

# THE EFFECT OF LEARNING MODEL CONCEPTUAL CHANGE BASED INSTRUCTION (CCBI) AND GENERATIVE LEARNING MODEL (GLM) AND CRITICAL THINKING SKILLS TO THE LEARNING OUTCOMES OF ACID-BASE

Wiwik Setiawan<sup>1</sup>, Suwirman Nuryadin<sup>2</sup>, Maria Paristiwati<sup>3</sup>

<sup>1</sup>Graduate Student of Chemistry Education, Science Faculty, UNJ, Jakarta, Indonesia.

<sup>2</sup>Lecturer Degree of Chemistry Education, Science Faculty, UNJ, Jakarta, Indonesia.

<sup>3</sup>Lecturer Degree of Chemistry Education, Science Faculty, UNJ, Jakarta, Indonesia.

E-mail : [mengkunegoro78@gmail.com](mailto:mengkunegoro78@gmail.com)

## Abstract

The purpose of this study was to determine effect of learning model Conceptual Change Based Instruction (CCBI) and Generative Learning Model (GLM) and critical thinking skills to the learning outcomes of acid-base. The research was conducted in SMA Bakti Mulya 400 lesson year 2015-2016. In this study were randomly selected sample (cluster random sampling). Data of learning outcomes and critical thinking skills are collected in the form of multiple-choice written test type. Data were analyzed using descriptive statistics and two ways ANOVA. Based on research, it was found. First there is a difference in student learning outcomes significantly between models CCBI with GLM model ( $F = 4.288, p < 0.05$ ), the second there is a difference in student learning outcomes significantly in the group of students with high critical thinking skills among models CCBI with GLM model ( $F = 4.34, p < 0.05$ ), the third there was no difference in student learning outcomes significantly in the group of students who have the ability to think critically low between models CCBI with GLM model ( $F = 0.194, p < 0.05$ ), and the fourth there are significant interaction between the learning model with the ability to think critically ( $F = 5.122, p < 0.05$ ).

**Keywords** : Learning Model, Critical Thinking Skills, Learning Outcomes

## INTRODUCTION

The quality of learning in Indonesia is one of the effect on improving the quality of education. Learning with good quality will improve the overall quality of education. Learning good to be able to explore the potential of students' cognitive, affective and psychomotor aspects of learning activities in the classroom. But the reality on the ground learning that takes still can't dig activity of students in developing the ability or potential students, to explore

the ability to think critically, creatively and innovatively.

Chemistry is a lesson that is still considered difficult by most high school students, not least in SMA BaktiMulya 400 Jakarta. It is a challenge for a chemistry teacher to be able to develop a learning model that is attractive and able to develop critical thinking skills, creativity and innovation of students. Learning in SMA BaktiMulya 400 Jakarta on the reality on the ground is still there the following matters:

1. The use of the lecture method is still dominating, the lecture method was effectively used if it is done at the right time, but this method is less so in digging optimize the role of students in learning, and this method is one-way from the teacher to the student.
2. Teachers are not able to optimize the role of students in the learning process. Students should be given a stimulus beforehand to come up with ideas or creativity in learning.
3. In the learning the student has not actively speak up and answer the question in the discussion process, both in group discussions and class discussions.
4. Students are not able to find connections between learning in the classroom / school with everyday life, but the chemistry is one of the sciences that is loaded will do with the environment in everyday life.
5. The absence of models that are matched to the characteristics of high school students BaktiMulya 400 Jakarta.

Learning Chemistry is basically learning about the concept. The concept is the basis for higher mental processes to formulate principles and generalizations. Formation of the concept of an inductive process, meaning that when students are exposed to environmental stimuli he will abstraction certain characteristics or

attributes equally from the stimulus, while assimilating the concept is a of a deductive process (Ausubel in Dahar, 2011: 62).

In the process of learning often found in schools are still many teachers who convey information in the form of facts from student or just transfer the concept of teachers to students through lecture method alone. Teachers assume students' brains like a book / blank paper ready to written. But the facts say that the brain is not empty when the students will learn in the classroom, but the students' brains have been filled knowledge relating to the subject matter gained from the experience. From that experience, already formed an intuition and the "theory of the students" are not necessarily intuitive and formed the correct theory. This intuition form a preconception that simple to complex, is quite logical, and consistent and difficult to change. Preconceptions brought by the students can be in accordance with the scientific concept / chemist, but not infrequently also different. Preconceptions are wrong or do not conform to the scientific concept generally will last a long time in a student's cognitive structure and would be difficult to be straightened or repaired during the learning process. Preconceptions of different students with the scientific concept is called misconceptions.

The concept of an acid-base is a matters which contain material conceptually

and mathematically also involves knowledge. This subject matters is a material that systematically sequence is from stoichiometry concept and the concept of the solution, so as to understand it needs to know in advance the previous concept. Acid-base concept also requires more work in the laboratory to interpret the concept. This is one being the difficulty of students in studying acid-base material, and allows happen misconceptions.

#### **FORMULATION OF THE PROBLEM**

The problem in this research are:

1. Do overall there are differences in learning outcomes acid-base among the students who follow the teaching learning model Conceptual Change Based Instruction (CCBI) and learning model Generative Learning Model (GLM)?
2. Are there differences in learning outcomes in a group of students with critical thinking skills in height between the learning model Conceptual Change Based Instruction (CCBI) and learning model Generative learning Model (GLM)?
3. Are there differences in learning outcomes in a group of students with critical thinking skills low between learning model Conceptual Change Based Instruction (CCBI) and learning model Generative learning Model (GLM)?

4. Is there an interaction effect between models of learning and critical thinking skills to the learning outcomes of students on the subject of acid-base?

#### **LITERATURE REVIEW**

In helping students as learners (to help the student increase of Reviews their power as learners) and to achieve the scope of the objectives of the curriculum, required learning model that is appropriate to the students' characteristics and the characteristics of the material to be studied are adjusted also with the ultimate goal of learning (Joyce, 2009 : 9). Learning model that will be used to be able to bring the student's ability, active, creative, critical and innovative thinking.

Model-based learning conceptual change (conceptual change based instruction) is one of the effective model to address misconceptions and to improve the understanding of the concept. The conceptual change model (conceptual change) is based on the constructivism learning theory that learning is a process of knowledge construction (Cobern in Kaya, 2011: 515). In the process of learning to constructivism, students should actively develop their knowledge with the help of a teacher. The learning model CCBI is based learning model conceptual change to improve student learning outcomes is done through collaborative learning, this model

can be implemented properly if between students in a collaborative group of mutual actively cooperate in its activities, because the learning success is their responsibility individually and in Group. This model requires six stages in the syntax of learning, namely: 1) commitment to results, 2) exploration of understanding, 3) confrontation understanding, 4) accommodation concept, 5) extension of the concept, and 6) passed.

In rectifying the misconception may be used generative learning model (Generative Learning Model). Generative learning is a learning model that emphasizes the integration of active new knowledge by using prior knowledge of students before (Osborn and Wittrock in Dahar (2011: 13). The new knowledge that will be tested in a way to use it in addressing problems or symptoms concerned. If the new knowledge to successfully answer the problems encountered, then new knowledge that will be stored in long term memory. The foundation of theoretical and empirical generative learning has a theoretical base rooted in theories of learning constructivist about teaching and learning. If teachers work to improve conception chemistry student, it must be acknowledged that there are conditions: 1) .siswa come to class with their own ideas, 2) these ideas are often different from the scientists, 3) misunderstanding / misconceptions will be

strong in the cognitive structure of students and resistance to change, and 4) traditional learning methods sometimes can not alter the state of these misconceptions (Udogu and Njelita, 2010: 219).

Based on theoretical studies and theoretical framework above, then the hypothesis is:

1. The results of students' overall learning model Conceptual Change Based Instruction (CCBI) was higher than the model Generative Learning Model (GLM).
2. The results of the study group of students with critical thinking skills high on the learning model Conceptual Change Based Instruction (CCBI) was higher than the model Generative Learning Model (GLM).
3. The results of the study group of students with the ability to think critically low on the learning model Generative Learning Model (GLM) is higher than the application of the model Conceptual Change Based Instruction (CCBI).
4. There is the influence of the interaction between the learning model with the ability to think critically about the learning outcomes of the students on the subject of acid-base.

#### **RESEARCH PURPOSES**

The purpose of this study was to determine:

1. The difference between the learning outcomes of students who take the

learning to the learning model Conceptual Change Based Instruction (CCBI) and learning model Generative Learning Model (GLM)

2. The difference in learning outcomes in a group of students with critical thinking skills in height between the learning model Conceptual Change Based Instruction (CCBI) and learning model Generative Learning Model (GLM)
3. The difference in learning outcomes in a group of students with the ability to think critically low between learning model Conceptual Change Based Instruction (CCBI) and learning model Generative Learning Model (GLM)
4. The effect of the interaction between the learning model and the critical thinking skills to the learning

outcomes of students on the subject of acid-base.

## RESEARCH METHODS

The method used is an experimental method by design Posttest-Only Design, this study used two experimental classes, one class using model Conceptual Change Based Instruction (CCBI) and the other class using model Generative Learning Model (GLM), before learning begins, both classes are given tests of critical thinking skills, to classify students into groups with the critical thinking skills of high and low. After learning activity is completed, it is given achievement test to measure the impact of the model given in the cognitive.

The design study is the treatment by the level of 2 x 2. The schematic design of the study are presented in Table 1.

Table 1. The Research Design Factorial of 2x2

| Critical Thinking Skills (B) | Models of Learning (A)        |                               |
|------------------------------|-------------------------------|-------------------------------|
|                              | CCBI (A <sub>1</sub> )        | GLM (A <sub>2</sub> )         |
| High (B <sub>1</sub> )       | A <sub>1</sub> B <sub>1</sub> | A <sub>2</sub> B <sub>1</sub> |
| Low (B <sub>2</sub> )        | A <sub>1</sub> B <sub>2</sub> | A <sub>2</sub> B <sub>2</sub> |

Information :

A<sub>1</sub>B<sub>1</sub> = learning outcomes of students who use the model CCBI in students with high critical thinking skills.

A<sub>2</sub>B<sub>1</sub> = Results of student learning using GLM model on students with critical thinking skills high.

A<sub>1</sub>B<sub>2</sub> = learning outcomes of students who use the model CCBI the students with the ability to think critically low.

A<sub>2</sub>B<sub>2</sub> = learning outcomes students using GLM model on students with the ability to think critically low.

The population in this study were students of class XI MIA SMA BaktiMulya 400 in the academic year 2015-2016. The sampling technique used cluster random

sampling. The sample selected is a class XI MIA 1 given learning models of CCBI and class XI MIA 2 given learning model GLM.

Data collection technique used: 1) the test instrument to measure critical thinking skills, 2) test instruments for assessing student learning outcomes in cognitive domain in acid-base material. While data analysis technique consists of analysis test prerequisite (test for normality and homogeneity), and hypothesis testing using 2-way ANOVA, aided IBM SPSS version 23 software.

## RESULTS AND DISCUSSION

The data collected in this study include the value of critical thinking skills, the value of student learning outcomes acid-base materials in the cognitive domain. Results summary of the research data are shown in the following Table 2:

Table 2. Summary Data Research

| Models<br>CTS          | CCBI (A <sub>1</sub> )   | GLM (A <sub>2</sub> )  |
|------------------------|--|--|
| High (B <sub>1</sub> ) | N = 10<br>$\bar{X}$ = 91,67<br>SD = 6,52573<br>S <sup>2</sup> = 42,585<br>Min = 76,67<br>Max = 96,67   | N = 10<br>$\bar{X}$ = 76,67<br>SD = 12,5700<br>S <sup>2</sup> = 158,005<br>Min = 56,67<br>Max = 90,00  |
| Low (B <sub>2</sub> )  | N = 10<br>$\bar{X}$ = 62,67<br>SD = 12,64911<br>S <sup>2</sup> = 160,000<br>Min = 46,67<br>Max = 76,67 | N = 10<br>$\bar{X}$ = 63,34<br>SD = 10,88526<br>S <sup>2</sup> = 118,489<br>Min = 46,67<br>Max = 83,33 |

### Hypothesis testing

Before being given treatment in the form of learning with models CCBI (experimental group I) and GLM model (experimental class II), the first given tests critical thinking skills that are taken from a book called Critical Thinking Sukses written by Laurent Starkey, to determine the students' thinking skills. Students with grades above average classed have the ability to think critically high, while below average classed have the ability think critically low.

Test the hypothesis preceded by the analysis prerequisite test, normality test and

homogeneity test. The aim of this test to see whether the data were normally distributed and homogeneous or not. Normality Test methods Kolmogorof-Smirnov test and the homogeneity test is a Levene's with a significance level of 5% or 0.05. Based on normality test and homogeneity test, showed that the 5% significance level of student learning outcome data were normally distributed and homogeneous, so that hypothesis testing with 2-way ANOVA can be carried out, followed by a further test of Tukey. 2-way ANOVA test results are shown in the following Table 3:

Table 3. Summary of Hypothesis Testing (results of 2-way ANOVA)

| statistical hypothesis   | Significance ( <i>sig.</i> ) | $\alpha$ | Decision       | Conclusion   |
|--|------------------------------|----------|----------------|--|
| $H_0 : \mu A_1 = \mu A_2$<br>$H_1 : \mu A_1 > \mu A_2$                 | 0,046                        | 0,05     | $H_0$ rejected | Student learning outcomes in the acid-base materials using models CCBI higher than GLM model   |
| $H_0 : \mu A_1 B_1 = \mu A_2 B_1$<br>$H_1 : \mu A_1 B_1 > \mu A_2 B_1$ | 0,021                        | 0,05     | $H_0$ rejected | Acid-base learning outcomes in a group of students with high critical thinking skills that use the model CCBI higher than GLM model.       |
| $H_0 : \mu A_2 B_2 = \mu A_1 B_2$<br>$H_1 : \mu A_2 B_2 > \mu A_1 B_2$ | 0,990                        | 0,05     | $H_0$ accepted | Acid-base learning outcomes in the group of students with the ability to think critically low using a model similar to the model GLM CCBI. |
| $H_0 : \text{Int A X B} = 0$<br>$H_1 : \text{Int A X B} \neq 0$        | 0,030                        | 0,05     | $H_0$ rejected | There is a significant interaction effect between critical thinking skills by learning model   |

## Discussion

### 1. First Hypothesis

From the statistical hypothesis test results obtained F count: 4.28, if corrected with F table with a significance level of 5% (0.05), obtained F table (1, 36) = 4.11, then the F count > F table and sig. 0,046 figures show that less than 0.05, which means that  $H_0$  is rejected. Based on the results of the statistical test showed differences in acid-base learning outcomes significantly between students who take the CCBI learning model and GLM. Models CCBI and GLM models are both that focuses on a conceptual change of students who have misconceptions, so that misconceptions students be dropped even disappear into the correct concept according to scientific concepts.

Some of the differences between the CCBI models and GLM is the model of CCBI students work collaboratively in an effort to change the concept (conceptual change). Collaborative learning is learning that engages students in a group seen as a process, this study looked at the students have been able to work socially in the group that without the help of teachers, students in the group were able to take their respective roles in obtaining the correct concept is based on the steps in CCBI, besides the collaborative learning students already have autonomy in determining the members of the group, without having to be established by the teacher. Changes conceptually arising from the discussion and dialogue between students in the group, each student is given an equal opportunity to express their opinions, so that raises conceptual

confrontation, both among students and among groups in the classroom. An interesting discussion among the students in the group and between groups raises a lively atmosphere in the classroom, learning of this kind is well-liked student. Conceptual confrontation also occurred between preconception students with the scientific concept of experimental results.

GLM model focuses on working cooperatively, in the cooperative learning, students must first be given an explanation of social skills (group work) because students are unfamiliar or not yet proficient in the working group. Cooperative learning is still involve teachers in providing guidance / assistance in designing activities do students in the group. Independence in GLM model has yet to be seen, especially in the working group. Teachers still play a role in directing the discussion among the group in the classroom, so that the involvement of teachers is still there, albeit slightly.

New scientific knowledge of the results of the learning process with CCBI models will be able to remember for a long time because of the activities of students in changing the concept of independence takes place directly and become a meaningful experience for students who have the ability to think critically high, or low. Unlike the CCBI, in the GLM learning model changes occur based on the concept that direct experience of the students, but the students'

independence has not been actualized, because there is still a bit of help from the teachers. It is for students who have high critical thinking skills are less attractive, but will appeal to students who have the ability to think critically low. The big difference between the characteristics of the implementation of learning collaborative and cooperative learning is what makes the difference between the acid-base learning outcomes of students who use the model CCBI (collaborative learning) with GLM model (cooperative learning).

## 2. Second Hypothesis

From the results of statistical test result the average difference in learning outcomes acid-base students who have high critical thinking skills among groups of students by learning model CCBI ( $A_1B_1$ ) and a group of students who were given a lesson by GLM model ( $A_2B_1$ ) ie 14.99 with sig.0,02 less than 5% (0.05), meaning that  $H_0$  is rejected, it shows there are significant differences between the groups  $A_1B_1$  with  $A_2B_1$ . Students with high critical thinking skills with the ability to analyze, logic, reasoning and making conclusions from the events or activities. The learning process with a model CCBI requires students to work independently in obtaining the correct concept of the process of changing the concept of the wrong (misconceptions), students with critical thinking skills high will be in accordance with this learning process, because without the help of the

teacher, the student is able to analyze the problem that is, reason and logic to deduce the outcome of its processes. Theoretically CCBI learning model provides an opportunity for students to construct new knowledge through the process of assimilation and accommodation, this process will produce acid-base learning outcomes are organized. The process of assimilation and accommodation (equating new information with prior knowledge of the students) performed by students with high critical thinking ability will be maximized because these students have the analytical skills, logic, reasoning and making inferences higher with collaborative learning process.

While the implementation of the GLM model, the role of teachers is still there in giving direction or determining the activity of the student. Students with high critical thinking skills expected to be less than optimal in learning with GLM model, because the actualization of the students' critical thinking is not well established in the process of GLM. Students with critical thinking skills generally are students who like to be a challenge, like the self-learning, where students will be able to analyze, manage and conclude that student learning outcomes do significantly. Students with high critical thinking skills also prefer learning more emphasis on the process of exploring the ability of independently according to his ability, without help from

the outside, so it is very appropriate when using a model of CCBI. Meanwhile, if students with high critical thinking skills using GLM model, then the actualization time is reduced to help students with the ability to think critically low. This is why there are significant differences between the learning outcomes of both acids and bases, was also apparent in the average value of a larger  $A_2B_1$  group of  $A_1B_1$ .

### 3. Third Hypothesis

The third hypothesis test showed the results of the average difference in learning outcomes of students who have the ability to think critically low among groups of students by learning model CCBI ( $A_1B_2$ ) and a group of students who were given a lesson by GLM model ( $A_2B_2$ ) of 0.66 with sig.0,99 greater than 5% (0.05), meaning that  $H_0$  is accepted. From this statistical test results showed no significant difference between the groups  $A_1B_2$  with  $A_2B_2$ , although the average  $A_2B_2$  value is higher than the group  $A_1B_2$  ie  $63.34 > 62.67$ , but still the difference was not significant.

Some of the things that led to this difference is the characteristics of the implementation of the learning model CCBI, which focuses on students' independence in the process of changing the concept, so that students with the ability to think critically low will have difficulties in the implementation process of experimentation, as well as discussion groups and classes, difficulty in expressing

ideas they each have no experience of actively thinking, creative and innovative in collaborative group work, which is why the average value learning results are not much different from that given student learning by GLM model.

While the implementation of the GLM model students with the ability to think critically low more comfortable learning in the learning process because they are given guidance / assistance of the teacher, so that in the process of changing the concept is more optimal. The role of the teacher as a facilitator would be perceived help especially in the group of students with the ability to think critically low given GLM learning, it also resulted in the average value of learning outcomes match the value of student learning outcomes in groups of CCBI.

Another thing that can be identified as the cause of the third hypothesis is rejected, because of possible achievement test given have not been able to distinguish the ability of students conceptually between the CCBI by GLM on students with the ability to think critically low, especially on the level of difficulty of questions and distinguishing matter. Taking the value of learning outcomes is only done once can be an influence in the absence of a significant difference between the results of the study group  $A_1B_2$  with  $A_2B_2$ .

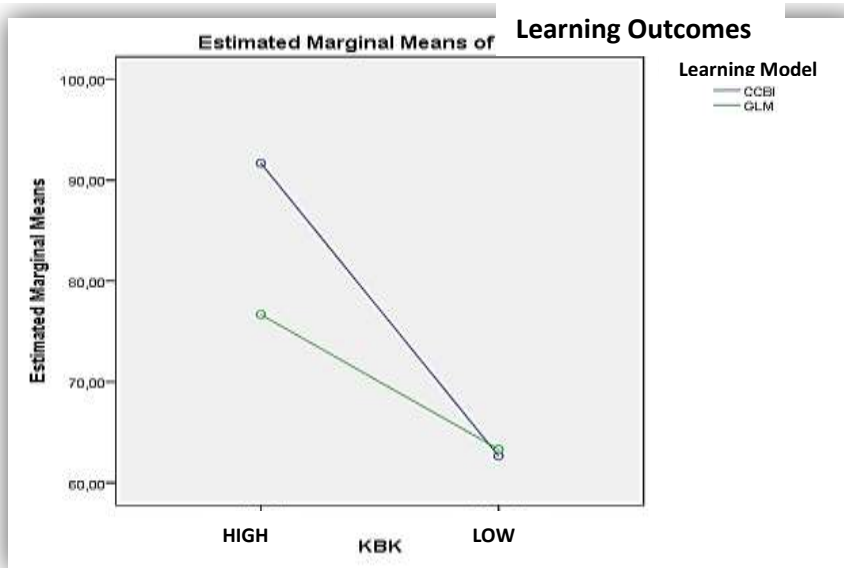
#### 4. Fourth Hypothesis

The test results for the fourth hypothesis statistics indicate that the magnitude of F count CTS \* learning model worth 5.12 greater than F table (4.33) and sig. 0.03 is less than 0.05, meaning that  $H_0$  is rejected. From these results we can conclude there is a significant interaction effect between learning model with critical thinking skills. Learning to use CCBI and GLM models both an emphasis on small group work of 4-5 people per group, conceptually change would be maximized if done by working in groups. their active interaction between group members pose a learning environment that supports the achievement of learning goals, namely a change in the concept of misconceptions into scientific concepts.

The learning model CCBI is constituted with collaborative learning and GLM model that is based on the cooperative learning requires student activity maximum in the working in groups, such as the process of communication, dialogue, exchanging ideas, arguing with each other, help each other with the purpose to achieve the correct concept. Students with high critical berikir capability will be able to help students with low critical thinking skills to understand a new concept, so that students with the ability to think critically low is not low self-esteem. Things like this one that causes an interaction between the learning model with critical thinking skills.

The ability of students to analyze, the ability of logic, reasoning and conclude a positive impact on the problems of a given model of learning, students are capable of critical thinking differently will achieve maximum learning results by using a learning model that relies on the active

activities of their students. The interaction between the learning model with the ability to think critically have an effect on learning outcomes acid base class XI MIA. The existence of these interactions can be seen also in the picture below:



Picture 1. Interaction Critical Thinking Skills with the Learning Model.

The above picture shows the interaction, seen from the intersection between the two lines on the graph. The above graph shows that the group of students with critical thinking skills high on the lessons to the model CCBI has an average value of learning outcomes are higher compared to using GLM model, while the students who have the ability to think critically low, a group of students who use GLM learning model has an average value of learning outcomes acid-base higher than in the group of students who use CCBI models, although the difference is not too high.

## CONCLUSION

Based on the research that has been done, then a number of conclusions as follows: 1) Conceptual Change Learning Model Based Instruction (CCBI) both used to address misconceptions in the chemistry subject matter of acid-base. CCBI learning model implemented with collaborative group work that give students the chance to change the misconceptions (misconceptions) towards scientific concepts through experience that they do independently. 2) learning model Conceptual Change Based Instruction (CCBI) is highly appropriate to the students who have the ability to think critically high.

This is because students are more likely to be active and fun with learning which demands independence in learning. These students are able to interact socially in the working group, able to explore ideas and ideas openly to the group members and students in a class, so that the learning model CCBI generate an average of better learning outcomes. 3) The learning model CCBI and GLM can be used on students with the ability to think critically low, this is because there is no significant difference between student learning outcomes GLM and CCBI group on students with the ability to think critically low. 4) There is an interaction effect between models of learning and critical thinking skills to the learning outcomes of students on the subject of acid-base. Model of learning and thinking skills have influence on learning outcomes acids and bases. Students with high critical thinking skills will be higher if

the value of learning outcomes using a learning model that demands a lot of activities that explore the ability of reasoning, logic, mathematical ability and the ability to make conclusions.

## REFERENCES

- Dahar, Ratna Wilis. (2011). *“Theory of Learning”*. Jakarta : Erlangga.
- Joyce, Bruce R. (2009). *“Models of Teaching”*. Jakarta : Pustaka Pelajar.
- Kaya, Ebru., Geban, Omer. (2011). *“The Effect of Conceptual Change Based Instruction on Students ‘ Attitudes Toward Chemistry”*. ScienceDirect Journal, <http://www.sciencedirect.com>, (accessed August 31, 2015).
- Starkey, Lauren. (2010). *“Critical Thinking Skills Success”*. Jogjakarta : Bookmarks.
- Udogu, Njelita. (2010) *“Effect Constructivist-Based Instructional Model on Students’ Conceptual Change and Retention on Some Difficult Concepts in Chemistry”*. African Journals Online, <http://www.ajol.info>, 2010. (accessed August 31, 2015).