The implementation of problem based learning model with the science writing heuristic approach to increase mastery of concept and critical thinking skill at junior high school student on simple machine

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Abstract. This research aims to know the increase mastery of concept and critical thinking skill through problem based learning model with a science writing heuristic approach on simple machine. Methods of this research using pre-experimental with one group pre-test - post-test design. The subject of this research is student grade VIII at one of Junior High School in Bandung. Instrument that used for this research is a test form of mastery of concept and critical thinking skill. Improvement mastery of the concept and critical thinking skill is measured by the normalized gain. The result shows an average gain of N-gain the mastery of concept is 0.59 with fair category. And the critical thinking skill is 0.63 with fair category. The response of students to the implementation of problem-based learning models with the Science Writing Heuristic approach shows that almost all students gave positive responses. Thus, the increase of mastery of concept and critical thinking skill and at students on the simple machine through the implementation of problem based learning model with the approach science writing heuristic has improved. Student responses to the learning model that is implemented positively.

1. Introduction

Science education is one of subject that has potential to improved ability of critical thinking students. The teachers have to development science education become more interesting and attractive for students. Student with high passion to learn science education will have a great long term memory of that subject material [1]. Thinking skills is one of the goals of intellectual learning science on the 2013 that aims to develop the potential of students become reflective in thinking ability. In accordance with the education of the future will be realized in case of a change of mind-set in the learning process that emphasizes the study of student-centred, interactive, active investigating, relate to the context of the real world, learning team-based, cooperative, critical thinking, and knowledge exchange occurs [2].

The results of the preliminary study through critical thinking skills test and mastery of material science at one of Junior High School in the city of Bandung obtained that critical thinking skills and mastery of the concepts students on material science still needs to be improved. Thompson (2011) stated that critical thinking skills students need to be developed early on. So, those students are able to face the
challenges of the future [3]. Critical thinking skills and mastery of the concept are the two important things that need to be supplied to the students [4]. To increase critical thinking skills and mastery of concept to students it necessary to implemented science learning that can improvement those skills.

Critical thinking is divided into eight interrelated processes and functions namely 1) question at issue: Ask questions that identify problems, 2) purpose: Analysing the objectives of the actions taken, 3) information: Provide information that is found and researched, 4) concepts: Describe concepts related to material and/or phenomena discussed from one or several disciplines, 5) assumptions: Formulate assumptions from a phenomenon that occurs, 6) points of view: Interpret and understand the other person's point of view, 7) interpretation and inference: Presenting the results of processing data from observed phenomena in the form of interpretations and conclusions, 8) implications and consequences: Making implications of observed phenomena by linking the concepts that apply in them and predicting the consequences that occur from a phenomenon based on the concepts learned [5].

Mastery of concepts is the ability of students to understand the meaning of learning and be able to apply it in solving problems in everyday life [6]. Mastery of concepts is the ability of students to understand concepts scientifically, both concepts in theory and their application in everyday life. The mastery of concept indicators is associated with the level of cognitive thinking Bloom revision consists of six levels with different aspects of learning, namely remembering (C1), understanding (C2), applying (C3), analysing (C4), evaluating (C5), and creating (C6) [6].

Science Writing Heuristic (SWH) approach encourages students to use the activity of scientific inquiry in laboratory are directional and work collaboratively in groups to discuss actively and build knowledge. SWH Approach integrates the activity of inquiry activity, working collaboratively in groups, and meaning making through strategy and argumentation writing-to-learn [7]. A pattern approach to SWH can facilitate students to hone critical thinking ability. The SWH approach includes two heuristic templates that are used as teaching structures and learning tools and require an active and interactive role from teachers and students in laboratory investigations [8].

The SWH template for the teacher includes eight phases, namely: 1) Exploration: The teacher involves students to gain initial knowledge and gain an understanding of the scientific context into the laboratory situation, 2) Pre-laboratory Activities: Teachers can design pre-laboratory investigations such as brainstorming, developing questions about the topic, or expressing prior knowledge, 3) Participation: The teacher guides students to think about the meaning of the data they obtain through journal writing, 5) Negotiation Phase II: The teacher encourages students to negotiate their understanding of the data obtained with their peers. Students are encouraged to make knowledge claims into explanatory forms for their data, 6) Negotiation Phase III: The teacher helps students to compare their ideas with books or online encyclopaedias, 7) Negotiation Phase IV: The teacher encourages students to communicate their current understanding of inquiry in a more subtle form, namely making reports, making presentations or posters, 8) Exploration: The teacher involves students to reflect on their understanding of the concepts obtained in the laboratory [8]. Using the SWH approach, students are involved in the entire scientific process of investigation [4].

Problem-based learning (PBL) model is demanding students active in solving problems of inauthentic to build knowledge, develop inquiry and high level thinking ability, develop self-reliance, and confident [9]. Important conditions that need to be considered in implementing the PBL model are the teachers whose role is to facilitate the passage of student discussions that form critical investigations and analyses [10]. The syntax of the PBL model consists of five steps, namely: 1) Student orientation to the problem: The teacher explains the learning objectives and facilities or logistics needed. The teacher motivates students to be involved in solving real problem activities that are chosen or determined, 2) Organize students: The teacher helps students define and organize learning tasks related to problems that have been oriented in the previous stage, 3) Individual and group research guide: The teacher encourages students to gather the appropriate information and carry out experiments to get the clarity needed to solve the problem, 4) Develop and present the work: The teacher helps students to share assignments and plan or prepare works that are appropriate as a result of problem solving in the form of
reports, videos, or models, 5) Analyse and evaluate the problem-solving process: The teacher helps students to reflect or evaluate the problem solving process [11]. Through problem-based learning model students are led to connect between the phenomena with the concepts that they learned. Problem based learning model with SWH approach is viewed can improve students’ critical thinking skills and mastery of concept learning especially on simple machine.

2. Methods

Methods of this research is using pre-experimental with one group pre-test-post-test design. This treatment is for problem bases learning model with Science Writing Heuristic approach. The subject of this research is student grade VIII at one of Junior High School in Bandung. Instrument that used for this research is a test form of mastery concept and critical thinking skill, observation form to measure the implementation stage of activity, and questionnaire form to collect student responses against implementation of this model. Quantitative data in the form of score subject concept and critical thinking skill acquired by the students in learning science. Qualitative data in the form of observation and response of the students on this implementation model. Increased mastery of concept and critical thinking skill data processed by using the equation of the mean gain score normalize [12].

\[
N - Gain = \langle g \rangle = \frac{\%<g> - \%<S_i>}{\%<S_f> - \%<S_i>} \times 100 \%
\]

(1)

Data on student’s response being processed by classifying the responses of students and calculating all the answer of respondents and change into percentage with this formula [13]:

\[
R \%(\%) = \frac{P}{F} \times 100 \%
\]

(2)

R (%) = percentage of student responses
P = the number of students who choose the available answers
F = the number of all students who gave responses

3. Results and Discussion

3.1. Increase of concept mastery

Increase of concept mastery is in the medium category with the achievement of N-Gain value of 0.59, as presented in Figure 1.

![Figure 1. Increase of concept mastery.](image)

Based on Figure 1, it appears that the achievement of the post-test average score is increased compared to the achievement of the average pre-test score. The percentage of the average N-Gain value is 59%. Based on the results obtained, it can be concluded that the increase in mastery of concepts occurs after a problem-based learning model is implemented with the Science Writing Heuristic approach to simple machine.
Increase of concept mastery in each aspect reviewed in this study is based on Bloom's revised taxonomy cognitive domain consisting of C1 (remembering), C2 (understanding), C3 (applying), C4 (analysing), C5 (evaluating) and C6 (creating). Increased of concept mastery in each aspect are presented in Figure 2.

![Figure 2. Increase of concept mastery in each aspect (%)](image)

Based on Figure 2, it appears that the increase of concept mastery in C1 (remembering) aspect is highest, while the lowest level is in the 6 (creating) aspect. Overall there was an increase in the mastery of student concepts after the implementation of a problem-based learning model with the SWH approach to simple aircraft material. The money learning model implemented can build broader student concepts. This finding supports the opinion of Turpin & Cage 2004 which states that involving students actively in science activities can foster thinking and reasoning abilities [14]. The results of this study are in line with previous research which found that effective science learning can significantly improve student learning outcomes [15].

3.2. Increase of critical thinking skills

Increase of critical thinking skills is in the medium category with the achievement of n-gain value of 0.63, as presented in Figure 3.

![Figure 3. Increase of critical thinking skills](image)

Based on Figure 3 it appears that the achievement of the post-test average score is increased compared to the achievement of the average pre-test score. The percentage of the average N-Gain value is 63%. Based on the results obtained, it can be concluded that the increase in critical thinking skills
occurs after a problem-based learning model is implemented with the Science Writing Heuristic approach to simple machine.

Critical thinking aspects reviewed in this study are based on aspects of critical thinking skill namely: (1) question at issue, (2) purpose, (3) information, (4) concepts, (5) assumptions, (6) point of view, (7) interpretation and inference, and (8) implications and consequences [5]. Increase of critical thinking skills in each aspect are presented in Figure 4.

![Graph showing increase of critical thinking skills](image)

**Figure 4.** Increase of Critical Thinking skills in each aspect (%)

Based on Figure 4, it appears that the increase of critical thinking skills in question at issue aspect is highest, while the lowest level is in the point of view aspect. Students' critical thinking skills in each aspect have increased after the implementation of problem-based learning models with the SWH approach to simple aircraft materials. This is in line with previous research that the problem-based learning model can significantly improve students' critical thinking skills [16]. Critical thinking is a very important skill for solving problems, investigating and finding through a systematic approach to evaluating information to get solutions to various problems [3].

4. **Conclusion**

Enhancing the mastery of concepts and critical thinking skills of students through the implementation of problem-based learning models with the Science Writing Heuristic approach to simple machine in the medium category. The response of students to the implementation of problem-based learning models with the Science Writing Heuristic approach shows that almost all students gave positive responses.

5. **References**

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