

THE DEVELOPMENT OF STUDENT WORKSHEET PROBLEM SOLVING ORIENTED TO TRAIN STUDENTS CRITICAL THINKING SKILL ON ACID-BASE MATERIAL IN CLASS XI MIPA MAN LAMONGAN

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Abstract

This study is aimed to develop student worksheet problem solving oriented to train student critical thinking skill on acid base material. Worksheet based on the steps of problem solving. According to Facione (in Filsaime, 2008), critical thinking skill that can be trained are: interpretation, inference, and analysis. This study is developed by using Research and Development (*R & D*) of Borg and Gall's design. The design consists three steps: introduction, development, and test. This study was limited to development. Student worksheet problem solving oriented is declared feasible. It can be seen from the validity, practicality, and effectivity. Worksheet was declared valid in terms of content validity which reached 82.81% and the construct validity which got 79.33%. Student worksheet was declared practical in terms of student responses get a percentage of 78.33% and supported by students activities. Student worksheet is declared effective in accordance with the critical thinking skill test with each student obtaining the value of ≥ 2.67 .

Keywords: student worksheet, problem solving, critical thinking skill.

INTRODUCTION

Based on Permendikbud No. 64 in 2013, the students elaborate their scientific attitude of critical thinking. Commonly, the skills of students' critical thinking are still low because the learning is concerned to the teachers not for students. Therefore, the learning becomes passive. Nowadays, there is a change of learning system from teacher-centered becomes student-centered, from passive becomes active, critical and independent on finding information and problem solving [1].

Based on the results of tracking test of the critical thinking in MAN Lamongan is found that the students lack to train critical thinking skills. The students who lack to train in critical thinking are 46%. There are 46% students that able to make research problem. There are 53% students that able to make hypothesis and 46% students are able to determine research variable. Then, there are 33% students capable for analyzing the data correctly and 53% of students are capable to make conclusion. Critical thinking skills can be learned, estimated and taught. It means that critical

thinking is a self-maintain in deciding something that produces interpretation, analysis, evaluation and inference, as well as the exposure of proof, concept, methodology, criterion or contextual consideration as the fundamental for making decision. Critical thinking skills consists: interpretation, analysis, evaluation, inference, explanation and self-maintain [2]. It shows that critical thinking skills are a cognitive process to gain the knowledge, comprehension and skills to be able to solve the problems.

Critical thinking is a process that emphasizes a logical and rational basis of belief, providing a set of standard and procedure for analyzing, testing and evaluating [2]. It can be interpreted that critical thinking is a logical and rational process of thinking for solving a problem by analyzing, conducting investigations and evaluating based on the arguments.

Chemical learning in senior high school mostly focuses on the aspects of knowledge and comprehension while for application, analysis, synthesis and even evaluation aspects is not emphasized. The skills of student critical thinking are still low because they lack practice for

analyzing, synthesizing, and evaluating. As the impact, they become poorly trained to solve the problems and they can not make decisions appropriately [3].

Critical thinking skills can be trained through learning model. Learning models that can involve the students to be active, independent and critical. The compatible learning model for critical thinking skill is problem solving. It is reinforced by the results of research at SMA Negeri 12 Surabaya that students' critical thinking skills can be improved by the using of problem solving learning model. It can be seen from the score of N-gain that reached 0.85 with high criteria so that imply the completeness of learning outcomes from classical students through problem solving that reached 94.87% [4].

Problem solving is the process of thinking to solve the difficulties which are known or described, collecting the facts about those difficulties and determining the additional information required. Next, making conclusion or proposing an alternative problem and examine it [5]. The students can solve the problems encountered by identifying problems, establishing the hypothesis, examining the hypothesis, analyzing it which is related to the problems, and making conclusions.

Five steps for solving the problem as follows:

- 1) there is a clear problem to solve;
- 2) looking for the data or information that can be used to solve the problem;
- 3) establishing a temporary solution (hypothesis) for this problem;
- 4) testing the truth of the temporary solution (hypothesis);
- 5) making conclusions [6].

Critical thinking skills which are trained such as: interpretation, inference and analysis. Those skills are trained because critical thinking skills are more easily raised in problem solving steps.

Based on the results of interviews with teachers at MAN Lamongan that the teaching materials used is student worksheet. The student worksheet used from the publisher therefore it is not compatible with the curriculum applicable on school, there is no component of critical thinking skills and problem solving. Teachers only develop book of practical that contain labels, practical purposes, material summaries, tools and materials and experimental steps. It shows that student worksheet can not to trained critical thinking skills and solve the problems.

The result of development worksheet at SMA Negeri 1 Manyar is good response consists of: 97.5% for presentation, conformity with general structure of worksheet is 88.75%, and language of worksheet is 86.67% [7]. It is supported by the result of research at MAN 2 Gresik that the student worksheet based on problem solving is valid as the learning media by obtaining the content validity that consist: 85.42% for content criteria and the 80.55% for language on very valid category. Construct validity include: graphical criteria getting 81.66% and the presentation getting 93.75% on very valid category [8].

Student worksheet can be consisted of students' understanding that can be used to solve the problem [9]. It is supported by the result of interviews with teachers at MAN Lamongan the desired format of student worksheet in the learning process is student worksheet that contains problem solving. The development of student worksheet can establish students to solve problems and train critical thinking skills.

Students get difficulties in the concept of acid-base. First, they can not relate one concept to the others concept. Second, misapply the symbols and mathematical formulas. Third they ignore the context of acid-base. Fourth, they generalize the problem without understanding the context [10].

Chemistry, especially acid-base are most difficult subjects supported by the results of pre-research at MAN Lamongan that 53% of students considered of difficult material. It is because they lack understanding the sub primary material to determine the pH of acid-base. The results of interviews with the teachers explain that the most difficult material in class XI is acid-base. The students can not gain the minimum score to meet the standard as much as 75%. Based on the description of the background this research is conducted entitled "The development of student worksheet problem solving oriented to train students critical thinking skills on Acid-Base Material in Class XI MIPA MAN Lamongan".

METHOD

This research uses the method of Research and Development (R & D) by Borg and Gall [11]. It is only done until the development stage.

Methods data collection consist: review sheet, validation sheet, student response, student activity and critical thinking skill test. Review sheet is used to get the input and suggestion from teacher and Chemistry lecturer of student

worksheet draft 1 and making revision to produce worksheet draft 2. Validation sheet is aimed to get the feasibility of research data from student worksheet which is viewed from content and construct validity. Student response is aimed to get the responses or opinions of students about student worksheet. Student activity is aimed to obtain research data during the learning process. Critical thinking skill test is aimed to know students critical thinking skill, such as: interpretation, inference and analysis.

Teachers and lecturers of chemistry fill out validation sheets by giving value as follows:

Table 1 Likert Scale

No.	Criteria	Value
1.	Very bad	1
2.	Bad	2
3.	Good enough	3
4.	Good	4
5.	Very good	5

[12]

The students fill out the student response questionnaire with yes and no criteria in accordance with Table 2 below:

Table 2. Guttman Scale

Jawaban	Value
Yes	1
No	0

[12]

Observation of student activity is suitable with the rubric. The calculation of the validation sheet, questionnaire of student response and student activity is using the following formula:

$$\text{percentage} = \frac{\text{total score of data collection}}{\text{criteria score}} \times 100$$

Criteria score = high score x total aspects x total reviewer

Percentage results of the validation sheet and student response questionnaire can be interpreted into Table 3.

Table 3. Criteria Interpretation Score

No.	Percentage	Category
1.	0% - 20%	Very less
2.	21% - 40%	Less
3.	41% - 60%	Enough
4.	61% - 80%	Feasible
5.	81% - 100%	Very feasible

[12]

Critical thinking skill test uses a scale of 1-4 (multiple of 0.33). Then it is converted to predicate A to D. Students are said to think critically if they get result of critical thinking skill test value ≥ 2.67 with good predicate (B-).

Student worksheet is considered as feasible when validation gets $\geq 61\%$, practical if

student response and student activity reach the percentage of $\geq 61\%$, and effective if result critical thinking skill test gets ≥ 2.67 with good predicate (B-)

RESULT AND DISCUSSION

1. Validity

Validity is viewed from the validity of content and construct. The average of content validity got 82.81% with very feasible category. Average of construct validity got 79.33% with feasible category. There are the criteria for each validity:

a. Content Validity

Content validity consists of material conformity with basic competence and learning indicator, conformity with problem solving, and conformity with critical thinking skill that are trained.

Table 4. Percentage of Content Validity

No.	Aspects	Average Percentage	Criteria	
			F	VF
1.	Conformity with basic competence and learning indicator	84.44 %		√
2.	Conformity with problem solving	84.00 %		√
3.	Conformity with critical thinking skills which are trained such as: interpretation, inference and analysis	80.00 %		√
Total Average		82.81 %		√

Average of content validity reached 82.81%, very feasible category. First aspect, it got very feasible category because the student worksheet has been suitable with basic competence in curriculum 2013, learning indicator and material of breadth-depth. The material breadth includes material which is noted in the student worksheet, such as: natural indicator, artificial indicator and pH acid-base. The material depth includes details concept of acid-base.

Second aspect got very feasible category because it has been suitable with the steps of problem solving. Steps of problem solving are

obvious problems to solve, searching for data or information that can be used to solve the problems, assigning hypotheses, testing hypotheses and making conclusions [6].

Third aspect of critical thinking skills which are trained include interpretation, inference and analysis [2]. Interpretation got 80% with feasible category, inference got 80% with feasible category and analysis got 80% with feasible category.

b. Construct Validity

Average of construct validity is 79.33% with feasible category. First aspect is concepts that are presented sequence, accurate and logic to get percentage of 80% with feasible category. Presentation of concepts is suitable with the 2013 curriculum so sequence and logic material. Material based on book sources which are related to acid-base. Validity presentation includes a sequence of material presentation [13].

Second aspect is language which is using standard language, clear and easy to understand for students got of 80% with feasible category. Student worksheet developed using clear and standard language. Therefore, they can understand clearly.

Third aspect is layout of text, images, tables, and graphs which are attracted students interest and attention to learn and gets of 73.33% with feasible category. This aspect got the lowest percentage because students are less interested to learn student worksheet. Design of student worksheet in the layout of drawings, tables and graphs should be able to attract the interest and attention of students to learn it [13].

Fourth aspect got 80% percentage with a feasible category. The materials which are presented are focused on students and they can practice their critical thinking skills through student worksheets that have been developed.

2. Practicality

a. Student Response

Student response questionnaire sheet consists of content and construct criteria. The following table shows average of content and construct criteria:

Table 5. Average of Student Response Criteria

No.	Student Response	Average Percentage	Criteria F VF
1.	Content Criteria	80.21 %	√
2.	Construct Criteria	72.91 %	√
	Total Average	76.56 %	√

Content criteria includes student worksheet suitability with problem solving steps, conformity with critical thinking skills which are trained. Average of content got 80.21% with feasible category.

Construct criteria includes presentation, language and graph. First aspect is related to presentation student worksheet got of 66.67% with feasible category. Second aspect is related to the language got of 83.33% with very feasible category. Third aspect is related to language reached 75% with feasible category. Fourth aspect is related to graph got of 66.67% with the feasible category. The average percentage of student responses in terms of construct criteria gets 72.91% with feasible categories.

Percentage viewed content and construct criteria of student response got 76.56% with feasible category. Student worksheet can be declared practical for trial based on the result of student response.

b. Student Activity

Student activity can support student response. Result of student activity shows that students have critical thinking skills include interpretation, inference and analysis are classified as good. At the meetings 1, 2 and 3 when the student worksheet is used their activity is increasing. It can be seen through the percentage of student worksheet 1, 2 and 3 of 74.58%, 82.92%, and 90.42%.

3. Effectivity

a. Critical Thinking Skill

Critical thinking skills test for students is used to know the students critical thinking skills. The questions of critical thinking skill test consists five essay are appropriate to critical thinking skill which are trained such as: interpretation, inference and analysis. Student worksheet considered feasible if score of students critical thinking skills is ≥ 2.67 with B- (good) predicate.

Table 6. critical thinking skill

No.	Student name	Score	Predicate	Explanation
1.	Student 1	3.2	B+	Good
2.	Student 2	3.8	A-	Very good
3.	Student 3	3	B	Good
4.	Student 4	3.8	A-	Very good
5.	Student 5	3	B	Good
6.	Student 6	3	B	Good
7.	Student 7	3.2	B+	Good
8.	Student 8	2.8	B-	Good

No.	Student name	Score	Prediccate	Explanation
9.	Student 9	3	B	Good
10.	Student 10	3	B	Good
11.	Student 11	3.4	A-	Very good
12.	Student 12	2.8	B-	Good

There are three students get A- (very good), two students got B- (good), five student get B (good) and two students got B- (good). Student got score 2.8 with B- (good) criteria because information obtained by student is not include long-term memory. Information can be student understanding about knowledge gathered. Information will be remembered to person senses and received by sensing register then transferred to short-term memory, process for transferred to long-term memory [14]. It shows that critical thinking skill are skill be trained continuously so student are able to critical thinking.

Assessment used was Facione assessment, scores of each question has range 1-4. Critical thinking skill of student is low gets score 1. The score 2 show critical thinking skill is enough, score 3 show critical thinking skill is good, score 4 show critical thinking is very good [2].

CLOSURE

Conclusion

Student worksheet problem solving oriented to train students critical thinking skill on acid-base material was declared feasible. It can be seen as follows:

1. Student worksheet was declared valid viewed from content and construct validity which got 82.81% in content validity and 79.33% in construct validity.
2. Student worksheet was declared practically viewed by student response that reached 76.56% and supported by student activity terms of student worksheet 1 of 74,58%, student worksheet 2 of 82,92% and student worksheet 3 of 90,42%.
3. Student worksheet was declared effectively viewed from critical thinking skill test. The students are said surpassing completeness with the score > 2.67.

Recommendation

1. Applying student worksheets that have been developed on acid-base material at the appropriate time.
2. The research is only development step. Therefore, it is necessary to do further research until the final step of Research and

Development (R & D) method by Borg and Gall namely test of product.

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