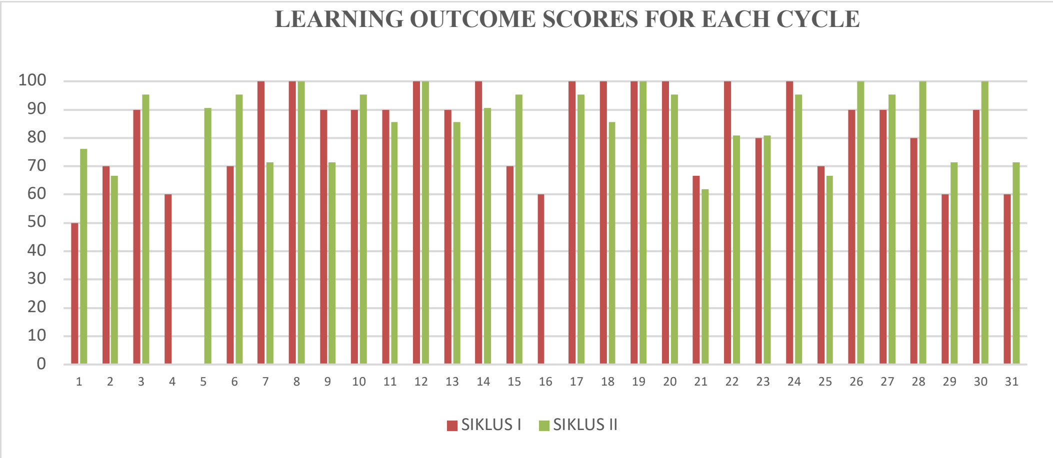

Figure 3. Learning Outcome Value of Each Cycle

Based on the results of the study, there was an increase in students' science literacy skills during PBL learning, this was due to improvements in the learning process during the study, in cycle I it was observed through video recordings in each room that the active discussion of each room tended to be passive, for example, one room with 4 students, only 3 of them discussed while the other students looked confused and scratched their heads when the group leader asked about his opinion the student pleadingly answered but the answer was considered incorrect by other members, this made the group leader teach the student slowly. According to the researcher, the number of students 3-4 in the group is quite good because each student can remind each other to actively discuss and more easily ask each other's opinions.

The cause of students' incomprehension during learning is that before learning students are required to understand the asynchronous video and ask if they do not understand, but in reality, not all students do it, this adds to their difficulties when discussing in groups. This is also revealed in the following reflective journal:

"I hope there will be more explanation first." (Reflective Journal, student 22, October 12, 2020)

In another room with a total of 4 students, it was observed that active discussions only occurred for 2 students, the problem occurred when the network of one of the active students was disrupted so that he had to leave Zoom, there were times when the group leader asked for opinions, the other 2 people were just silent. The results of this observation are following the reflective journals of several students as follows:

"During breakout rooms in Zoom, I still often feel stiff to talk to others. I hope that in this type there is at least one person I know well enough so that I can be more cooperative" (Reflective journal, student 15, October 12, 2020).

This is following research (Fitriani et al. (2015) which states that the weakness of PBL is the students' lack of independence to enrich themselves with knowledge before solving the given problem. Students' ignorance of this initial material is what makes students difficult and not confident in participating in discussions so they lose interest in learning. According to (Adiwiguna et al., 2019) the science process in learning will occur when there is an exchange of opinions between students regarding the issues presented in the discourse and the search for information to solve problems.

On the other hand, some rooms are observed to have good communication between their members, this is also evident in the following journal reflections:

> "I think breakout learning like this is very exciting and useful because it strengthens communication between friends." (Reflective Journal, student 11, October 12, 2020)

This is following Yanti's research (2017) that PBL learning will improve communication between students. This is due to the problems that must be solved together, good communication and cooperation will make the information needed to solve will be collected more quickly. Through PBL learning, each student is encouraged to have a sense of responsibility for their group (Hartati, 2016).

Although there are shortcomings, the overall learning cycle went well, this can be seen from the results of the assessment of students' science literacy which has an average value of 84%. This happened because during learning in groups, students listened to the opinions of other students and had the opportunity to ask if they were confused without feeling embarrassed to be heard by many people when understanding the problems in the discourse and their solutions. This is one of the advantages of PBL learning where students feel comfortable working in small groups to increase student confidence to find solutions to the problems given (Abanikannda, 2016).

Some of the feedback obtained in cycle I was used as evaluation material by researchers, including;

1. Uploading asynchronous videos a week before learning
2. Allowing students to choose their group members and inform the teacher directly.
3. Giving more time for discussion because based on the results of student interviews, the discourse makes them have to read carefully so that it takes longer to do the worksheet.
4. The worksheet for each meeting must be collected at the end of PJJ to ensure that during group discussions each student actively answers the LKPD and corrects it if, during the presentation of the work, there are incomplete or incorrect answers.
5. During the presentation of the work, the teacher asks group representatives to read the answers to the worksheet randomly, not just the group leader to train students to focus because of the possibility of being asked to present their group's answers.

In cycle II learning, it was observed that most of the room was more active, this can be seen in the Zoom breakout recording, students were observed to be getting used to understanding the discourse and answering questions. This is because they have gotten the pattern that scientific issues related to reaction rates will be related to effective collisions.

According to some students, the learning this time was good because they were encouraged to think critically and connect the daily problems in the discourse with the lessons at school. This can also be seen in the following journal reflections:

"Through learning with problems such as the discourse found earlier, it makes students think about the relationship between problems that occur in everyday life and relate them to chemistry lessons." (Reflective Journal, student 14, October 12, 2020)

This opinion is following research (Adiwiguna et al., 2019) which states that PBL learning can improve literacy and critical thinking skills. Through presenting problems in discourse, students are encouraged to understand the discourse and think to find the relationship between discourse and the concept of reaction rate factors, students are encouraged to observe several sources of information to help them analyze the discourse and finally explain scientifically the solution to the problem in the discourse.

Cycle II learning ended with a learning outcomes test and an average student score of 86.86% was obtained. These results indicate that with the implementation of PBL, there is an increase in students' scientific literacy abilities. This happens because in PBL learning students are trained to read and understand discourse before answering questions, besides that because they have previously watched asynchronous videos and answered in class, students already have initial knowledge that can be used to apply concepts to each problem.

In Diagram 2 it is observed that the increase in scientific literacy competency only occurs in identifying scientific issues and using scientific evidence while explaining phenomena scientifically decreases. This happens because when learning students are encouraged to understand discourse and explore information such as practical videos and then connect it with scientific concepts. This activity enables students to apply concepts to solve problems in discourse. In the competency to use scientific evidence, students are asked to involve evidence in the form of data processed in other forms. The more frequently they do this activity, the more students' ability to identify science issues and use scientific evidence increases.

The competency to explain scientific phenomena decreases because at this stage students have to explain why the phenomena in the discourse occur according to the concept of reaction rate factors. Most of the students answered correctly but incompletely, students tended to immediately explain without discussing the data described in the discourse before giving conclusions regarding the phenomenon that made the score not optimal, this caused the score in cycle II to decrease.

Based on the results of each student's learning test in Diagram 3, it is shown that there are various increases and decreases in scores, there are also several students who consistently get perfect scores. One student said that the increase in grades occurred because working on LKPD containing discourse made him read more often to be able to answer, other students also argued that because the problems in the discourse were relevant to everyday life, it added curiosity to answer questions. This is under the opinion of (Chin & Osborne, 2008) which states that mastering contextual concepts and topics will make students want to be active in learning. This opinion supports the aim of this learning, namely training students to answer scientific issues or phenomena using the knowledge they gain at school.

On the other hand, unstable or decreasing grades are caused by students not watching asynchronously and still being embarrassed to ask questions or express opinions so that understanding of concepts during learning is not absorbed optimally. This condition makes students not optimal during distance learning and learning results tests.

5. Conclusion

Based on this research, it can be concluded that students' scientific literacy skills develop through the application of the problem-based learning model. This improvement can be seen from the average results of student learning tests which increased from cycle I by 84% to 86.86% in cycle II. This happens because problem-based learning can train students' accuracy in understanding discourse, besides that discourse that discusses everyday life makes them feel interested in solving problems according to the concepts learned at school.

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