

APPLICATION OF HYPOTHESIS DEDUCTIVE CYCLE LEARNING MODEL IN THE MATTER OF CHEMICAL EQUILIBRIUM TO IMPROVE CRITICAL THINKING SKILLS STUDENT HIGH SCHOOL

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ABSTRACT: This experimental research aims to improve the mastery of the concept of chemical equilibrium and critical thinking skills students high school Pasarwajo. Samples purposively taking two classes, one class as class experiments using hypothetical deductive cycle learning model, and the control class using direct learning model. This study uses a pretest-posttest control group design. the results obtained: (1) increased mastery of concepts and critical thinking skills of students in chemical equilibrium material hypothetical deductive cycle learning model better than students who take the direct learning model. It can be seen from the average normalized gain mastery of concepts and critical thinking skills to students experimental class of 77% increase in high-quality category, while the average normalized gain mastery of concepts for grade control of 48.74% with a moderate increase in the quality category;(2) increased mastery of the concept of state of equilibrium, the equilibrium shifts, and the equilibrium constant on students who take the hypothetical deductive cycle learning model is better than the students who take the direct learning model;(3) Improved critical thinking skills of students who take the hypothesis deductive cycle learning model for the indicator: determining decisions based on reason; determining a decision based on a result; uses logic strategy; conduct and consider induction; conduct and consider the deduction; identifying phrase the question; create a form definition, all increasing better than students who take the direct learning model;(4) increased mastery of concepts and critical thinking skills of students who take the hypothesis deductive cycle learning model significantly better than the students who take the direct learning model. The results of t-test showed significant differences at the 0.05 significance level.

Keywords: hypothetical deductive cycle learning model, critical thinking skills.

1. INTRODUCTION

Chemistry is the science that is closely related to science and nature, and therefore chemistry is also referred to as the central contact with nature even though not directly. Various materials related to natural phenomena in chemical subjects. One such material is a chemical equilibrium. Chemical equilibrium is a circumstances where the concentration of all ingredients are no longer subject to change, because the substances on the right to form and dissolve back at the same speed. Studying the chemical equilibrium is not difficult but must have a very high accuracy, it is certainly in need of critical thinking skills.

The above explanation indicates the importance of chemistry students master the material taught in schools completely. The role of the teacher in the learning process is essential. Selection of the approach or model of learning that suits the character of the subject matter and character of students would be effective to achieve the learning objectives. Therefore, teachers must be keen in choosing and determining the learning models used, so that the implementation of learning can be run effectively and efficiently.

Based on the analysis of the results of studying chemistry 2012/2013 academic year on the subject of chemical equilibrium is divided into two phases replay showed that of the 28 high school students of class XI Natural Sciences Pasarwajo sampled, with a minimum completeness criteria 70, there are 10 students or 35, 71% who have not reached the minimum completeness. It can be concluded that the learning outcomes of chemical equilibrium high school students of class XI Natural Sciences Pasarwajo yet both classically and individually.

The results also showed observation packaging science learning in elementary school to high for critical thinking skills and science learning outcomes have not been systematically addressed. Less creative teachers to create the conditions that lead students to be able to integrate the experience of daily life with the knowledge gained in the classroom. Learning that teachers tend to be regularity activity centered on the teacher. Follow-learning is allegedly as a barrier to the achievement of critical thinking skills. As a result, the achievement of the essential objectives of science education failure. It also occurs in high school students Pasarwajo.

Application of learning models of effective and efficient will escort students to play an active role in the learning process, and students can absorb the knowledge they have acquired well. Learning effective and efficient stressed that the knowledge learned should be done by the students, while the teacher only as a companion. This is in line with the philosophy of constructivism, that knowledge is formed (construction) students themselves who are learning (Suparno, 2001). Knowledge formed by itself should bring encouragement to look for or find new experiences. The role of a teacher or educator in a stream of constructivism is as a facilitator or moderator. Its task is to stimulate, helping students to want to learn themselves, and formulate your understanding. According to Martin (2005) with constructivism foundation, students will be able to improve the skills of critical thinking and problem solving.

Learning cycle model first developed by Robert Karplus of the University of California, Barkley 1970. Karplus identify the three phases used in this model are preliminary exploration,

invention, and discovery. In connection with the three phases of the learning cycle, Barman and Tolman use the term exploration, concept introduction, and concept application. Abruscato use the term exploration, acquisition concept, and concept application. While Marek use the term exploration, term introduction, and concept application. Although referred to by different terms, but basically have the same meaning. In fact, learning cycle model which consists of three phases were further developed and specified back so comes the learning cycle model which includes five phases: engagement, exploration, explanation, elaboration, and evaluation (Dasna, 2004).

Learning cycle is a form of student-centered learning (Budiasih, 2004). Learning cycle model can encourage students actively involved in processes such as science experiments, using instruments, observing, measuring, collecting data, conclude, and so forth. Learning cycle is a series of stages of activities (phase) is organized such that students can master the competencies that must be achieved in learning to play an active role.

Deductive learning cycle hypothesis calls for the assessment (explanation) some phenomena. Measures that might be done with creative conceptions or misconceptions by generating arguments, disequilibrium (imbalance), and data analysis to solve the problem (conflict). Thus the hypothesis deductive learning cycle calls for the creation and testing of real various hypotheses to explain the phenomenon. It was expected to appear the question of causation, and the student must submit various hypotheses. Furthermore, this hypothesis should be tested through a deduction against the consequences of prediction and experiment. This can help students to be able to initiate and skilled critical thinking.

Hypothesis learning issues is the use of the learning cycle right gives opportunity for the students to give a conception beforehand and the chance to debate and examine this conception thus not only making headway in the conceptual knowledge of students, but also raise awareness and ability to use patterns of reasoning involved in the formation and testing of conceptual knowledge (Yusrin, 2013).

Learning cycle consists of three phases of the exploration phase, the phase of concept introduction and concept application phase. In a simple learning cycle model can be described as follows.

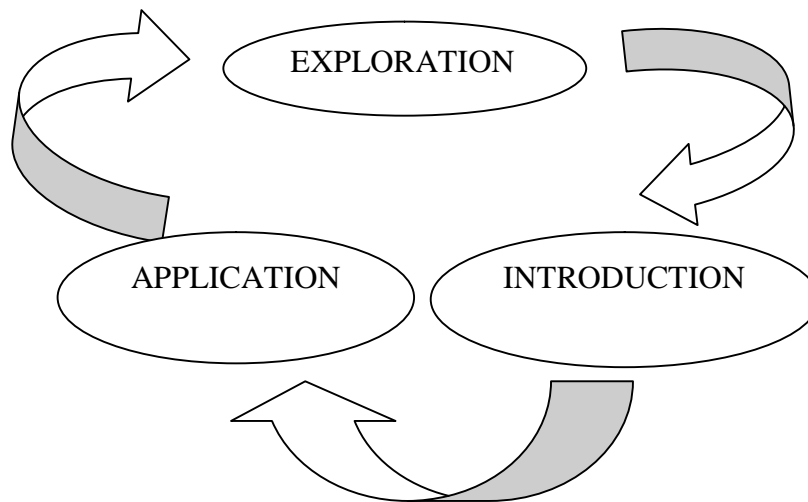


Figure 1 Learning Cycle Model

One would have expected when students have an active role in the learning process is the increasing mastery of concepts and critical thinking skills of the student. Critical thinking someone is not innate, and can not grow by itself, but must be with the process of learning and training. Critical thinking can be easily obtained if a person has the motivation or inclination and skills are perceived as the nature and characteristics of critical thinkers. In addition, critical thinking can also be influenced by emotional factors that viewed a decision by way of skepticism.

Critical thinking is reflective thinking that is focused students to decide what to do. Critical thinking skills include the ability to explain, identify the main argument, showing their similarities and differences, draw conclusions, logically deduce, evaluate based on facts and choosing the right strategy. Nazir research results (2010) that the critical thinking plays an important role in education, and is the object of study, research should focus on the discovery of the most effective learning methods for its development. Hofreiter, Monroe, and Stein (2007) in his research states that critical thinking can be improved by learning which involves discussions and assignments that are linked together. Thomas (2011) states that Provides ideas of the skills the students need to develop and how we can integrate the students' understanding of Reviews those skills with Reviews their learning in the classroom and through Reviews their first-year assignments and activities.

According to Ennis (1996) there are six basic elements of critical thinking, namely: Focus, Reason, Inference, Situation, Clarity, and Overview. These six basic elements are described in 5 aspects of critical thinking skills, namely (1) elementary clarification; (2) basic support; (3)

inferring; (4) advanced clarification; (5) strategies and tactics. Meanwhile, Garrison, Anderson, and Archer (2000) divides the four phases of critical thinking, namely: (1) Trigger event, namely to identify or recognize an issue, a problem, a dilemma of one's experience, spoken instructor or another student, (2) Exploration, thought of the idea of personal and social in order to make preparation for the decision, (3) Integration, which is constructing a purpose / meaning of the idea and integrate relevant information that has been set in the previous stage, and (4) Resolution, which proposed a solution directly to the issue, dilemma or problem and to test ideas and hypotheses.

2. RESEARCH METHODS

This study is an experimental research. The population in this research all students high school Pasarwajo the academic year 2013/2014. Purposive sample was taken two classes of fifth grade there.

There are two variables that are used, the dependent variable is the mastery of concepts and critical thinking skills,, and the independent variable is the hypothetical deductive learning cycle model and learning model directly in the learning materials in chemical equilibrium.

Experimental design used in this study is a pretest-posttest control group design, which can be seen in Table 1 below.

Table 1 Design Research

Class	Test Early	Treatment	Tests Final
Eksperiment	T_{E-1}	X	T_{E-2}
Control	T_{K-1}	Y	T_{K-2}

Information :

$T_{(E-1)}$ = Initial tests on an experimental class

$T_{(K-1)}$ = Initial tests on the control class

$T_{(E-2)}$ = Tests of the experimental class

$T_{(K-2)}$ = the final Test at the control class

X = hypothetical deductive learning cycle model

Y = a direct learning model

(Modification of Issac and Michael, 1971)

3. RESULTS

a. Description Mastery of Concepts and Critical Thinking Skills

The material of chemical equilibrium in this study consisted of fourteen label concept, namely: Chemical equilibrium, Shifting Equilibrium, Principle le Chatelier, concentration, temperature, volume, pressure, equilibrium dynamic equilibrium Homogeneous, Equilibrium of Heterogeneous, equilibrium constant, equilibrium constant concentration (K_c), equilibrium constant gas pressure (K_p), the relationship between K_c and K_p .

In order for the delivery of the concepts may be more structured and simplify the data analysis, the fourteenth label these concepts are classified into 3 sub subject. All three sub-issues are: (1) The state of equilibrium, (2) shift the equilibrium, (3) equilibrium constant. Where the subject of the third sub includes three indicators of mastery of concepts, namely: The state of equilibrium chemical equations are analyzed, the concentration of one component changes in practice to determine its effect on the number of equilibrium, equilibrium law is evidenced by the calculation to find the value of the equilibrium constant.

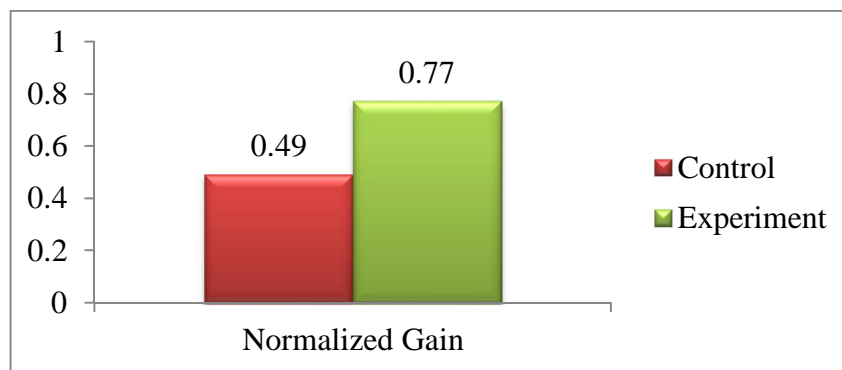


Figure 2. Comparison of the mean increasing mastery of concepts and skills critical thinking experiment class and control class

Furthermore, analysis of data on the experimental class and control class, sub subject of a state of equilibrium is obtained normalized gain as in figure 3.

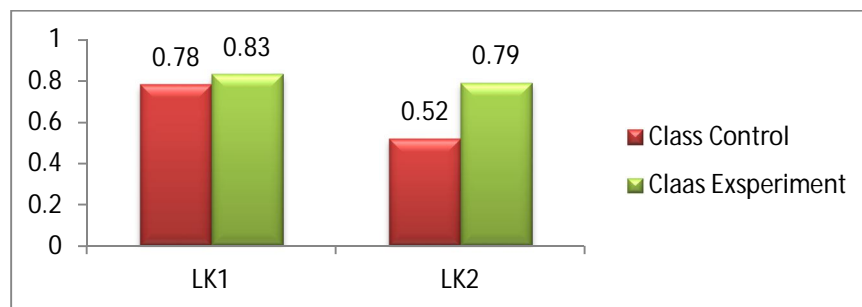


Figure 3. Comparison of the average gain is normalized label on the concept of sub staple discussion of the state of equilibrium

Description: LK1= homogeneous equilibrium; LK= dynamic equilibrium

Analysis of the data on the experiment class and control class, sub subject of equilibrium shifts obtained normalized gain as in Figure 4.

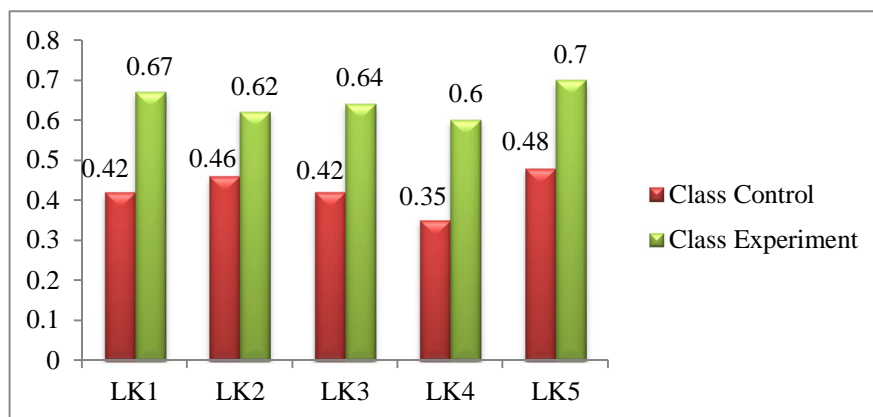


Figure 4. Comparison of the average gain is normalized label on the concept of sub staple discussion equilibrium shifts

Description: LK1= Le Chatelier's Principle; LK2 = Concentration; LK3 = Temperature; LK4 = Volume; LK5 = Pressure

Analysis of the data on the experiment class and control class, sub subject of equilibrium constants obtained normalized gain as in Figure 5.

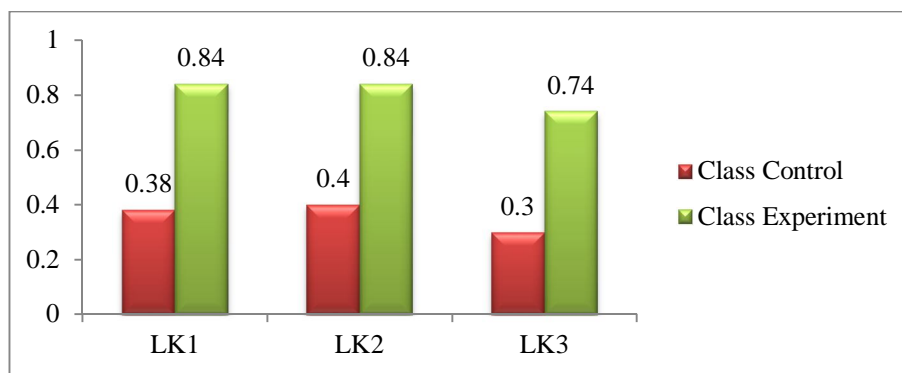


Figure 5. Comparison of normalized average gain in the sub label concept principal the equilibrium constant discussion.

Description: LK1 = equilibrium constant concentration; LK2 = Defined The equilibrium partial pressure of gas; LK3: The relationship between the price of K_c and K_p

Furthermore, the increase in critical thinking skills students experiment class and control class judged on the answers pretest and posttest students. Indicators of students' critical thinking skills examined included: 1) determining decisions based on reason; 2) determine a decision based on a result; 3) using the logic of the strategy; 4) conduct and consider induction; 5) conduct and consider the deduction; 6) identifying sentence question; 7) create a form definition. Data analysis and the experimental group obtained a mean gain control class to be normalized as in Figure 6

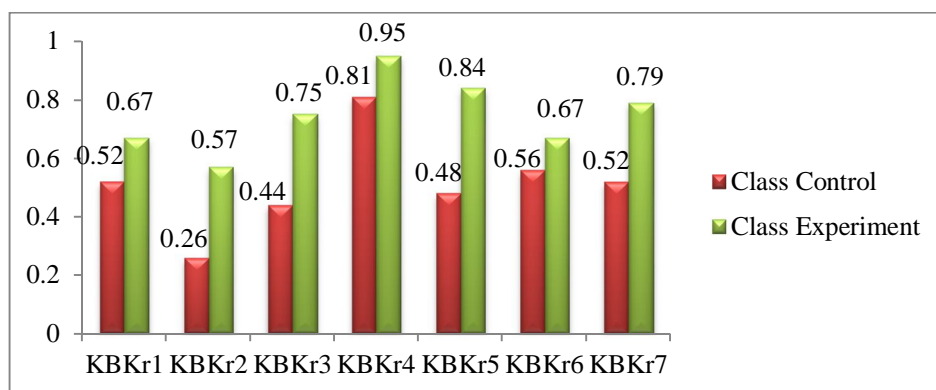


Figure 6. Comparison of the mean scores of students' critical thinking skills indicators between the control class and experimental class

Description: KBKr1 = determining decisions based on reason; KBKr2 = determining a decision based on the result; KBKr3 = using logic strategy; KBKr4 = doing and consider induction; KBKr5: conduct and consider the deduction; KBKr6 = identifying sentence question; KBKr7 = create a form definition

b. Parametric Test Mastery of Concepts and Critical Thinking Skills

Different test (t) data of the pretest, posttest and gain normalized mastery of concepts and critical thinking skills in the subject matter of chemical equilibrium graders experimental and control classes in full can be found in appendix 19, and briefly the results of different test (t) pretest, posttest and the gain normalized experimental class and control class can be seen in Table 2.

Table 2. Results of different test (t) pretest, posttest and normalized Gain experiment class and control class

Data were tested	t_h	t_{table}
Pretest	1,116	1,671
Posttest	11,23	1,671
Normalized Gain	11,13	1,671

Information *) $\alpha = 0,05$

Based on the test results on the attachment 19, the statistical test average of the results of the pretest mastery of concepts and critical thinking skills of students showed no significant difference between prior knowledge grade students experiment with the control class based on the value $t_h = 1,116$ smaller than $t_{table} = 1,671$ at $\alpha = 0, 05$.

While the statistical test result mean posttest mastery of concepts and critical thinking skills of students showed no significant difference between the students after receiving study with the hypothesis deductive learning cycle model compared with the direct learning model based on the value of $t_h = 11,23$ is greater than $t_{table} = 1,671$ at $\alpha = 0.05$.

Statistical test normalized average gain mastery of concepts and critical thinking skills of students showed a significant difference between the students after receiving the learning hypothesis deductive learning cycle model (experimental class) compared to using direct learning model based on the value of $t_h = 11,23$ is greater than from the $t_{table} = 1,671$ at $\alpha = 0.05$.

4. DISCUSSION

Quality improvement or normalized gain mastery of concepts and critical thinking skills to the experimental class of 0.77 to a high category while the average acquisition normalized gain control class is 0.4874 with medium category. Showed that the average increase in mastery of concepts and critical thinking skills to the experimental class is the category of high-quality enhancement. While the average increase in mastery of concepts and critical thinking skills to control classes that are in the category of medium quality improvement.

This means learning by using deductive learning cycle model hypothesis is better to improve the mastery of concepts and critical thinking skills of students than direct learning model. This is possible because the learning model with deductive learning cycle hypothesis can stimulate students to recall the subject matter they have enjoyed previously; motivate students to become more active and add a sense of curiosity; trains students to learn to identify concepts through experimentation; trains students to verbally convey the concepts they have learned; provide opportunities for students to think, explore, discover and describe examples of the application of the concepts learned (Huang, 2008). Moreover, in the learning process when the discussion of the material takes place, the students seemed very enthusiastic and try to understand the material presented correctly. Various kinds of feedback given by the teacher can respond either by students.

While indicators of change in concentration, one practiced components to determine its effect on the number of equilibrium, had a mean gain the smallest normalized. This is caused by students who are less conscientious in solving so that students are stuck with posing questions that exist.

Based on the analysis of data on each sub-topic, the obtained mean normalized biggest gain mastery of concepts in the experimental class on the subject of the equilibrium constant sub indicators equilibrium law. This is evidenced by the calculation of the equilibrium constant search for value, with an average gain of 0.86 normalized. While the smallest average mastery of concepts contained in the subject sub equilibrium shifts with changes in the concentration indicators, one practiced components to determine its effect on the number of equilibrium, with an average gain of 0.68 normalized.

Indicators equilibrium law proved through calculation of the equilibrium constant search for value that includes the concept of equilibrium constant, with an average gain the greatest normalized. It is caused by several things, among others: (1) the concept was discussed at the third and fourth meetings where students are getting used worksheets of students who have been provided in accordance with the hypothesis deductive learning cycle model; (2) For the purposes of this material, students are very enthusiastic about working on a worksheet students are there, so the student activity reached 82.14% and 85.71% excellent category; (3) The mean scores of students at the time of worksheets students last meeting both categories with mean of 87.3. This indicates the student a good understanding of the material that has been given.

In the control class, increased mastery of concepts and critical thinking skills of students is highest in the concept of equilibrium constant with the equilibrium law indicator, which is

evidenced by the calculation of the equilibrium constant search for value, with an average gain of 0.54 normalized. While the concept mastery obtained at the lowest sub equilibrium shifts subject to change indicator concentration, is one component in practice to determine its effect on the number of equilibrium, with an average gain of 0.42 normalized.

Increased mastery of concepts and critical thinking skills in the experimental class indicators: the decision making based on reason; determining a decision based on a result; uses logic strategy; conduct and consider induction; conduct and consider the deduction; identifying phrase the question; create a form definition, all soared higher than the control class (see figure 6). Thus it can be said to be increasing mastery of concepts and critical thinking skills experimental class is better than the control class.

In general, it can be said that the average increase in comparison indicators of mastery of concepts and critical thinking skills class students experiment better than the control class. This is consistent with the results of research Yuniawati (2011) which states that learning to use deductive learning cycle model hypotheses can lead to either the thinking of students compared with expository teaching model. Research results also showed that mastery learning is achieved by students in the experimental class at 79.59% and the control class is 36.73%.

Furthermore, testing the effectiveness of increasing mastery of concepts and critical thinking skills are meant to see any significant difference using hypothetical deductive learning cycle model the experimental class with the direct learning model in the control class. In this study, used two different test average (t-test). To assist in the analysis of data processing, the data processing was performed using SPSS 15 for windows.

Based on the test results in Table 2, statistical tests mean results of the pretest mastery of concepts and critical thinking skills of students showed no significant difference between prior knowledge grade students experiment with the control class based on the value $t = 1.116$ smaller than $t_{table} = 1.671$ at $\alpha = 0, 05$.

While the statistical test result mean post test mastery of concepts and critical thinking skills of students, showed no significant difference between the students after receiving the learning model with deductive learning cycle hypothesis than students receiving learning by direct learning model, based on the value of $t = 11.23$ is greater of $t_{table} = 1.671$ at $\alpha = 0.05$.

Statistical test normalized average gain mastery of concepts and critical thinking skills of students, showed a significant difference between the students after receiving the learning hypothesis

deductive learning cycle model, compared with students receiving learning by direct learning model, based on the value of $t = 11.23$ is greater than of $t_{table} = 1.671$ at $\alpha = 0.05$.

Differences mastery of concepts and critical thinking skills of students in the subject matter of chemical equilibrium occurs, for their treatment of different learning models to groups of students. Mastery of concepts and critical thinking skills of students who take the hypothesis deductive learning cycle model is better than the students who take the direct learning model. Due to the learning of students who take the hypothetical deductive learning cycle models get a chance to develop more comprehensive as it gets a lot more opportunities to learn independently. This is supported by a learning activity at this stage of exploration, the introduction of the concept and application of the concept is dominated by the activities of students. This condition is very good for building self-concept in students independently. Application of hypothetical deductive learning cycle model provides wider opportunities for students to think and argue. The ability to argue strongly associated with critical thinking skills.

Results of research Adnyana (2012) about the critical thinking skills and understanding of the concept of students in learning cycle model hypothesis deductive, found that there are significant differences critical thinking skills and understanding of chemical concepts among students who take the learning cycle model hypothesis deductive and direct instructional model with the value of F 17.639 at $\alpha = 0.05$.

When viewed by the average student activity at all meetings of the obtained average percentage of 80.36% activity, good category yet. This means that the students gave a positive response to the application of the hypothetical deductive learning cycle model. The high percentage of the average student activity on all the meetings due to the availability of student worksheets they have to do, where the hypothetical deductive learning cycle model requires students to find their own concepts of chemical equilibrium through group discussion. This spurred the students to continue to put forward the idea / ideas to the friends group to produce the appropriate conclusions and better. Therefore, students are more active and motivated in carrying out the study.

5. CONCLUSION

Based on the results of research and discussion we can conclude the following matters:

1. Increased mastery of concepts and critical thinking skills of students in chemical equilibrium material modeled hypothetical deductive learning cycle better than students who take the direct learning model. It can be seen from the average normalized gain

- mastery of concepts and critical thinking skills to students experimental class of 77% increase in high-quality category, while the average normalized gain mastery of concepts for grade control of 48.74% with a moderate increase in the quality category.
2. Increased mastery of the concept of state of equilibrium, the equilibrium shifts, and the equilibrium constant on students who take the hypothetical deductive learning cycle model is better than the students who take the direct learning model.
 3. Improved critical thinking skills of students who take the hypothesis deductive learning cycle model for the indicator: determining decisions based on reason; determining a decision based on a result; uses logic strategy; conduct and consider induction; conduct and consider the deduction; identifying phrase the question; create a form definition, all increasing better than students who take the direct learning model
 4. Increased mastery of concepts and critical thinking skills class students experiment better than the control class. The results of different test (t-test) showed significant differences at the significance level of 0.05, where $t = 11.13$ is greater than $t_{table} = 1.671$.

REFERENCES

- Adnyana, Gede Putra. 2012. *Keterampilan Berpikir Kritis dan Pemahaman Konsep Siswa Pada Model Siklus Belajar Hipotetis Deduktif*. Jurnal Pendidikan dan Pengajaran, Jilid 45, Nomor 3, Oktober 2012, hlm.201-209.
- Budiasih, E. & Widarti, H. R. (2004). Penerapan Pendekatan Daur Belajar (*Learning Cycle*) dalam Pembelajaran Mata Kuliah Praktikum Kimia Analisis Instrumen. *Jurnal Pendidikan dan Pembelajaran*. 10(1), 70-78.
- Dasna, I W., dan Sutrisno. 2004. Pengembangan Bahan Ajar Model Learning Cycle Untuk Pengajaran Kimia di SMA. *Makalah*. disajikan dalam Konvensi Nasional Pendidikan Indonesia V di Surabaya tanggal 5 – 9 Oktober 2004.
- Ennis, Robert H. 1996. *Critical Thinking*. New jersey : prentice – Hall, Inc (online). Tersedia di : <http://faculty.ed.uiuc.edu/rhennis.html> (15 Juni 2013)
- Garrison. D. R., Anderson, T. & Archer, W. 2000. *Critical Thinking and Computer Conferencing: A model and Tool to Asses Cognitive Presence*. Tersedia :<http://communitiesofinquiry.com/documents/CogPresFinal.pdf>. (Akses internet juli 2009).
- Hofreiter, DT., Monroe, MC., Stein, TV. 2007. *Teaching and Evaluating Critical Thinking in an Environmental Context*. *Applied Environmental Education and Communication*. 6:149–157. Taylor & Francis Group, LLC.

- Huang, Kuan-Jhen dkk. (2008). *Embedding Mobile Technology To Outdoor Natural Science Learning Based on the 7E Learning Cycle*. the National Science Council of the Republic of China, Taiwan, for financially supporting this research under Contract No. NSC 097-2811-S-008-001.
- Issac *et al*, 1971. *Hand Book In Research and Evaluation: A Collection of Principles, Method and Strategies Useful In the Planning. Design and Evaluation of Studies in Education and Behavioral Science*. McGraw Hill Book Co. USA.
- Martin, R., Sexton, C., Wagner, K. & Gerlovich, J. 2005. *Teaching Science for All Children: Methods for constructing understanding*. Second ed. Boston: Allyn and Bacon Inc.
- Mohd. Nazir Md Zabiti. 2010. *Problem-Based Learning on Students' Critical Thinking Skill in Teaching Business Education in Malaysia: A Literature Review*. *American Journal of Business Education*. 3 (6): 19-32.
- Suparno, P. 2001. *Teori Perkembangan Kognitif Jean Piaget*. Yogyakarta: Kanisius
- Thomas, T. 2011. *Developing First Year Students' Critical Thinking Skills*. *Asian Social Science*. Vol. 7, No. 4; April 2011.
- Yuniawati, N.W. & Redhana, I.W. 2011. *Model Siklus Belajar Hipotesis Deduktif Untuk Meningkatkan Hasil Belajar Siswa*. *Jurnal Pendidikan Kimia Indonesia, Volume 1, Nomor 2, Oktober 2011*, 4655.
- Yusrin. 2013. *Siklus Belajar*. <http://yusrin-orbyt.blogspot.com/2013/02/siklus-belajar.html>, (15 Februari 2013).