

IMPROVING STUDENTS' CRITICAL THINKING AND CHARACTER SKILL THROUGH CHEMISTRY LECTURE

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ABSTRACT

The aims of this research are to develop learning kit to improve characters and critical thinking skills of students. This research is designed based on research and development model (R & D) and focused on development, and limited trial. Instruments used are validation sheet for lesson plan/Satuan Acara Perkuliahan (SAP), assessment sheet of accomplished SAP, observation sheet of student activity, observation sheet of character skill, observation sheet of self assessment character skill, and questionnaire sheet of students' respon. Validation sheet is analyzed using Likert scale, and the others are analyzed using descriptive method. The results show that learning kit for Stoichiometry in General Chemistry lecture feasible to use and can improve students' critical thinking skill, but not so significant. That is relevant to students' activity record that shows lack of asking activity. Therefore, good characters showed by all students during the lecture.

Keywords: critical thinking, character, chemistry

INTRODUCTION

One of Indonesia's national development mission is to create a nation with great competitiveness. Priority of this mission is increasing human resources quality (RJPN 2005 – 2025). This statement is clarified with others policy below it, such as vision of strategic plan Kementerian Pendidikan Nasional on 2010-2014 are improving professionalism human resources on education and providing learning facility. The strategic goal of Direktorat Jendral Pendidikan Tinggi is provide great quality of high education as required by national development demand. More specific, the goals of strategic plan of Universitas Negeri Surabaya are to improve (1) continuing science and education to create professional educational human resources, (2) elementary and middle school, and (3) high quality learning kit for elementary and middle school (Unesa, 2011). Thus policy headed to great plan to improve human resources to face global competition on 21st century. That could be done by giving high quality learning to Indonesian students to improve their thinking skill.

On the other hand, found the fact how Indonesian students are and what skill that require nowadays. PISA and TIMSS studies shows that education should improve not only routine manual and routine cognitive, but also complex communication and expert thinking skill. The result of this study was known that Indonesian students were lack of expert thinking skill. Five skill measured by TIMSS test are (1) *Understanding Simple Information*, (2) *Understanding Complex Information*, (3) *Theorizing, Analyzing, and Solving Problems*, (4) *Using Tools, Routine Procedures, and Science Processes*, (5) *Investigating the Natural World*. Skills (2), (3), (4), dan (5) are indicator for *expert thinking* and we got low score for thus.

High order thinking skill concept on this paper would refer to 21st century skills concept that have been studied in USA *The Partnership for 21st Century Skills* (P21)

established on 2002 as a coalition that unite society of businessman, educator, and legitimator to study how important *21st century skills* for all student is. That partnership presented a viewpoint for *21st century teaching and learning* and well known as *21st Century Students Outcomes dan Support Systems*. Nowadays, it has been realized that innovation and learning skills give the differences between the *ready to work* student and the other one. Focused on creativity, critical thinking, problem solving, learning strategies, communication, and collaboration are essential subject to prepare students' future.

The low level of thinking skill of Indonesian people did not mean that they have no potential thinking skill. Research result of PSMS Unesa showed that low skill was just happened because they had no occasion to learn it. Habitually, teachers make learning activities based on national exam latticework. As we knew, this latticework was not represented all skills the students should have to graduate (Nur, 2008).

In line with that, a research to train process skill for deaf students have been done (Poedjiastoeti, et.al., 2007; Poedjiastoeti, S., 2008). The result of this research showed that, deaf student could master process skill in chemistry learning by using learning kit and interactive multimedia. Learning kit was designed with writing to learn strategies to accommodate their inability to hear. This learning kit consisted of worksheet to do some experiments. Writing to learn strategies gave opportunity to them for expressing their thought. Interactive multimedia was designed with more visual stimulus and attractive motion. In addition, it contained chemistry daily activities and phenomena to give experience learn from daily life for students. Both of them, learning kit and interactive multimedia, used hand signal language to accomodate students need. Process skill trained was basic process skill, such as observing, measuring, recording data, and applying procedure. at the end of research we knew that they could master process skill and had ability to be trained higher level thinking skill.

By training higher level of thinking skill for students' university, hoped that would result professional educational human resources. Furthermore, they would teach younger generation with good thinking skill, as required. Based on this reason, this research, focused on critical thinking and character skill. The aims of this research is to create learning kit model is that can teach critical thinking an character skill in Stoichiometry topic of General Chemistry Lecture.

METHOD

This research planned based on research and development (R & D) method. The phase of research and development design are preliminary study, development, and limited trial phase (Sukmadinata, 2010). Instruments used are validation sheet for lesson plan/Satuan Acara Perkuliahan (SAP), assessment sheet of accomplished SAP, observation sheet of student activity, observation sheet of character skill, observation sheet of self assessment character skill, and questionare sheet of students' respon. Instruments analyzed using description method. Likert's scale was used for validation sheet, and percentage was used for the others. Table 1 shows the Likert's scale.

Table 1

Score	Criteria
0,0 – 1,0	Poor
1,1 – 2,0	Enough
2,1 – 3,0	Good
3,1 – 4,0	Very good

(Riduwan, 2005)

RESULT AND ANALYSIS

Learning Kit for General Chemistry

Validated syllabus and SAP of Stoichiometry in General Chemistry lecture implemented on real lecture for bachelor degree class of Chemistry Education 2013. Developed learning kit

designed for topic Stoichiometry and referred to main competency: (1) Using ICT in learning process; (2) Mastering base concept in General Chemistry; (3) Designing and doing an experiment; and (4) Responsibility in mastering concept and experiment. Stoichiometry topic elaborated to 4 subtopics, (1) definition of stoichiometry, (2) calculation of stoichiometry, (3) limiting reactant, and (4) percent yield (Glencoe Science Chemistry Matter and Change, 2002; Brady, 2004; and Chang, 2005). First of all, the students learned scientific method and properties of matters.

SAP was planned for three lecture, on the 7th, 8th, and 9th lecture of General Chemistry. On 7th lecture, students studied the definition and calculation of stoichiometry. At the beginning of lecture, they've done the structural task about reaction between vinegar and baking soda based on LKM – 1. Using daily material aimed to related theory on lecture with their life. Students found that there is quantitative relationship between number of reactants and the number of products they got. Therefore, students could identify problem formula, explain the aims, give hypothesis, and determine variables (manipulation, response, and control variable). Given hypothesis tested through experiment. Because of that, student should determine what material needed on their experiment based on the procedural instruction. While experimenting, hoped that students could organize the data they got and followed by good analyzing, so they could give the right conclusion. Through this activity, students' critical thinking and character skill would be trained.

As well on 8th lecture, it began with practical task given on 7th lecture. The aim of the task was to find relationship between calculation of stoichiometry with limiting reactant based on LKM – 3. This activity would stimulate student to improve their process skill. In addition, stoichiometry concepts would be trained using LKM – 2 about definition of stoichiometry, calculation of stoichiometry, and LKM – 4 for limiting reactant, and percent yield. The last lecture, 8th, held test to measure students' comprehension for stoichiometry concepts using critical thinking problems, and psychomotoric skill of using buret.

Result and analyze learning kit consist of: (1) accomplishment of SAP, (2) students' activity on lecture, (3) result study, (4) observed and self-assessment character skill, and (5) students response.

1. Accomplishment of SAP

The SAP developed was designed to improve students' critical thinking and character skill through General Chemistry Lecture on Stoichiometry topic. The validation of learning kit developed showed that it's feasible to use and could be used for testing. While testing, the accomplishment of SAP was observed of two observer. Observation result showed SAP have been done well as written on Table 2. All learning step was done well.

Table 2. The Accomplishment of SAP

Learning step	Lecture 7 th			Lecture 8 th		
	Acc	N-Acc	Score	Acc	N-Acc	Score
Preliminary phase						
1. Opening lecture and doing <i>class setting</i>	√		3	√		3
2. Doing <i>apperception</i>	√		4	√		3,5
3. Motivating student	√		5	√		4
Main phase						
4. Guiding the observation of the result of structural task (experiment)	√		3,5	√		4
5. Guiding discussion of the result of structural task (experiment)	√		1	√		4

6. Giving accentuation for the conclusion of the result of structural task (experiment)	√	3	√	2				
7. Giving information	√	4	√	3				
8. Applying given information	√	3,5	√	2				
9. Guiding students work on team	√	3	√	3,5				
10. Guiding students present their discussion result	√	4	√	4				
Learning step		Lecture 7 th		Lecture 8 th				
		Acc	N-Acc	Score	Acc	N-Acc	Score	
Finishing phase								
11. Guiding students summarize their discussion result	√			2	√			3
12. Giving reinforcement for the best team	√			3	√			3
13. Giving structural task for next lecturer	√			4	√			3

Note: Acc :accomplished N-Acc : not accomplished

Critical thinking skill was trained through *LKM – 2: Stoichiometry Calculation* and *LKM – 4: Determine Limiting Reactant and Percent Yield* that have been done on team, there're 7 teams. Not all of critical thinking component was on thus LKM, it just used the one which are relevant to Stiochiometry topic. They are: 1) interpretation (significant coding), 2) analyzing (analyzing argument), 3) evaluation (evaluating argument), 4) interfering (interfering alternatives and making conclusion), and 4) explanation (explain result). The result of LKM – 4 showed on Table 3.

Table 3. LKM – 4 Determine Limited Reactant and Percent Yield

No.	Critical Thinking Component	Description
A.1	Explanation/ Explain result	Well done by all team, average score 4.4/5
A.3	Interpretation/ Significant coding	Well done by all team, average score 5/5
A.5	Interpretation/ Significant coding	Almost all teams made mistake on it
B.1	Interfering/ Interfering alternative	Some teams gave the wrong answers, just two teams done it well
B.3	Evaluation/ Evaluate argument	Some teams gave right answers along with good argument
C.4	Explanation/ Explain result	Well done by almost all team
C.5	Interpretation/ Making conclusion	Some teams haven't done it yet, so the result could not be analyzed

LKM – 1 :Reaction between Acetic Acid Solution and Baking Soda and *LKM – 3:Reaction between Sodium Carbonat Solution and Plumbum (II) Nitrat Solution* designed to improve students' process skill. Considering that chemistry is science, which is developed from experiments, so chemical experiment was used on this lecture. Because of that, learning and assessment for chemistry should concern science characteristic as a product and process. (Ibrahim, et al, 2010).In addition, students' ability of process skill could be observed through assessment of experiment report. The process skill are formulating problem, making hypothesis,

determining variable, organizing data, and making conclusion. The report sent on *softfile* format to familiarize using ICT for lecture. Generally, their process skill increased in LKM – 3, because they made a reflection in LKM – 1, so they could revise the wrong one. Increasing process skill showed on Table 4.

Table 4. Increasing Students' Process Skill

Process Skill Component	LKM – 1 : <i>Reaction between Acetic acid solution and Baking soda(s)</i>							LKM – 3: <i>Reaction between Sodiumcarbonat solution and Plumbum (II) Nitrat solution</i>						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
Formulating problem	-	√	√	√	-	-	-	√	√	√	√	√	-	-
Making hypothesis	√	√	√	√	√	-	-	-	-	√	√	√	√	-
Determining variable	√	√	√	-	√	-	√	√	√	√	√	√	√	√
Organizing data	√	-	-	-	-	-	-	√	√	√	√	√	√	√
Making conclusion	-	√	-	√	-	-	-	-	√	√	√	-	-	-

Students' character skill improved by doing activities through cooperative learning that focused of being polite, honest, and accurate. Students learned to be polite when discussion was held. They learned to be honest when reporting the result of team discussion and the result of experiment. On other side, they learned to be accurate when solving the problem in LKM.

2. Students' Activity

Students' activity was observed by two observer. It was not a general observation, every observer just observed a team and their member. Figure 1 shows the activity score for 10 students during the lecture.

Based on that, can be stated that students' activity on 7th lecture better that on 8th lecture. On 7th lecture, all students was so active and marked good activeness score (>0.5 of 1.0), but just one students was marked active with activeness score >0.5 of 1.0. Based on observers' note, on lecture 7th all students did a experiment. For addition, on 8th lecture, the team gave presentation. The complete result showed on Figure 1 and Table 5.

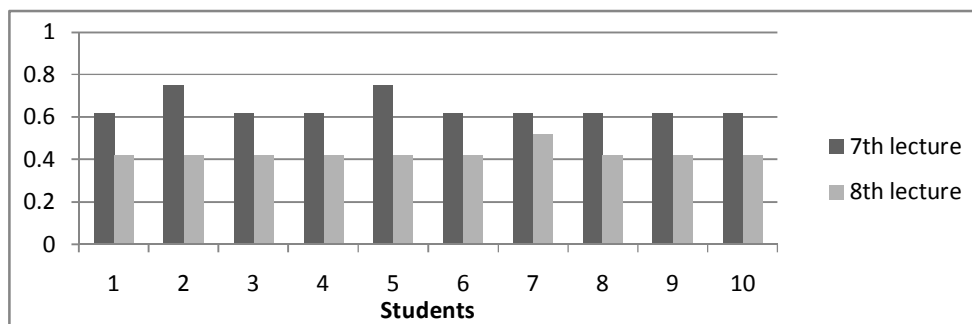


Figure 1. Students' Activity

Based on Table 5 known that the worst is asking activity, both of mutual questioning on preliminary learning and discussion. The students needed more guidance to improve how to communicate the ir idea which is one of process skill components.

Table 5. Students' Activity

No	Activities	%	
		7 th lecture	8 th lecture
1.	Doing mutual questioning about preliminary concept	0	0
2.	Observing the result of structural task	100	100
3.	Doing mutual questioning about structural task	10	10
4.	Aplying concept on given problems	100	100
5.	Discussing on team	100	100
6.	Presenting the result of team discussion	100	0
7.	Doing mutual questioning about the result of team discussion presented	20	0
8.	Doing experiment	100	-

3. Observation and Self-Assesment Character Skill

Character skill of 10 students observed by two observers. Their result would be compared with students' self assessment. Go on Table 6 for complete result.

Generally, while lecturer students showed good character skill, especially for being accurate. All of observed students did the task as it instructed, solving calculation problem based on the steps, and reporting perfectly. But, this good result should be compared with students' result study, both of in example problem and comprehension test.

Students' needed more improving for their honest to communicate their own argument and the habit for raising hand before giving argument. The score for thus two activity was not so good, but it didn't mean that they lack of character. In some cases, found that students' too shy or too afraid to communicate their idea, question, or argument, so they asked the other to do it for them. This habit could be classified as not being honest. This type of students did not have good process skill, considering that communicating skill is one of process skill component. In addition, by doing that, they would classified as unactive students (Lickona and Davidson, 2005 & Facione, 1990).

Table 6 Students' Character Skill

Character Skill Components	(%)	
	7 th lecture	8 th lecture
Honest		
1. Reporting the result study include the references	100	100
2. Reporting the observation result as it found in fact	100	100
3. Communicating their own opinion	60	60
Polite		
1. Being good listener on group discussion	100	100
2. Not cutting off the others word roughly	100	100
3. Raising hand before asking or giving argument	40	20
Accurate		
1. Doing the tasks as it instructed	100	100
2. Solving calculation problem follow the steps	100	100
3. Reporting result of the task correctly as instructed	100	100

4. Students' Result Study

Students' result study consist of: (1) mark of pretest and posttest for stoichiometri comprehension and critical thinking skill, and (2) psychomotoric skill. Based on data, known that students' stoichiometry comprehension was improved. Average rate 18.6 for pretest increase to 56.29 in posttest. Although it significantly increased, but it's not good enough. Because number of students that not passed the standart (grade C, >56 rate) is 19 of 38 students. In depth, 18 students got >55 rate, the highest rate is 89 and the lowest is 39 of 100 rate. It showed

how heterogenous the class is. Pretest and posttest rate analyzed to know students' critical thinking skill on Stoichiometry topic. The result of this analysis showed on Table 6.

Almost all of this critical thinking component showed increasing. It meant this learning kit can improve students' critical thinking skill. For addition, most of students are usual using shortcut steps to solve the stoichiometry calculation problems in pretest, so they got some difficulties to solve it with the right steps. So, it's a homework for next research to make more highlight for preliminary concepts to avoid misconception. Not all of critical thinking skill was trained on this lecture, but only some relevant critical thinking skill. Actually, there are six critical thinking skills and the subtopics included. They are (1) interpretation (classifying, significance coding, clarifying); (2) analyzing (studying ideas, identifying argument), (3) evaluation (evaluating claim, evaluating argument); (4) inferring (questioning proof, looking for alternative, making decision), (5) explanation (giving result, approving procedure, giving argument); and (6) self regulation (studying their self, evaluating her self) (Lai, 2011)

Table 6. Students' Critical Thinking Skill Based on Stoichiometry Comprehension Test

No.		Critical Thinking Component	Score	
Pretest	Posttest		Pretest	Posttest
2 a	1 a	Interpretation/ significance coding	0,97	0,93
2 b	1 b	Interfering/looking for alternatives	0,15	0,75
5	2	Interfering/making conclusion	0,17	0,50
9	5	Interfering/making conclusion	0,05	0,63
11	6	Explanation/explain argument	0,15	0,51
12	8	Interfering/making conclusion	0,04	0,27

5. Students' Response

Through students' response would be known how the student responded during lecturer. It said that most of the command for thinking critically and behaving in good character was received well by the students. Students' critical thinking skill needed more improvement through every lecturer they'll do. Their character skill for being honest, polite, and accurate were good enough and needed more improvement for the others component of character skill. So, it needs to keep integrating character skill in every lecturer.

CONCLUSION

The testing result of developed learning kit showed that it could improve students' critical thinking but not so significant. In line with the the lack of students' asking activity in other hand, students' gave good mark for polite, honest, and accurate character skill.

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