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DEVELOPMENT OF STUDENT WORKSHEET WITH INQUIRY-BASED TO TRAIN STUDENTS' CRITICAL THINKING SKILL ON EQUILIBRIUM SHIFT MATTER GRADE XI

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Abstrak

Penelitian ini dilatarbelakangi oleh rendahnya keterampilan berpikir kritis siswa pada pembelajaran kimia. Tujuan dari penelitian ini adalah mengetahui kelayakan teoritis dan empiris LKS berbasis inkuiri untuk melatihkan keterampilan berpikir kritis siswa pada materi kesetimbangan kimia. Kelayakan teoritis ditinjau dari kriteria isi, kebahasaan, penyajian, kegrafikan, kesesuaian dengan model pembelajaran inkuiri, dan kesesuaian dengan komponen keterampilan berpikir kritis. Kelayakan empiris ditinjau berdasarkan hasil tes keterampilan berpikir kritis siswa dan respon siswa. Keterampilan berpikir kritis yang dilatihkan yaitu intrepretasi, analisis, inferensi, dan evaluasi. Jenis penelitian ini adalah penelitian pengembangan yang mengacu pada model pengembangan 4-D. Tahapan yang dilakukan hanya sampai tahap Develop karena penelitian ini dilakukan untuk mengetahui kelayakan teoritis LKS dan dilakukan ujicoba terbatas kepada 15 siswa kelas XI MIA SMAN 12 Surabaya. Berdasarkan hasil penelitian dapat disimpulkan bahwa LKS yang dikembangkan layak secara teoritis maupun empiris. Persentase hasil validasi kelayakan kriteria isi 94,07%, kebahasaan 90,56%, penyajian 92,89%, kegrafikan 87,41%, kesesuaian dengan model pembelajaran inkuiri 81,33%, dan kesesuaian dengan komponen keterampilan berpikir kritis 85,00% dengan kategori sangat layak. Keseluruha siswa dinyatakan tuntas pada tes keterampilan berpikir kritis dan respon siswa sangat baik dengan persentase keseluruhan aspek sebesar 92,78%.

Kata-kata Kunci: Lembar Kegiatan Siswa, model pembelajaran Inkuiri, keterampilan berpikir kritis, kesetimbangan kimia.

Abstract

This research was motivated by the low of student's critical thinking skill on chemistry subject. The aim of this research was to know the theoretical and empirical feasibility of worksheet inquiry-based to rehearse student's critical thinking skill on chemical equilibirum matter. The theoretical feasibilities were explored from criteria of content, language, presentation, grahic, suitability of inquiry learning model, and sutability of critical thinking skill component. The empirical feasibility was explored based on results of critical thinking skill test and students' responses. Critical thinking skills that rehearsed were interpretation, analysis, inference, and evaluation. Kind of this research was research development that reffered to 4-D model. The stage that conducted only up to Develop stage because this research was conducted to know theoretical feasibility and then conducted a limited test to 15 students grade XI MIA SMAN 12. Based on research result could be concluded that the developed worksheet was feasible theoretically and empirically. Feasibility validation results percentage of criteria of content was 94.07%, language 90.56%, presentation 92.89%, graphic 87.41%, suitability with inquiry learning model 81.33%, and suitability with critical thinking component 85.00% with very feasible category. All students were passed on critical thinking skill test and students' responses were very good with whole aspect presentage 92.78%.

Keywords: Worksheet, Inquiry learning model, critical thinking skill, chemical equilibrium.

INTRODUCTION

Education is one of important sectors for a nation because it is as a standard that determines wheter a nation has quality or not. Without a qualitied education, a nation will not have qualitied human resources. The big challenge that deals with is how to transform productive human resources become competent and skilled through education in order not to be burden [1]. To have quality generations, government designs a suitable curriculum because it will be applied as a basic for education stuff.

Curriculum 2013 emphases the change of passive learning to critical learning that is also a demand of Curriculum 2013 [1]. In scientific learning, especially chemistry, teacher is expected to be able to give critical learning so students are able to acquire a good concept and are not passive. Teacher is given free chance to implement suitable learning model and method in learning activity. Besides, students also needs relevant learning source so they are able to acquire accurate information.

Chemistry is the study of matter and the changes it undergoes. Compared to the other disciplines, chemistry is considered more complicated [2]. There are some reasons, one of those is chemistry has particular vocabularies and most its concept is abstract. Although it is considered has many benefits, but it is still considered as confused subject because finite on concept, theory, and many formulas.

One of matters that studied in chemistry is chemical equilibrium. According to Hunddle dan White, Paiva *et al*, and Bellamy chemical equilibrium is one of the most difficult in chemical education [3]. Based on result of pre-research in Senior High School 12 Surabaya, 56,67% students considered chemical equilibrium matter was difficult matter and 86,67% students stated that learning activity was only conducted on class without experimental activity on that matter. It will be as well to students to acquire their own concept. One of concept acquirement independently ways is through inquiry instruction.

National Science Education Standard characterize inquiry instruction as involving students in a form of active learning that emphasizes questioning, data analysis, and critical thinking [4]. Student's concept acquirement independently could make their own concept became meaningful. One of activities in inquiry is experiment. This activity also can train student's critical thinking skill.

Facione states there are six critical thinking skills named 1) interpretation, 2) analysis, 3) evaluation, 4) inference, 5) explanation, dan 6) self-regulation [5]. Critical thinking is a demand in global era to make students are able to solve problem that relates with their daily life. By developing critical thinking skill, student is able to understand whole concept and not separate out.

Zhou's researches (2010, 2013) state that student's critical thinking skill on analysis, evaluation, and inference stage need to be improved [6] [7]. This critical thinking skill can be trained to students through learning strategy and model that is used by teacher in the class as inquiry instruction that involved experimental activity, or instructional media like worksheet . Relevant LKS usage could become an alternative to teachers to train student's critical thinking skill.

Worksheet is one of learning stuff that used by teacher in supporting learning activity in the class. Based on interview to SMAN 12 Surabaya teacher, known that worksheet used not using inquiry approach. This made student's critical thinking skill was still low, shown by result of pre-research that only 13.33% students were able analyzing correctly and only 13.33% student that were able making appropriate conclusion. This showed that worksheet that helped students to improve their critical thinking skill and able to acquire concept independently was required.

Worksheet that can facilitate students to acquire concept independently is effective to improve students' completeness. Students also

are expected to improve their critical thinking skill through usage of relevant worksheet. This was supported by preview research had been conducted showed that average score of students' high order thinking skill after usage of inquiry-based worksheet on reaction rate matter was 83.33% on very good category interval 81%-100% [8].

Based on the background, inquiry-based student worksheet is developed to train student's critical thinking skill on chemical equilibrium matter. By training student's critical thinking skill, students are expected to acquire concept well so their learning result can achieve expected standard.

METHOD

Research Goal

The type of this research was developing research and the goal was to develop student worksheet with inquiry-based to train student's critical thinking skill.

Research Design

The research referred to 4-D Thiagarajan model but limited until Develop stage because the developing stage of student worksheet only until limited test stage. The stages were conducted were Define, Design, and Develop stages.

Technique of Data Analysis

Data analysis technique of validation sheet had conducted after student worksheet was reviewed by chemistry lecturer and teacher. The assessment was about criteria of content, language, presentation, graphic, suitability of inquiry learning model, and suitability of critical thinking skill component was used to collect data during developing student worksheet. The assessment of validation sheet was done by two chemistry lecturer and a chemistry teacher.

Result data of validation sheets from validators were analyzed descriptively that included feasibility criteria of inquiry-based student worksheet that was developed corresponded to BNSP's feasibility criteria [9]. The assessment based on Likert scale, shown on Table 1 [10].

Table 1. Likert Scale

Scale	Category
1	Very bad
2	Bad
3	Good enough
4	Good
5	Very good

Calculation used:

$$Percent\ (\%) = \frac{obtained\ score}{maximum\ score} \times 100\%$$

Obtained percentage then converted into category on Table 2.

Table 2. Criteria of Score Interpretation

Percentage	Category
0% - 20%	Very bad
21% - 40%	Bad
41% - 67%	Feasible enough
61% - 80%	Feasible
80% - 100%	Very feasible

Student worksheet is stated theoretically feasible if the obtained percentage was ≥61% on each aspect assessed [10].

After student worksheet is stated theoretically feasible, limited test would conduct to know empirical feasibility based on test result of student's critical thinking skill and student's response. Test result of student's critical thinking skill was assessed based on scoring on each question number that corresponded to critical thinking skills that were trained based on rubric scale of Facione's critical thinking skill [11] shown in Table 3.

Table 3 Scoring Category of Critical Thinking Skill

Score	Category
4	Very good
3	Good
2	Enough
1	Lack

Total score that achieved by student expressed to formula:

$$score = \frac{achieved\ score}{maximum\ score} \times 4$$

Score of student's critical thinking skill then converted into category shown on Table 4 [12].

Table 4. Score Conversion and Learning Achievement Predicate of Skill

Skill	
Average Score	Predicate
3.85 – 4.00	A
3.51 – 3.84	A-
3.18 – 3.50	B+
2.85 – 3.17	B
2.51 – 2.84	B-
2.18 – 2.50	C+
1.85 – 2.17	C
1.51 – 1.84	C-
1.18 – 1.50	D+
1.p00 – 1.17	D

Student worksheet was stated empirically feasible if test score that student achieved was ≥2,51 or achieve B- predicate.

Analysis of student responsewas used to estimate student's response to learning activity using inquiry-based student worksheet. Student response questionnaire contained statements about student's response after learning activity using inquiry-based student worksheet that was stated with "Yes" or "No" and then descriptively analyzed. Each answer would be given score as in Table 5 based on Guttman's scale [13].

Table 5. Criteria of Guttman's Scale

Response	Score
Yes	1
No	0

Calculation used:

$$Percent\ (\%) = \frac{obtained\ score}{maximum\ score} \times 100\%$$

Percentage that was obtained then converted into category as on Table 6.

Table 6. Interpretation Criteria of Likert scale

Average Score (%)	Caegory
0%-20%	Very bad
21%-40%	Bad
41%-60%	Feasible enough
61%-80%	Feasible
81%-100%	Very feasible

Student worksheet is stated empirically feasible if the obtained percentage was ≥61% [10] on each aspect assessed.

RESULT AND DISCUSSION

1. Stage of Developing Product

a. Define

The purpose of this stage was to set and define the learning terms. The stage contained of five steps, namely front-end analysis, learner analysis, task analysis, concept analysis, and specifying instructional objective.

b. Design

There were two steps of this stage, which were to compose and to select format of developed student worksheet, then student worksheet was designed. After both steps were conducted, consultation with advisor was performed to gain advice that would be considered to design inquiry-based student worksheet.

c. Develop

This stage would be generated Inquiry-based student worksheet to train critical thinking skill that revised by reviewers who were two chemistry lecturers and a chemistry teacher. After revised based on reviewers' advices, student worksheet then assessed by validators who were two chemistry lecturers and a chemistry teacher. Student worksheet that was stated as theoretical feasible would test finitely to students.

2. Theoretical Feasibility

Validation results by validators shown on Table 7.

Table 7. Validation Results of Inquiry-based Student Worksheet to Train Critical Thinking Skill

No	Assessed Criteria	Percentage	Category
1	Content	94.07%	Very feasible
2	Language	90.56%	Very feasible
3	Presentation	92.89%	Very feasible
4	Graphic	87.41%	Very feasible
5	Suitability of inquiry learning model	81.33%	Very feasible
6	Suitability of critical thinking skill component	85.00%	Very feasible

a. Content Criteria of Student Worksheet

There were six aspects in content criteria of student worksheet namely suitability of matter on student worksheet with curriculum, relevancy between matter with basic competency and instructional objective, matter contains important concepts, suitability of experimental activity with developed basic competence, suitability of questions on student worksheet with instructional objective and student worksheet is able to develop student's critical thinking skill. Table 7 showed that average percentage of content criteria validation of student worksheet was 94.07% with very feasible category because it was in interval 81%-100% [10]. This shown that student worksheet had conformed feasibility of BNSP's content criteria [9].

b. Language Criteria of Student Worksheet

There were four aspects assessed in criteria of language, namely the using of Bahasa Indonesia and English appropriately, the using of suitability language with students' cognitive, the using of appropriate and easily understood terms, and the using of simple and unambiguous language. Based on Table 7, average percentage of language criteria validation of student worksheet was 90.56% with very feasible category because it was in interval 81%-100% [10]. This shown that student worksheet had conformed feasibility of BNSP's language criteria [9].

c. Presentation Criteria of Student Worksheet

There were six aspects assessed in criteria of presentation namely logic and systematic presentation, able to motivate students, appropriate with student's standard of thinking and reading ability, making student engaged actively in learning activity, and the last was interesting and amuse presentation. Table 7 showed that average percentage of presentation criteria validation of student worksheet was 92.89% with very feasible category because it was in interval 81%-100% [10]. This shown that student worksheet had conformed feasibility of BNSP's presentation criteria [9].

d. Graphical Criteria of Student Worksheet

There were three aspects assessed in graphical criteria of student worksheet, namely Cover presented contents of student worksheet, legible size and form of font, and suitability of illustration or picture with matter. Based on Table 7, average percentage of graphical criteria validation of student worksheet was 87.41% with very feasible category because it was in interval 81%-100% [10]. This shown that student worksheet had conformed feasibility of BNSP's graphical criteria [9].

e. Criteria of Suitability with Inquiry Leaning Model

Student worksheet should reflect inquiry phases. Phases in inquiry are presenting phenomena, formulating

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hypothesis, collecting data, formulating explanation, and reflecting problem [12]. Based on Table 7, average percentage of criteria validation of suitability with inquiry learning model of student worksheet was 81.33% with very feasible category because it was in interval 81%-100% [10]. This shown that student worksheet had been suitable with inquiry learning model.

f. Criteria of Suitability with Critical Thinking Skill Component

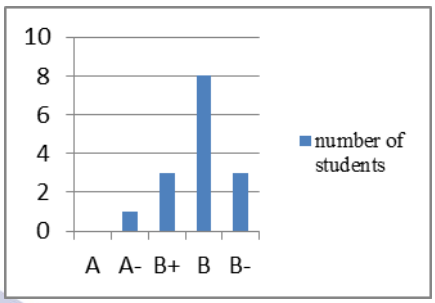
Developed worksheet had purpose to train student's critical thinking skill. There were four critical thinking skill that trained suitable with critical thinking skill component according to Facione, namely interpretation, analysis, inference, and evaluation [5]. Based on Table 7, average percentage of criteria validation of suitability with of critical thinking skill component of student worksheet was 85.00%with very feasible category because it was in interval 81%-100% [10]. This shown that student worksheet had been suitable with critical thinking skill component according to Facione (2011) [5].

Based on percentage on each criterion that had been explained so inquiry-based student worksheet to train student's critical thinking skill on chemical equilibrium matter that developed was theoretically feasible to be used because the percentage on each criterion was ≥ 61%.

3. Empirical Feasibility

a. Student's Critical Thinking Skill

Critical thinking skill test was given to 15 students after learning activity conducted using inquiry-based student worksheet on chemical equilibrium matter. Based on result of student's critical thinking skill test, all students were stated the critical thinking skill passed because the score that achieved was ≥2.51 or achieved B- predicate. Result data of students' critical thinking skill test shown in Picture 1.



Picture 1. Graphic of Students' Predicate Achievement in Critical Thinking Test

b. Student's Response

Empirical feasibility of developed student worksheet was stated also based on student's response t

Based on Table 8, aspect 1 was presentation of worksheet is systematic and logic had percentage 100.00% with very feasible category based on interpretation score of Likert scale [10]. This showed that students were easily understood whole student worksheet because its presentation was systematic and logic. Aspect 2 was presentation of worksheet attracts student's interest. The percentage on this aspect was 93.33% with very feasible category, it meant students were motivated to study student worksheet because its interesting presentation and supported by features on student worksheet. Aspect 3 was suitability with standard of thinking and reading ability obtained percentage 100.00% with very feasible category. It means students were able to understand and comprehend the terms on student worksheet.

Aspect 4 was presentation makes students active which means student worksheet presentation made students engaged actively on learning activity obtained percentage 100.00% with very

feasible category. Developed student worksheet was inquiry-based that made students discover their concepts by themselves and it made students directly engaged in discovery learning and active on learning activity. Aspect 5 was interesting and pleasing presentation of worksheet obtained percentage 93.33% with very feasible category.

Aspect 6 was worksheet used language appropriates to corrected spelling obtained percentage 80.00% with feasible category. The using of suitable language with EYD was also important in order to makes students understood. Aspect 7 was worksheet used language that suitable with cognitive level obtained percentage 86.67% with very feasible category. This means students were able to understand and comprehend each intention of student worksheet because the language that used was suitable with their cognitive level.

Aspect 8 was worksheet used appropriate and easily understood terms obtained percentage 73.33% with feasible category. Aspect 9 student worksheet used simple and unambiguous language obtained 93.33% with very feasible category.

Aspect 10 was worksheet used cover that presented the content of student worksheet obtained percentage 93.33% with very feasible category. Aspect 11 was about legible size and form of font that used in student worksheet obtained percentage 100,00%with very feasible category. Aspect 12 was worksheet used suitable illustration and picture obtained percentage 100,00% with very feasible category. All aspects was related with appearance of student worksheet had very feasible category that means students considered that student worksheet appearance was suitable and not make them had difficulties when understand it.

Based on the result of critical thinking skill test score that achieved score ≥2.51 or achieved at least B-predicate and all the students' response on each aspect of developed student worksheet, students' responses were very feasible and qualified the student worksheet feasibility qualification when obtained percentage ≥61% on each aspect of students' responses questionnaire. In other words, inquiry-based student worksheet to train students' critical thinking skill can be stated empirically feasibility.

CLOSURE

Conclusion

Based on result and discussion of development research of student worksheet with inquiry-based to train student's critical thinking skill on chemical equilibrium matter can be concluded that:

1. Student worksheet can be stated theoretically feasible on criteria of content, language, graphical, presentation, suitability with inquiry learning model, and suitability with critical thinking skill component obtained perentage respectively 94.07%, 90.56%, 92.89%, 87.41%, 81.33%, and 85.00%.
2. Student worksheet can be said empirically feasible because students' score achievement was ≥2.51 or achieved at least B- predicate on critical thinking skill test and percentage of students' response was 92,78% on very feasible category for whole aspects.

Suggestion

Suggestion that can be suggested to next researcher as follows:

1. Research of development of inquiry-based student worksheet to train student's critical thinking skill on chemical equilibrium matter only limited until finite test, so it needs to conduct

implementation on bigger group learning to train students' critical thinking.

2. In view of student's evaluation component of critical thinking skill in good enough category, so the next research should take notice of this component.
3. To the next researcher should take notice of assistance that given and it should be appropriate to student's ability

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