Improving Critical Thinking Skills Of Senior High School Students Using The Problem Based Learning Model

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Abstract. The problem currently faced by physics teacher is the students are less skilled in developing their critical thinking skills. Students critical thinking skill can be improved by applying learning methods that require students to be more active during the learning activities. One method that can be used to improve students critical thinking skill is to use the Problem Based Learning model. This research used qualitative research methods. Qualitative research methods used to obtain a description and analysis of the problem to be researched. This research was conducted in class XII Science 1 of SMA Negeri 1 Rumbio Jaya. The steps that can be used to determine student’s mental activities in critical thinking solve a problem are identify, define, enumerate, analyze, list, and self-correct. The applying of Problem Based Learning models in the learning process in class has a real impact on improving students critical thinking skills.

1. Introduction
One of the challenges that must be faced in carrying out learning activities at this time is to improve students' thinking abilities. The selection of learning models and methods must be adjusted to the capabilities and suitability of the material to be delivered, so that the learning objectives that have been prepared by the government can be achieved. The activity that is often done in teaching and learning activities in the class by most teachers is by requiring students to memorize various kinds of knowledge. This activity causes boredom for most students so that learning activities are no longer effective. In the end, the lesson objectives cannot be achieved properly.

Physics is one of the subjects developed through a series of scientific inquiry activities related to matter and energy [1]. Scientific inquiry basically has to start from the curiosity possessed by students. This curiosity is expected to arise so students have critical thinking skills. The problem currently faced by physics teachers is students are less skilled in developing critical thinking skills. So the physics learning activities in the class become less well directed.

Research to improve students critical thinking skills has been conducted by several researchers. Latifah uses a Puzzle Token type cooperative learning model to improve students' critical thinking skills [2]. The research shows that the use of cooperative learning models with puzzle-assisted time tokens has a significant influence on students' critical thinking skills. Low critical thinking skills are characterized by the difficulty of students to provide simple explanations, build basic skills, infer, and provide further explanation.

The application of critical thinking skills in learning activities can be done with active learning. One of learning model that can be used is Numbered Head Together (NHT). The NHT learning model
requires students to be always active and try to improve their critical thinking skills. Wati et.al [3] conducted a study using NHT learning models to improve students critical thinking skills. The research shows that the critical thinking skills of students in the class who use the NHT type of cooperative learning model are better than classes that do not use the model.

The use of appropriate methods in learning activities can improve students' critical thinking skills. Pratiwi et.al [4] applies an integrated type of integrated learning pattern. The results showed that the critical thinking skills of students who implement integrated learning activities integrated type are better than conventional classes. Students' critical thinking skills can also be improved by using contextual learning models with SQ4R techniques. Rustina [5] applies a contextual learning model with SQ4R techniques to improve students' understanding and critical thinking in learning mathematics. This study shows that mathematical understanding and critical thinking skills in groups of students who get contextual learning with SQ4R techniques have improved better than groups of students who get conventional learning.

Critical thinking skills are the ability possessed by someone to make logical reasoning to the problems they face. Someone who has critical thinking skills will be able to recognize a problem, find a solution to overcome the problem, be able to convey the solution to others, and evaluate the solution of the problem [6]. Siegel [7] states that critical thinking skills as a form of problem solving can be formulated through seven components. These components are identifying and solving problems; clarify the meaning of terms, phrases and sentences; gather evidence that matches the problem; assess the evidence collected; deduce conclusions; consider other relevant information; conduct an overall assessment taking into account all components of the critical thinking process.

Critical thinking skills are a series of activities to collect, interpret, analyze, and evaluate information to make valid conclusions [8]. To achieve this set of activities, steps and indicators are needed that can be used to practice students' critical thinking skills. Facione in Amir [9] describes steps that can be used to determine students' mental activities in critical thinking solving a problem. These steps are identify, define, enumerate, analyze, list, and self-correct. Peter in Amir [9] compiled indicators of critical thinking that can be used to solve problems in the form of story problems based on the steps of critical thinking. These indicators can be seen in Table 1.

### Table 1. Steps and Indicators of Critical Thinking

| Critical Thinking Steps | Indicator |
|-------------------------|-----------|
| Identify                | Mention the subject matter |
| Define                  | Mention facts that limit the problem |
|                         | Mention the information needed includes what is known and asked in the problem |
|                         | Mention information that is not used |
| Enumerate               | Mention choices of ways and answers that make logic |
| Analyze                 | Analyze options for choosing the best way and answer |
| List                    | Citing the right reasons for the method and best answer chosen |
| Self-Correct            | Check back thoroughly the answer process |

One of the goals of learning physics is to practice thinking skills that are systematic, logical, critical and consistent. To understand physics properly it is necessary to be able to apply various formulas. One effective way to learn physics is to work on problems. To solve the calculation questions in a directed and systematic manner, certain steps are needed. These steps are broadly divided into 2, namely the stage of explaining the material, the stage of the practice questions. In the exercises phase the teacher guides students in analyzing the questions, transforming the questions, performing the count operations, checking the answers and presenting the answers. After students are trained to work on problems in groups to find out the extent of student understanding of learning material. With the
guidance in solving problems, it is hoped that students' critical thinking skills can be improved for the better. This activity is expected to be able to influence the success of the learning process.

Students' critical thinking skills can be improved by applying learning methods that require students to be more active during the learning activities. The method that can be used to improve students' critical thinking skills is to use the Problem Based Learning (PBL) learning model. Arends in Rerung et.al [10] states that PBL is learning that has the essence of presenting a variety of authentic and meaningful problems to students, which can serve as a means of conducting investigations and investigations. This learning model requires students to find solutions to problems that are given during the learning activities.

PBL is a learning model that presents learning material in the form of problems. PBL is a learning process that begins by observing an event, then looks for problems in the event, and solves the problem. The problem based learning model, consists of several phases. These phases can be seen in Table 2.

| Phase   | PBL Model                           | Teacher Behavior                                                                 |
|---------|-------------------------------------|-----------------------------------------------------------------------------------|
| Phase 1 | Provide orientation regarding problems in students | Discuss learning objectives, describe important needs, and motivate students to get involved in problem solving activities |
| Phase 2 | Organizing students to research     | Helping students to define and organize tasks related to the given problem         |
| Phase 3 | Helping independent and group investigations | Encourage students to get the right information, conduct experiments, and look for explanations and solutions |
| Phase 4 | Develop and present artifacts and exhibits | Helping students plan and prepare appropriate artifacts, such as reports, video recordings, models, and help students present them to others |
| Phase 5 | Analysis and evaluation of the process of overcoming the problem | Helping students reflect on their investigations and the processes that students do |

Based on the description of the problems above, PBL learning models are considered able to improve students' critical thinking skills. Choi et.al [11] stated that although learning outcomes in the PBL group showed a higher increase than in the traditional group, but statistically the learning outcomes between the PBL and traditional groups did not show a significant difference. This might be due to lack of time to apply the PBL learning method, so that it affects the results obtained by students. Zhou et.al [12] conducted research using the Test-Based Learning (TBL) method to practice students' thinking skills. The results showed that TBL can provide benefits in fostering critical thinking of students. However, learning outcomes in the experimental group have not shown much change, so it takes longer to implement a learning method.

Based on observations on the results of the national exams and national standard school final examinations for physics subjects, the grades of SMA 1 Rumbio Jaya students are still far below the standard. This is because students have difficulty in understanding the characteristics of the questions given. Difficulties that are often faced by students in solving problems are caused because students are not careful enough in understanding the sentence questions. As a result students are less precise in determining what is known, what is asked, and how the steps will be used in solving the problem. These weaknesses can be overcome by practicing students' critical thinking skills. The application of the Problem Based Learning model is expected to improve the critical thinking skills of SMA Negeri 1 Rumbio Jaya students. With the increase in students' critical thinking skills, it is expected that students' weaknesses in answering questions can be improved.
2. Methodology
This study used qualitative research methods. Qualitative research methods intend to obtain a description or description of the problem to be investigated [13]. Qualitative research methods can be used to find something that is sometimes difficult to understand satisfactorily [14].

The study was conducted in odd semester of the 2017/2018 school year. The research subjects were students of class XII Science 1 of SMA Negeri 1 Rumbio Jaya in the Academic Year of 2017/2018 consisting of 30 students. Data collection techniques in this study used total sampling, in which all subjects were research samples.

The design of this study uses a spiral model proposed by Kemmis and Taggart [13]. This model consists of four stages, namely planning, action, observation, and reflection. These stages are in accordance with Figure 1.

Figure 1. Classroom Action Research Cycle of Kemmis and Taggart Models.

The planning phase includes the activities of designing learning tools, preparing evaluation of learning, and making observation sheets of student activities. The action phase includes the presentation of subject matter regarding sound waves, group discussions, and question exercises. The observation phase includes data collection activities by filling in the observation sheets of students' critical thinking skills during the learning process. The reflection phase includes the activity of analyzing the weaknesses of the learning activities throughout the study, so that they can be corrected in the next cycle.

The instrument used in this study was the observation sheet of students' critical thinking skills and notes during the research. Student observation sheet is an instrument used by researchers to observe all events during research in class. Notes during the study are used as reflection sheets during learning activities, these notes contain events in class that are not found on the observation sheet of students' critical thinking skills.

Observation notes are the basis of the teacher to find solutions to overcome the problems found during observation. Improvements to the learning methods carried out by the teacher can make
students' critical thinking skills increase, so that student learning outcomes can also be improved. For more details, this research framework can be seen in Figure 2.

![Research thinking framework](image)

**Figure 2.** Research thinking framework

Data analysis in this study uses data analysis techniques developed by Miles Huberman. Sukidin [15] explains that the steps in data analysis activities using models from Miles and Huberman consist of data collection, data reduction, data display, and conclusions. This technique is used to see the description of students' critical thinking skills and measure the improvement of student learning outcomes after using the Problem Based Learning model. Undang [13] explains that research that aims to get an overview is enough to present a single table and percentages for each category, to calculate percentages for each category a formula can be used:

\[ P = \frac{F}{N} \times 100\% \]

- \( P \) = Percentage
- \( F \) = Frequency that appears
- \( N \) = The amount of data

The percentage results are then stated in Table 3.

| Percentage | Criteria   |
|------------|------------|
| 81 – 100   | Very good  |
| 61 – 80    | Good       |
| 41 – 60    | Enough     |
| 21 – 40    | Less       |
| 0 – 20     | Very less  |

**3. Results and Discussion**

This research was conducted in three cycles. Observations in the first cycle were made 3 times face-to-face meetings in class by applying the Problem Based Learning model. Observation of students' critical thinking skills is done at the end of the first cycle. The observations in 1st cycle are shown in Table 4.
Table 4. Observation of Critical Thinking Skills in 1st Cycle.

| Indicators of Critical Thinking Skills | Results (%) | Criteria |
|---------------------------------------|-------------|----------|
| Identify                              | 83,33       | Very good|
| Define                                | 80,00       | Very good|
| Enumerate                             | 63,33       | Good     |
| Analyze                               | 53,33       | Enough   |
| List                                  | 56,67       | Enough   |
| Self-Correct                          | 46,67       | Enough   |

Table 4 illustrates the ability of students' critical thinking skills in 1st cycle. Based on the table, the results show that higher critical students' critical thinking skills are identified as indicators that get a value of 83.33% with a very good category. The lowest critical thinking skills of students are found in the self-correct indicator which scores 46.67% with an enough category. While the other indicators are in the very good category for define indicators (80.00%), good categories for enumerate indicators (63.33%), and enough categories for analyze indicators (53.33%) and lists (56.67%).

The observations in this first cycle show that students already have the skills to find the main problem and find the facts and information needed to limit the problem. But in the skills to recheck and correct mistakes in solving problems is still lacking. By looking at observations in 1st cycle, the self-correct indicator (46.67%) needs to be improved for the second cycle because it is still within enough criteria. Improvements that can be done is to encourage students to always review the results of problem solving during the learning process. This self-correct activity is carried out by comparing the results they get with the actual results by making notes of improvement on their worksheets.

The second cycle was held 2 times face to face meeting. The second cycle is carried out by making improvements to learning activities based on the results of reflexes in the first cycle. Observations made on students' critical thinking skills are made at the end of the second cycle. Observations of students' critical thinking skills produce data as in Table 5.

Table 5. Observation of Critical Thinking Skills in 2nd Cycle.

| Indicators of Critical Thinking Skills | Results (%) | Criteria |
|---------------------------------------|-------------|----------|
| Identify                              | 90,00       | Very good|
| Define                                | 86,67       | Very good|
| Enumerate                             | 76,67       | Good     |
| Analyze                               | 66,67       | Good     |
| List                                  | 60,00       | Enough   |
| Self-Correct                          | 70,00       | Good     |

Table 5 illustrates the ability of students' critical thinking skills in 2nd cycle. The table shows that students' higher critical thinking skills are on the identify indicator which scores 90.00% with a very good category. The lowest critical thinking skills of students are on the list indicator which scores 60.00% with enough categories. While the other indicators are in the very good category for define indicators (86.67%), and good categories for enumerate indicators (76.67%), analyze (66.67%) and self-correct (70.00%).
Figure 3 shows a graphic increase in indicators of critical thinking skills between the first cycle and the second cycle. Based on these graphs, it can be seen that indicators of students' critical thinking skills in the second cycle have shown improvement rather than the first cycle. In the first cycle the highest indicator is Identify and the lowest indicator is Self-Correct. While in the second cycle the highest indicator is Identify and the lowest indicator is List. After making improvements to learning activities using the problem-based learning model, it can be seen that the indicator that experienced the smallest increase was in the List indicator, and the indicator that experienced the greatest increase was in the self-correct indicator. Thus it can be concluded that the improvements made by the teacher in the second cycle have happened well.

By observing the results of observations of students' critical thinking skills in the second cycle, it is necessary to improve the students' thinking skills on the indicator list (60.00%) which still obtains enough criteria. The improvement that can be done by the teacher is by practicing the students' ability to convey and explain the reasons for solving the problems they have solved. This improvement will be carried out in the 3rd cycle.

The third cycle was held 2 meetings. The third cycle is carried out based on the results of the reflection of learning activities in 2nd cycle. The observation of the critical thinking skills of students is carried out at the end of the third cycle. The observations in the third cycle are in accordance with Table 6.

| Indicators of Critical Thinking Skills | Results (%) | Criteria       |
|--------------------------------------|-------------|----------------|
| Identify                             | 96.67       | Very good      |
| Define                               | 96.67       | Very good      |
| Enumerate                            | 90.00       | Very good      |
| Analyze                              | 86.67       | Very good      |
| List                                 | 83.33       | Very good      |
| Self-Correct                         | 90.00       | Very good      |
Table 6 illustrates the ability of students' critical thinking skills in 3rd cycle. Based on the table, it is found that higher students' critical thinking skills are in the identify and define indicators which score 96.67% in the excellent category. The lowest critical thinking skills of students are on the list indicator which scores 83.33% with a very good category. While the other indicators are already in the very good category for enumerate indicators (90.00%), analyze (86.67%) and self-correct (90.00%).

Figure 4 shows a graphic increase in indicators of critical thinking skills between second cycle and the third cycle. The graph shows that in general all indicators have experienced a significant increase. In the second cycle, the lowest indicator is the list and the highest indicator is identify. Meanwhile for the third cycle, the lowest indicator is the list, and the highest is the identify and define. The smallest increase in critical thinking indicators was in identifying and the biggest increase was in the list. This shows that improvements in learning activities using problem-based learning models have been done well, even though the list indicator is still the weakest indicator.

According to Levy in Sarwi et.al [16], scientific communication skills in physics include several indicators, namely: (1) identifying the ability to obtain information, (2) can state daily events in languages or physical symbols, (3) contribute ideas in group work, and (4) explain physical ideas and tasks in the production of products / reports, and (5) communicate the results of products or works / reports. Critical thinking skills and scientific communication skills have a strong connection. In scientific communication in writing requires the ability to think logically and analytically, analyze data scientifically.

Various attempts have been made to improve students' scientific communication skills. Kulsum et.al [17] conducted a study to determine students' scientific communication skills using Cooperative Problem Solving learning models. The results showed that the scientific communication skills of students for the experimental class were in good indicators (74.12%) and control classes were in good indicators (64.82%). These results are also in line with research conducted by Sarwi et al., [16] of physics education students through the implementation of the open inquiry experimental model, which obtained that the average score of students' scientific communication skills was 79.8 (tutorials) and
78.4 (non tutorial). Both of these studies are in line with the results of the average measurements conducted in this study.

The observations in this third cycle show that all indicators of critical thinking skills are in the very good category. Thus all the improvements made by the teacher by applying the Problem Based Learning (PBL) model to improve students' critical thinking skills are going well. Thus the implementation of classroom action research is considered complete, because all indicators have improved and are in the excellent category.

![Graph showing increased students' critical thinking skills](image)

**Figure 5.** Increased students' critical thinking skills between 1st cycle, 2nd cycle, and 3rd cycle.

Figure 5 shows a graphic increase in indicators of critical thinking skills in 1st cycle, 2nd cycle, and 3rd cycle. The increase that occurred significantly was in the self-correct category, and the smallest increase was in the indicator indicator. The application of Problem Based Learning models in the learning process in class has a real impact on improving students' critical thinking skills. The improvements made by the teacher during each cycle, not only increase the indicators to be improved, but can also improve other indicators.

Improvements made during learning activities are by involving students actively. One learning model that can actively involve students is through the application of the Problem Based Learning model. Zamzam et.al [18] states that there are several advantages to the Problem Based Learning model, including being able to make students more active during the learning process, so students are more creative and responsive in facing the problems given to them.

Students' skills in giving reasons for choosing answers can be seen from their lack of confidence in the answers they give in dealing with problems. One way that can be done is by practicing students' speaking skills in solving problems. Teacher strategies to motivate and conduct information discussions in learning activities should be able to lure students to express their opinions. Proper motivational strategies can improve students' thinking skills. Cholisoh et.al [19] stated that students with high learning motivation have better critical thinking skills than students with low learning motivation. Provision of exercises done in groups can make students seriously pay attention to the teacher's explanation. Problem Based Learning is a learning model expecting students to be able to work together in solving problems. This can lead to a spirit of togetherness, thus the activeness of students will be more developed [20].
Another way that can be done to improve students' skills in expressing reasons is to do some scientific activities in learning. Learning like this will make students more active than the teacher directly explains the understanding directly. Because students find that incident in daily life. Besides that students will also longer remember the subject matter because they are active in finding the learning material. The application of problem-based learning models provides many choices for students in solving count problems so that presentations will create discussions / interactions between students in the form of questions and responses. By applying the Problem Based Learning model, students' scientific activities in classroom learning activities will affect the students' psychomotor aspects [21].

4. Conclusion

Research to improve students' critical thinking skills by applying problem-based learning models is carried out in three cycles. The results showed that there was an increase in students' critical thinking skills on all indicators. The indicators used to measure students' critical thinking skills in this study are identify, define, enumerate, analyze, list, and self-correct. Significant improvements in this study were found in self-correct indicators and Analyze. Thus it can be concluded that the application of the Problem Based Learning (PBL) learning model can improve students' critical thinking skills.

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