# Application of Problem-Solving Learning Model Based Blended Learning to Improve Students' Metacognitive Skills on Reaction Rate Material

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DOI: 10.29322/IJSRP.12.02.2022.p12222
http://dx.doi.org/10.29322/IJSRP.12.02.2022.p12222

***Abstract-*** Chemistry is one of the subjects in school that is theoretical and mathematical and has many concepts that must be understood, so the right strategy is needed to understand it. Therefore, research has been carried out to improve students' metacognitive skills in the reaction rate material using a problem-solving learning model based on blended learning. This research uses pre-experimental research at MAN 2 Pamekasan on 30 students of class XI IPA 4. The research instrument used was a learning model application sheet, student activity sheet, student metacognitive skill sheet, and student response questionnaires. Research data analysis using n-gain, mean, percentage, normality test, and paired t-test techniques. The results showed: (1) The average percentage of application of the problem-solving learning model based blended learning is 90.63% (outstanding category) (2) Student activities carried out well after following the problem-solving learning model based blended learning with the percentage of relevant student activities of 89.81% (3) The students' metacognitive skills has increased as seen in the n-gain score that is 0.56 (medium criteria), and 4) In the student response questionnaire, the learning model applied affects student interest and learning outcomes.

***Index Terms***- Problem-solving, metacognitive skills, blended learning, reaction rate

## I. INTRODUCTION

Education in Indonesia is experiencing a situation that continues to develop to improve the quality of human resources and education to have the knowledge, attitudes, and skills to increase the mastery of science and technology. That can be seen in the curriculum development in Indonesia, where Indonesia is presently implementing the 2013 curriculum.

The 2013 curriculum comes with various improvements and updates. The teacher-centered learning model becomes student-centered. Students must be independent, critical, and actively looking for what will be studied. This shows that education guides students to independently explore what they want to know and solve problems encountered by using knowledge from various sources of information to manage their minds well and solve the problems they face. The 2013 curriculum is also suitable for science learning, particularly chemistry, containing facts and concepts.

Chemistry is a subdivision of natural science specializing in the composition and structure of matter, changes, and the energy associated with these changes. One of the competencies that students must possess in chemistry is designing and conducting chemical experiments, that include formulating problems, proposing hypotheses, determining variables, collecting, processing, and analyzing data, drawing conclusions, and communicating experimental results in oral and written form(Permendikbud, Nomor 21 Tahun 2016). One of the chemical materials that students learn is the reaction rate.

The reaction rate is a chemical material taught in XI class. Sub material reaction rate, factors that affect the reaction rate, require practical activities to support students in understanding and mastering conceptual understanding. Through the practicum, students can actively and independently find concepts (Joyce, 2009). It is still difficult for students to study the reaction rate material because it is theoretical and mathematical and has many concepts that must be understood. While the teacher who teaches the material is not too detailed, there are also no practical activities that support students to understand the material more deeply.

Easy-to-understand concepts are needed to apply the reaction rate material in the learning process. Understanding concepts in the learning process is crucial. Wherefore, it affects attitudes, decision-making, and methods to solve the problem. The lack of abstract thinking skills and the many concepts make it difficult for students to connect macroscopic, submicroscopic, and symbolic representations through analytical and systematic thinking. One effort to overcome the difficulties faced by students in interpreting this understanding is to involve metacognition in learning (Thomas & Anderson, 2014).

Metacognitive is a skill where the individual stands outside his head and tries to get how he thinks or understands the cognitive processes by planning, monitoring, and evaluating components (Desmita, 2011, p. 133).

Livingston revealed that metacognition plays an essential role in successful learning, so studying metacognitive activities is necessary to determine how students use their learning strategies to achieve the desired understanding. Metacognitive skills in education are mainly to design the knowledge that will be studied later, monitor the progress of the learning process, and evaluate the knowledge learned to solve problems. So, students can find their shortcomings and hope will be motivated to do their assignments and look for information independently.

Based on questionnaire results obtained by researchers on October 29, 2021, in XII IPA 4 class in MAN 2 Pamekasan, the results obtained from 28 students, as many as 85.71%, considered that the reaction rate material was challenging. 60.71% of students often received learning by the lecture method. As many as 35.71% stated that chemistry is a boring subject. Learning chemistry using the lecture method will cause students to become less active during the learning process, so students cannot develop their thinking skills. This allows teachers to use the correct model in chemistry learning. Teachers have to choose the suitable learning model to understand each material presented to create maximum learning. One alternative method of learning model is the application of problem-solving.

Problem-solving is a deliberate learning process consisting of problems, proposing and testing hypotheses, and then choosing the suitable alternative. (Moreno, 2010). Problem-solving is an activity designed by the teacher which aims to challenge students through assignments or problems based on the material that has been given, and students create their way of solving the problem. Azizah, Nasrudin, & Rusmini's research shows the problem-solving learning model could improve students' thinking skills, meaning the students' academic achievement increases. The research results conducted by Sudjana and Wijayanti also prove this, indicating that applying problem-solving learning models can improve students' metacognitive skills and increase student learning activities (Sudjana & Wijayanti, 2018).

The reaction rate material contains an abstract chemical aspect, and there are also concepts so that students' understanding is needed. Therefore, the teacher must interestingly introduce the concept and teach by solving the problem. Therefore, a learning model of problem-solving is applied to solve the problem.

In addition to these alternative learning models, learning that is considered adequate for improving students' understanding of mathematical concepts is based on blended learning, a composite of direct (face-to-face) learning with internet-based learning by utilizing electronic media. Psychologists view learning like a cognitive process that is influenced by several factors. For example, individual circumstances that affect learning are independent (Amir & Risnawati, 2015). Therefore, learning independence is also needed in the application of blended learning. Learning independence serves to form a person who always wants to find out about a given problem so that students are free to seek answers based on their knowledge. This means that students can learn anywhere, anytime, with anyone, and through any source.

Based on the description above, researchers obtained the research entitled "Application of Problem-Solving Learning Model Based Blended Learning to Improve Students' Metacognitive Skills on Reaction Rate Material."

## II. LITERATURE REVIEW

### *Problem-Solving Learning Model*

Problem Solving is one of the learning models in which students are faced with problematic situations. Students must find several strategies to solve the problem (Janawi, 2013). Problem-solving is a model of teaching the students to solve problems by providing problems in everyday life to be more developed and creative. This learning model requires the ability to see causal relationships, observe problems, find relationships between collected data, and draw conclusions about problem-solving.

According to Polya, the stages of problem-solving are as follows: (1) Understanding the problem, at this stage, students can do several activities, that is, reading the problem then rewriting it in their own words, and understanding the problem given to determine the purpose of the problem. (2) Devising a plan, students find essential things, describe the problem, and choose a suitable strategy to solve various problems. (3) Implementing the plan, the students can use the steps in solving the problem, checking the specified solution step by step. If the plan prepared cannot solve the problem, then look for another more suitable solution. (4) Looking back, students can evaluate and draw conclusions from the results obtained and provide alternative solutions to solve problems (Polya 1957).

### *Blended Learning*

Stein and Graham (2014: 12) state that blended learning combines traditional (face-to-face) and online learning to improve learning methods that are more efficient, flexible, and effective. This type of learning method uses the latest learning technology to improve learning in the classroom. The purpose of blended learning is to present practical facilities to students and teachers to study independently increases flexible schedules for students by combining these aspects of learning, which can help students evolve much better in the learning (Husamah, 2014, p. 22).

### *Constructivism Learning Theory*

This constructivist theory states that students must find and modify complex information independently, use old rules to check for new information, and revise rules when they no longer fit. To understand their knowledge, they should work hard to solve various problems, decide things, and think hard. By this theory, one of the essential principles in education is that a teacher not only provides

knowledge of students. Teachers can facilitate this process by providing opportunities for students to find and adjust their ideas and instructing students to be aware of the learning strategies they use (Trianto, 2009).

***Metacognitive Skills***

Metacognitive skills are dimensions of knowledge related to thinking or increasing one's cognitive awareness and learning. Thinking creates new mental expressions through information transformation, which involves complex interactions with mental processes like imagination, consideration, and solving problems (Azizah & Nasrudin, 2021).

Metacognitive skills are someone's thinking skills to be aware of their thought processes related to planning, monitoring, and evaluating when solving problems. Planning skills: The teacher provides students opportunities to find out the material to be studied, provide physical and mental, and formulate a plan to obtain a problem to be studied. Monitoring skills: The teacher allows students to ask themselves the benefits of studying this subject matter, how they can understand it, and whether they can understand it. Evaluation skills: The teacher gives students facilities to inquire how they can understand the knowledge, why they find it difficult or easy to master the subject matter, and whether they have taken action (Cohors-Fresenborg and Kaune 2007).

***Learning Outcomes***

Abdullah (2017) states that learning outcomes express a person's achievement after making an effort. The results show a person's learning achievement in a specific time interval associated with learning. Learning outcomes are divided into three parts, namely affective, cognitive, and psychomotor. Affective relates to developing students' emotions, feelings, and attitudes. Cognitive relates on the brain development and reasoning abilities of students. Psychomotor are related to the way students develop these two learning outcomes. The three learning outcomes are interrelated. Therefore, the evaluation of learning outcomes is the achievement of educational goals, including the progress of the thinking process, the use of the five senses, and the ability to develop morals and personality. (Arikunto S. , 2001).

It can be concluded that learning outcomes result from an activity or effort carried out by a person whose changes can be seen from the knowledge, understanding skills, attitudes, and values resulting from his experience in interacting with the environment.

***Reaction Rate***

Speed refers to something that happens in one unit of time (Petrucci, Harwood, & Hering, 2011). The reaction rate decreases the number of reactants or increases the number of products (reaction products) per unit time. A chemical reaction involves the change that occurs from reactants to products.

Reactions occur due to collisions between reactant particles. However, not all collisions result in a reaction. Only collisions between particles with specific minimum energy and collisions in the right direction can produce a reaction (practical collision). Before the collision occurs, the particles require minimal energy, called the activation energy. The more minor the activation energy value, the easier the reaction will occur, so the faster the reaction will occur (Ningsih & dkk, 2007).

Four factors that can affect the reaction rate are the concentration of reactant, surface area, temperature, and catalyst. These factors are directly related by the collision theory to cause a fast or slow reaction.

## III. METHODS

This research used pre-experimental research using quantitative descriptive methods. Only one class was used in the pre-experimental research, and there was no control class, so this research did not use a comparison class (Sugiono, 2015). The research object used was 30 students of XI IPA 4 class in MAN 2 Pamekasan. The design that will be used in this research is the One-Group Pre-test – Post-test Design which is explained in the following formula:

$$O_1 \; X \; O_2$$

Information:

$O_1$: Pre-test scores (before being treated with the application of problem-solving model)

X: Application of problem-solving model

$O_2$: Post-test scores (after being treated with the application of the problem-solving model)

(Sugiono, 2015)

The tools and instruments of learning used consist of a syllabus, student worksheets, lesson plans, application of learning models observation sheets, metacognitive skills test sheets, student activity observation sheets, student response questionnaire sheets, validation sheets, and learning device review sheets. In this research, data collection methods used observation, test, and questionnaire methods.

The data analysis technique to determine the quality of the application of the problem-solving model obtained from the observation method is processed by the formula below:

$$\% \text{ application} = \frac{\text{score obtained}}{\text{max score}} \text{ x } 100\%$$

**Table 1. Category of Assessment of the Application of the Learning Model**

| Percentage (%) | Category |
|---|---|
| 81%-100% | Outstanding |
| 61%-80% | Good |
| 41%-60% | Medium |
| 21%-40% | Bad |
| 0%-20% | Very bad |

Learning management is considered adequate in the good and outstanding category (Riduwan, 2015).

Student activities throughout the learning process were analyzed from the average results of observations from 2 observers Student activities are said to be well carried out if the relevant percentage activities with a score of 75% are more significant than the irrelevant percentage.

$$\%\text{Student activity} = \frac{\Sigma \text{ frequency of activities appear}}{\Sigma \text{ overall activity frequency}} \text{ x } 100\% \qquad \text{(Arifin, 2011)}$$

Students' metacognitive skills were analyzed by the results of pre-test and post-test were carried out by students.

$$\text{Metacognitive skills} = \frac{\Sigma \text{ score obtained}}{\Sigma \text{ max score}} \text{ x } 100 \quad \text{(Permendikbud, Nomor 23 Tahun 2016)}$$

After that, the gain index value is calculated by the formula below:

$$\text{Gain score} = \frac{\text{posttest score} - \text{pretest score}}{\text{max score} - \text{pretest score}}$$

**Table 2. Score Gain Category**

| Score | Category |
|---|---|
| G < 0,3 | Low |
| 0,3 ≤ G > 0,7 | Medium |
| G ≥ 0,7 | High |

(Hake, 1999)

Through problem-solving learning models, students' metacognitive skills increase if the gain score has a medium or high category. Then, a normality test was conducted to decide whether the research data were normally or not normally distributed. When the research data were normally distributed, then proceed with paired samples test.

Questionnaires were used to determine student responses to the problem-solving learning model applied. The percentage of student responses to learning is analyzed using the formula below:

$$P = \frac{F}{N} \text{ x } 100\%$$

Information:
P: Student responses percentage
F: Many students answer a choice
N: Total of students who gave feedback

**Table 3. Criteria for Percentage of Student Responses**

| Achievement Percentage | Description |
|---|---|
| 0% - 10 % | Not interested |
| 11% - 40 % | Slightly interested |
| 41% - 60 % | Interested enough |
| 61% - 90% | Interested |
| 91% - 100% | Very interested |

(Arikunto S. , 2004, p. 18)

## IV. RESULTS AND DISCUSSION

### *Application of Problem-Solving Learning Model*

This learning model is applied based on online and offline blended learning. Online, the learning media used are WhatsApp Group and Google Meet, where the media is used as a substitute for face-to-face meetings. Meanwhile, when learning is offline, the teaching is done directly in XI IPA 4 class in MAN 2 Pamekasan. This observation describes the application of problem-solving syntaxes. The application of this problem-solving learning model was observed by two observers who held two meetings with the following research results:

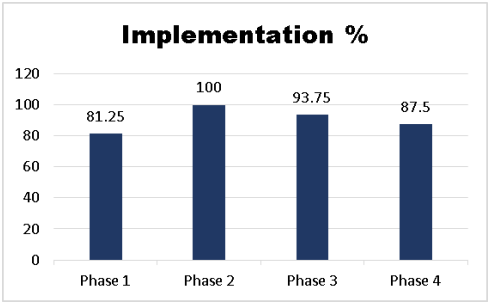


Figure 1. Average Percentage of Application of Problem Solving

In the picture above, it can be seen that overall, at meeting one and meeting two, the application of the problem-solving learning model had an outstanding category.

Phase 1 is understanding the problem (Polya, 1957). The first phase was conducted online using the Google Meet application with an average percentage of application the problem-solving learning model, 81.25%, with outstanding category. Activities at this stage are, students listen to apperception, fundamental competencies, and learning objectives conveyed by the teacher; students are oriented to the motivation and phenomena that exist in the student worksheets; then write down and share his opinion; students are guided to formulate problems and formulate hypotheses; look for data that can be used to solve problems by determining tools and materials, variables, and practical steps; and students are organized into groups. This phase aligns with the metacognitive skills, i.e., planning skills, which include identifying to get information, thinking, and writing what is found.

Phase 2 is making a completion plan (Polya, 1957). The second phase was also carried out online using the Google Meet application with an average application problem-solving model, 100% with outstanding category. Activities at this stage are that students discuss experimental tools and materials with their groups via WhatsApp Group, observed variables, and practical steps through experimental videos.

Phase 3 is implementing the completion plan (Polya, 1957). In the third phase, the average percentage of the problem-solving learning model application is 93.75%, with an outstanding category. Activities at this stage are done using Google Meet. Students convey the results of their discussions, fill in the observation data, answer analysis questions, draw conclusions, and put on the discussion results offline in the class. This phase is in line with the metacognitive skills, namely monitoring skills, which include analyzing the experiment results; and solving other problems.

Phase 4 is looking back (Polya, 1957). In the fourth phase, the average percentage of application the problem-solving learning model is 87.50%, with an outstanding category. Students convey what they have learned, and students and teachers reflect on the learning process. This phase is oriented to metacognitive skills: evaluation skills that include reflecting on learning material and the learning strategies used.

***Students Activities***

Observation of student activity aims to see and observe all student activities in one group in the learning process using a problem-solving learning model. 2 observers observed this student activity through the student activity observation sheet, where each observer observed three groups every 2 minutes during the learning process. Student activities were observed during offline and online learning. Student activity is observed directly on Google Meet and WhatsApp Group when learning online. While in offline learning, student activities are observed directly in the classroom.

Students increase learning if the percentage of relevant student activities, which is 75%, is more significant than the irrelevant ones. Relevant student activities are activities by the syntax of problem-solving learning models. For example, they were making hypotheses, determining experimental variables, analyzing data, and drawing conclusions. At the same time, irrelevant activities are not under the syntax of the problem-solving learning model, for example, disturbing friends, playing cellphone, and making noise in the class.

Following is the student activity percentage during two meetings applies a problem-solving learning model.

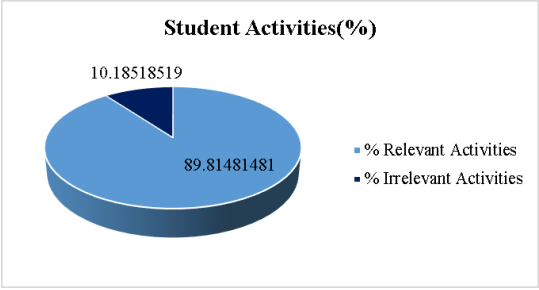


Figure 2. Student Activity Average Percentage

The diagram above exhibit the relevant activities percentage is higher than irrelevant activities. The relevant activity is 89.801%, and the irrelevant activity is 10.18%. This shows that students have an increase in learning. Students are very enterprising in learning about sub-material factors affecting reaction rate using a problem-solving learning model.

***Metacognitive Skill***

This metacognitive skill test is used to assess and measure students' metacognitive skills. It determines student achievement on the reaction rate material after implementing the problem-solving model designed in the lesson plan.

Before implementing the learning model, students were given a pre-test sheet to determine their initial metacognitive skills concerning reaction rate factors. Then, after applying the problem-solving learning model was carried out, students were given a post-test sheet, which was used to determine students' final metacognitive skills. The post-test questions used are the same as the questions in the pre-test.

This metacognitive test was conducted online and collected through the WhatsApp application with private chat. The metacognitive test consists of 12 descriptive questions. Each reaction rate factor consists of 3 questions: concentration, surface area, temperature, and catalyst, where the three questions cover metacognitive activities.

The assessment score given to each factor that affects the reaction rate is if students do not answer or the answers given are wrong, they get a score of 0. Meanwhile, if students answer all questions correctly, they get a score of 3. The metacognitive tests implementing the problem-solving model based blended learning are here.

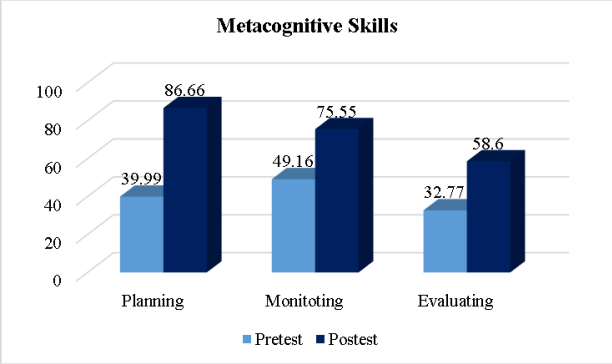


Figure 3. Average of Student Metacognitive Test Results

The table above shows that students' metacognitive skills by implementing a problem-solving model, all metacognitive indicators have increased. In planning skills, there is an enhancement from the pre_test to post_test value because students are practicing identifying to get information, thinking, and writing what is found based on the problems given. In monitoring skills, there was also an enhancement from pre-test to post-test scores because students were trained to review the results of experiments and solve additional problems. Evaluation skills were also enhanced from the pre-test to post-test because students were introduced to reflect on the learning material and the learning strategies used.

A normality test was carried out after getting the students' pre-test and post-test scores to determine whether the research data were normally distributed or not.

**Tests of Normality**

| | | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|---|
| | Kelas | Statistic | df | Sig. | Statistic | df | Sig. |
| Hasil Belajar Siswa | Pretest | .139 | 30 | .142 | .937 | 30 | .075 |
| | Postest | .110 | 30 | .200* | .955 | 30 | .224 |

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 4. The Results of Normality Test

The figure above shows that the student's pre-test is sig 0.075, while the student's post-test score is sig 0.224. These results indicate that the normality test scores show sig>0.05, meaning the research data obtained are normally distributed. The basis for making decisions using Shapiro Wilk, because the research data amounted to between 9 s.d. 50 (Setiawan & Aden, 2020).

After the normality test was carried out, a paired sample test was conducted to decide if, between the pre-test and post-test results, there was a significant difference.

**Paired Samples Test**

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference Lower | Upper | | | |
| Pair 1 | Pretest - Postest | -33.80667 | 12.45859 | 2.27462 | -38.45878 | -29.15455 | -14.863 | 29 | .000 |

Figure 5. The Paired Sample Test Result

The data above shows the value of sig. (2-tailed) is 0.000. These results indicate that between pre-test and post-test have a significant difference.

Furthermore, the calculation of the n-gain score was obtained from the results of students' pre-test and post-test. Students' metacognitive skills have increased if the gain score is in the range of 0.3 G > 0.7.

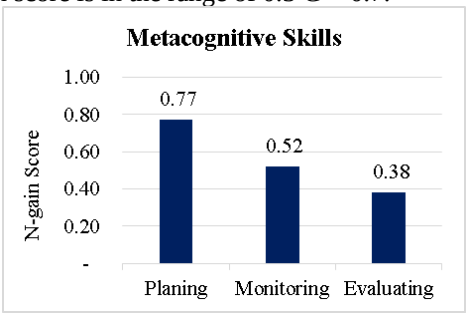


Figure 6. Results of N-gain Score on Students' Metacognitive Skills

The table above shows the students' metacognitive skills have increased. Students' metacognitive skills have increased by 0.77, with a high category in planning skills. Meanwhile, monitoring and evaluating skills increased by 0.52 and 0.38 with the medium category.

***Student Response Questionnaire***

Student response questionnaire, which is a questionnaire given to students, aims to see students' interest in the learning model applied, namely problem-solving based blended learning.

The student response questionnaires totaled 21 questions and statements with strongly disagree, disagree, agree, and strongly agree. The following are the results of the student response questionnaire after following the problem-solving based blended learning.

**Table 4. Student Response Questionnaire Result**

| Answer Options | Percentage (%) |
|---|---|
| Strongly disagree | 2.06 |
| Disagree | 12.06 |
| Agree | 38.25 |
| Strongly agree | 47.62 |

The table above shows that after applying the learning model to 30 students, the average number of students who voted strongly agree was 47.62%, agree was 38.25%, disagree was 12.06%, and strongly disagree was 2.06%.

This shows that many students agree with the applied learning model, namely the problem-solving based blended learning. In addition, it also affects student learning outcomes in chemistry learning, especially the reaction rate factors with the percentage strongly agree and agree was 85.87% with the criteria of students being interested.

## V. CONCLUSION

From the discussion above, the conclusion are the application of the problem-solving model had an outstanding category. Then for student activities, the relevant activities percentage is more significant than irrelevant activities, indicating that students have increased and are very enterprising involved in the learning. For metacognitive skills, students experienced improved learning outcomes in all aspects of metacognitive skills: planning, monitoring, and evaluating skills. The learning model applied affects student interest and learning outcomes in the student response questionnaire. This is evidenced by many students choosing the option strongly agree/agree with interested criteria.

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