



THE EFFECTIVENESS OF PROBLEM BASED WORKSHEET TO IMPROVE SENIOR HIGH SCHOOL STUDENTS' CRITICAL THINKING SKILLS

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Abstract

This research is a quasi-experimental with one group pretest-posttest design. The study aims to explore the effectiveness of using problem-based learning materials to improve students' critical thinking skills. The aspects of indicators of the critical thinking skills are a) interpretation, b) analysis, c) evaluation, d) inferential, and e) explanation. The subject of this research is the students of XI MIA class in a Senior High School in Mataram. There are three schools, which are SMAN 8 Mataram, SMAN 3 Mataram, and SMAK Kesuma Mataram. Each school has one class to represent. The researcher measured the effectiveness using N-gain test from the pretest and posttest result. The N-gain test resulted in 0.47. The score showed that the treatment was effective to improve students' critical thinking skills.

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INTRODUCTION

Science learning, especially chemistry in the 2013 curriculum, demands significant changes in the process of delivery. There is a fundamental change in the process of presentation which can give direct experience for students through observation and its scoring (Rahayu *et al.*, 2015). The success of the 2013 curriculum does not only influence the teacher to be always creative in developing the method. This curriculum also affects how the lesson materials should be given to the students. However, the fact shows that the availability of students' worksheet and a scoring instrument is absent. Based on the initial observation and interview with chemistry teachers in some schools, the learning process still uses the common students' worksheet and the guidebook. Besides, the learning process is still centralised to the students which result in a classroom activity. Furthermore, the current learning material is also not able to ignite students' affection awareness and less focusing on developing their soft skills. The given exercises to the students are also unable to dig their ability deeper on higher order thinking and investigating specific issues (Restuwati *et al.*, 2014).

Education has a vital role in developing the quality of human resource that they can have strong competitive skills in the workforce. One of the official ways to do that is through introducing the students with higher order thinking skills (Rofiah *et al.*, 2013). Higher order thinking skills can be seen when students can solve problems if they can implement the knowledge they have obtained to a new and unfamiliar situation (Sudarman, 2007). Higher order thinking skills cope with the ability to connect, to manipulate, and to transform knowledge and experience critically and creatively to make a decision and to solve a problem (Harianto.S, Dafik, Nurcholif.D, Sri.L, 2014). The statement is similar to Rofiah, E., Siti, A.N., Ekawati, E.Y (2013) that higher order thinking skills are the ability to develop critical thinking from the experiences and knowledge possessed by individuals.

The creativity of educators in optimising the process of learning is highly required to achieve the learning objective. They should not only limit the target based on the syllabus but also to the critical thinking skills of the students. A learning model with a scientific approach which is suggested by

2013 curriculum is the innovative problem-based learning (Permendikbud, 2016). Problem-based learning is a learning model which directs the students to think critically and objects to enhance their communicative skills (Asyari *et al.*, 2016). Problem-based learning focuses on the students to make them able to be active, creative, and comprehensively upgrade their ability. Besides, the learning process is also essential in engaging students to an independent, interactive, and informative learning environment (Sirisha & Paramjyothi 2016). Based on the research conducted by Asad, M., Iqbal, K., & Sabir, M (2015), problem-based learning is useful in developing students' critical thinking skills.

The use of learning material is required based on the demand of the curriculum, characteristic of the target, and the need for solving social issues. Learning chemistry will be more meaningful and exciting for students if the materials are relevant to their daily life (Mayer, 1999). According to the theory of Ausubel *et al.* (1978), the learning process should be "meaningful" that it connects new information with relevant concepts in people's cognitive structure. Apart from that, the learning process should also build students' critical thinking skills.

Critical thinking ability is a competence which should be developed and trained for students through learning activities that they can always grow and expand due to the importance of it for their life. In Ennis (2011), critical thinking is an ability to think reflectively and rationally to decide what should be believed or be done. In high school, critical thinking should be accomplished, for the students to construct their knowledge (Ismaniati & Christina, 2009). Critical thinking also challenges educators nowadays. Many programs and learning models are made to facilitate the development of this skill in the classroom (Lang, 2001).

METHODS

This research used a pre-experimental design of one group pretest-posttest design (Sugiyono, 2013).

Table 1. Experimental method

Group	Pretest	Action	Posttest
SMAN 8 Mataram	O ₁	X ₁	O ₂
SMAN 3 Mataram	O ₁	X ₁	O ₂
SMAK Kesuma Mataram	O ₁	X ₁	O ₂

School Name	N-Gain	Categories
SMAN 8 Mataram	0.20	Not Effective
SMAN 3 Mataram	0.56	Effective
SMAK Kesuma Mataram	0.62	Effective
Three schools	0.47	Effective

Note:

- O₁ = The result of pretest in the schools
 O₂ = The effect of posttest from the schools
 X₁ = The experiment of using problem-based learning

The effectiveness of the treatment was measured using N-gain.

$$g = \frac{S_{\text{posttest}} - S_{\text{pretest}}}{S_{\text{maximum}} - S_{\text{pretest}}}$$

Note:

- g = N-Gain
 S_{pre-test} = pretest score
 S_{post-test} = posttest score
 S_{maksimum} = ideal maximum score

In Hake (1998), the normalised gain score is divided into three modified categories. The categories can be seen in Table 2.

Table 2. Normalised Gain Criteria

Percentage	Criteria
$g < 0.3$	Not effective
$0.7 > g \geq 0.3$	Effective
$g \geq 0.7$	Very Effective

RESULTS AND DISCUSSION

The effectiveness of problem-based worksheet to develop students' critical thinking skills can be seen on the difference of the pretest and posttest score. The items of the test were essays which are following the Faceone (2011) indicators of critical thinking, which are interpretation, analysis, evaluation, inferential, and explanation.

Table 3. The result of the effectiveness of problem-based learning materials to students' critical thinking skills

Based on the table above, three schools obtained similar effectiveness score. The school with the highest score is SMAK Kesuma Mataram which is followed by SMAN 3 Mataram. The school with the lowest score is SMAN 8 Mataram. The result is influenced by the initial ability level and the different characteristics of the students in each school. The most active student group is from SMAK Kesuma Mataram. The students in SMAN 3 Mataram also showed similar trait although it is not from all of the students. Meanwhile, students in SMAN 8 Mataram were less active than the schools mentioned above. Also, the motivation of the students was also still in absence.

Hanson dan Wolfskill (2000) states that the solving of problems can be seen through group discussion. The discussion can improve students' activeness in reasoning. The idea is similar to the result of this research that in a learning process, the important factor in the study room, the environment of the study, and also the learning culture of the society. These factors influence students' learning preparation and outcome.

The problem-based students' worksheet demanded the students be ready before they come into the class. During the learning process, they are divided into small groups. In these groups, they can cooperate and share their thoughts. It is expected that students can appreciate other people's opinion and thoughts before coming into the conclusion of the discussion (Setyorini *et al.*, 2011).

Table 4. The result of worksheet's effectiveness the critical thinking skills' indicators

Schools Name	Indicators	N-gain	Categories
SMAN 8 Mataram	Interpretation	0.94	Effective
	Analysis	0.23	Not Effective
	Evaluation	-2.40	Not Effective
	Inference	0.12	Not Effective
	Explanation	0.11	Not Effective
SMAK Kesuma Mataram	Interpretation	0.59	Effective
	Analysis	0.28	Not Effective
	Evaluation	0.70	Effective
	Inference	0.78	Effective
	Explanation	-0.21	Not Effective
SMAN 3 Mataram	Interpretation	0.38	Effective
	Analysis	-0.27	Not Effective
	Evaluation	0.84	Effective
	Inference	0.84	Efektif
	Explanation	0.16	Not Effective
All Schools	Interpretation	0.61	Effective
	Analysis	0.11	Not Effective
	Evaluation	0.35	Effective
	Inference	0.53	Effective
	Explanation	0.03	Not Effective

In table 4, the result of the analysis showed the N-gain of students' critical thinking skills based on the indicators. The table also includes the combination of the three schools. From the combination, the effective indicators are interpretation, evaluation, and inference. Meanwhile, the ineffective indicators are analysis and explanation.

The difference of the result is because the learning process directs the students only to understand facts, concepts, and formulation of problems in their daily life. The students also analysed the data which are related to the phenomena as a form of critical thinking. They made a hypothesis and conclusion to make that in details. The activity helps the students to construct their understanding of the phenomena that the students can enhance their higher order critical thinking skills (Mayasari *et al.*, 2016).

The indicator with the highest score in the analysis is interpretation followed by inference and evaluation. The interpretation was mostly used in the classroom as well as evaluation. However, the students were still unfamiliar with the analysis in the learning process. Meanwhile, the least occurred indicator is the explanation. According to the research of Gadzella *et al.*, (1997) in Ricketts *et al.* (2004) that there is a

significant and positive relationship between the learning approaches and the critical thinking skills. The result of the research is in line to some previous studies which had found that internal and external factors also influence learning outcome.

The learning process of problem-based learning can sharpen students' ability to interpret data and enhance their ability to evaluate and inference. The approach has different responses from the analysis and explanation. Despite the training, the students still lack reading habit, especially in finding a relevant reference to describe something or to report an observation. Students are also unfamiliar on analysing things since they are familiar to multiple-choice test items which limit their ability to analysing things. Sudarman (2007) states that a learning approach should provide students with a real-world problem as a context for students to learn on how to think critically as well as to get the essential concept of the material in the learning process.

Based on the learning theory of constructivism, students are supported to apply the knowledge that they construct by themselves which include solving problems, formulating a hypothesis, gathering data, analysing, evaluation, and discussion, that the learning process will be more meaningful.

Asad, M., Iqbal, K., & Sabir, M (2015), also find that problem-based learning can direct students to become critical and communicative. Besides, Sirisha, R., & Paramjyothi, P (2016), say that problem-based learning is centered to students. The learning process facilitate them to be active, creative and improve their complete performance. Problem-based learning is a useful tool for students to become an independent, interactive, oriented, and presenting.

One of the syntaxes in problem-based learning is solving a problem. Thus, students are given questions to address. According to Thompson (2011), items are valid to direct students to interpret, analyse, synthesise, preview and reflect on finding the answers.

For each school, SMAN 8 Mataram has an only interpretation as the effective indicator. Meanwhile, SMAN 3 Mataram and SMAK Kesuma Mataram are effective in interpreting, evaluating, and inferencing. The ineffective indicators are analysis and explanation. The

learning materials are proven to give students new insight to solve problems. The worksheet was also effective to build students activeness and creativity to solve problems, think, work in a group, communicate, and inform something positive (Akinoglu *et al.*, 2007). Besides, the opinion of Semra Sungur & Ceren Tekkaya (2006) explains that the problem-based learning can help students to remind something new for a long-term.

CONCLUSION

The result of this research found that the problem-based learning worksheet can improve students' critical thinking skills and obtained the N-gain of 0.47 or categorised as effective. For future research, the problem-based learning should have a variation in developing students' critical thinking skills.

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