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The Effect of Cognitive Conflict Strategy to Chemical Conceptual Change

Herlina Labobar[1], Punaji Setyosari[2], I Nyoman S. Degeng[3], I Wayan Dasna[4]

[1]Postgraduate Student of the State University of Malang, Indonesia

[2, 3, 4]Department of Instructional Technology, State University of Malang

Abstract: ***This study aims to determine the effect of cognitive conflict strategy on the chemical conceptual changes of students on the acid-base material. The sample used is 51 students. We developed a two-tier diagnostic test instrument to test students' level of understanding. The data obtained were analyzed quantitatively and qualitatively. The results of the analysis provide a description of the misunderstanding profile of students, where before treatment there was a misunderstanding of the concept, but after being given treatment with cognitive conflict strategy, the level of misunderstanding of students decreased. Different tests on the pre and post test scores indicate that there has been a conceptual change. Based on the results, it is concluded that cognitive conflict strategies have an effect on the students' conceptual changes.***

Keywords: Cognitive Conflict, Misconception, Chemical Conceptual Change

1. Introduction

Many students have misconceptions about the topic of acid-base. Misunderstanding is a mistaken idea of the students and not in accordance with scientific ideas or concepts from experts. This misconception comes from the confusion and lack of knowledge about a concept. It certainly has the potential to become an obstacle in the process of learning and inhibit changes in the concept. There are several factors influencing the change of concept. One of the most important factors is the original concept of students before learning [1]. Students develop their own concept or idea informal, but often do not fit in with scientific concepts. Furthermore, the conception or idea which contain this misconception held firmly by the students, which can inhibit the formation of new concepts and are often resistant to change [2]. Thus teachers need to identify students' misconceptions and make efforts to reduce misunderstandings by pushing the conceptual change on the topic of acid-base chemistry.

Learning strategies used in the learning process determines the learning process and results [3]. The learning process needs improvement by providing space for student activity and the tools that support active learning and reduce dependence on the teacher as a source of information [4]. Efforts to involve students in active learning should be related to the real environment of students and give freedom to the learner in the learning process [5].

Learning process for conceptual change requires a constructivist approach where students can play an active role in the reorganization of their knowledge. Effective learning that can build understanding and empower the thinking skills of students is one which emphasizes the importance of learning as a personal process, where each student builds knowledge and personal experience [6]. One of the learning strategies that engage students actively and also cut down on misunderstandings of students is cognitive conflict strategy based on conceptual change. Effect of conflict on conceptual change will increase if there is an increase in knowledge-building activity, whereas conceptual changes will be difficult to achieve if there is no knowledge and building activity. This once again confirms the importance of learning in students and processing strategy by the teacher.

Cognitive conflict instructional strategy is a strategy in conceptual change that allows the stability of misconceptions of students falter towards scientific conceptions by giving examples of counterpoint, analogies, demonstrations and experiments [7]. The implementation of this strategy in the learning process aims to generate contradiction with the initial ideas of the students so that they are compelled to reconstruct their understanding and have the correct concept. The concept is really going to help the students in the acquisition and integration of knowledge and use of knowledge significantly. Instead misconceptions that have been believed by the students will inhibit the reconstruction of knowledge or conceptual change.

The creation of cognitive conflict can be implemented by causing the intellectual imbalance, which provides direct interaction or experience as much as possible can lead to a contradiction to the understanding of the students [8]. This contradiction makes students experiencing imbalances cognitive structure or schema (disequilibration), thereby motivating students to perform rebalancing the existing scheme (equilibration or self-regulation).

Cognitive conflict is the starting point of the conceptual changes. This is because the cognitive conflict can enable specific types of cognitive activities such as building knowledge leads to conceptual changes. Effect of cognitive conflict on conceptual change is also mediated by the attention and effort of teacher and student. The implementation strategy of cognitive conflict in learning is through four stages: identifying the concept of students, the creation of conditions of conflict, the provision of assistance to the equilibration and reconstruction of student understanding [9].

Several studies have demonstrated the success of cognitive conflict instructional strategies to change the concept of the student, and cognitive conflict turned out to have a positive impact on the effectiveness of the change of concept [10]. The results of this study reported that learning with cognitive conflict strategy provides a good contribution even help students reconstruct knowledge and create higher student achievement. But some researchers still doubt the impact of cognitive conflict on conceptual change. Limon states that cognitive conflict is not effective or consistent in influencing conceptual change [9]. The correlation between cognitive conflict and conceptual change was also found to be rather weak [11].

This study aimed to reveal the level of students' misconceptions and to determine the effect of the application of learning strategies cognitive conflict against conceptual change in acid-base chemistry topics. In this study, two-level diagnostic instruments (two-tier) was developed to identify students' conceptions of the acid-base materials, as well as interview techniques to obtain more detailed information about the initial concept of students. Limon found students' conceptions identification using two-tier instrument is very important to help students develop a scientific concept [9]. Two-level diagnostic instruments has the additional benefit of multiple choice, provide teachers with insights into student comprehension and their thought processes, as well as the awareness of students' conceptions [12]. Furthermore, researchers developed an experimental laboratory and demonstration activities as efforts to create a cognitive conflict in students.

2. Methods

This study uses a quasi-experimental design, the one group-pretest-posttest design and descriptive design, using one sample group of 51 students of class XI science as an experimental group, which was given treatment for 6 sessions. Pre-test conducted using two-tier diagnostic test as many as 20 items contain conceptual questions about the acid-base material. The first tier consists of a choice answer true/false, while the second tier is the reason of choice when giving a statement. This instrument was developed based on the student's knowledge of the content of the acid-base material beforehand. Furthermore, these instruments are validated by three content experts. Finally the test was carried out to obtain the level of validity and reliability of the instrument.

The process of testing instruments to students performed twice, both before and after treatment, while the interviews were conducted to ensure the consistency of the students' answers. In order to create a cognitive conflict in students, the design of treatment using the method of demonstration and experiments on some subject matter tailored to the curriculum. The material consists of the theory of acids and bases, identification of solution properties of acids and bases with various indicators, identification pH of the solution based on the concentration, estimating the strength of a weak acid and a strong acid of a solution having the same concentration, determines the strength of the acid based pH of the solution, the degree of ionization and constant acid-base, an acid or base power relationship with the degree of ionization (α) and acid constant (Ka) or a constant base (Kb).

Data analysis was conducted both quantitatively and qualitatively. In quantitative terms, the data were analyzed to get an overview of students' misconceptions profile, while quantitative, test score data were tested using different test (t-test).

3. Result and Discussion

a. Description of Misconception Level Data of Student on the Acid-Base Concept

Overall for the acid-base concept, it was found that the average level of students' understanding of concepts before learning is 16% of students could answer correctly for the first level or statement in a diagnostic test of the initial concept comprehension test. Moreover, the highest percentage of students who do not understand the concept is 64%. It was found that there are a number of misconceptions on the concepts tested.

On the concept of acid-base theory, for example, students are expected to classify acids and bases by the ability to produce H + or OH- ions when dissolved in water. Students can answer this question correctly with the reason if the students have understood the concept of the definition of acids and bases, as well as the concept of ion reaction. The results of the testing prior to treatment showed that 64% of students do not understand the concept and only 16% of students who understand the concept. Most of the other students only understand some of these concepts or able to answer correctly on the statement but could not give a good reason. Then, after following the learning process with cognitive conflict strategy, there is a change where the number of students who were able to answer correctly increased to 80%.

On the other acid-base theory concepts, namely the concept of conjugate acid base pairs, students must have knowledge to answer questions that the conjugate acid is a substance produced from a base which receives or proton acceptor, whereas the conjugate base is a substance that releases or proton donor. In general misunderstanding shown by students on this concept is that students tend to pair between compounds that positively and negatively charged. Students assume the conjugate acid as anion, and conjugate bases as cation, without understanding their proton transfer as a basic understanding of the concept of conjugate acid-base pair.

Recovery process of this condition after the learning process has had an impact. This is indicated by a change in the number of students at the level of understanding of the concept. Data described the number of students who understand the concept has increased from 4% to 48%, the number of students who do not understand decreased to 24%.

Tests on the students' understanding of concepts related to the pH of the solution require students to sort the pH of solutions with different concentrations. To answer this question, the student must first calculate the concentration of

the third example of the solution, only then they can apply the formula to calculate the pH of the solution.

Based on test data and quotes taken from interviews, students' understanding of these concepts can be identified. For all the same solution, the pH value is no different. The volume of the solution had no effect on the pH of a solution. In addition, students understand that in the water solvent, the solution with high concentration is more acidic, while the solution with a low concentration of more dilute or acidity is reduced. Other findings from the test of concept understanding before learning is a lot of students who understand that the higher the concentration the higher the pH of the solution to all the same solution, although different concentrations and pH values are no different. The more volume added for dissolving a compound, the more the solution diluted, and the higher the pH of the solution. The level of incorrect understanding of this concept is quite large, which is about 44%. After being given the treatment this number has decreased significantly.

In general, the results of diagnostic examinations and interviews provide information about the initial concept of the student, which is largely different from the concepts which can be scientifically acceptable. The initial concept contains a number of misconceptions students, were identified from the results of the test students' understanding of concepts and segregated by three levels of understanding. It indicates a superficial understanding of the concept of student and still be rote, thus application of cognitive conflict instructional strategies proven to reduce the level of students' misconceptions on the acid-base concept.

b. Different Test Result of the Average Score of Student Understanding Concept on Pre-Test and Post-Test

Based on the results of the different test to the scores of pre-test and post-test, it can be explained that the average score of understanding the concept of acids and bases in the group treated with cognitive conflict strategies before learning is learning is 29.48 and after 62.56. This means that there has been a significant increase of 37.08. The results of the statistical test obtained t value of 24.341 and p-value 0.00 (<0.05). Based on these values, it can be concluded that there are significant differences in the average scores of the understanding of the acid-base concept of students before and after the learning, or conceptual changes have occurred, as a result of the treatment of cognitive conflict strategy premises. Cognitive conflict strategy, generally involves the evaluation of student knowledge, present information that is contradictory, and then re-evaluates and identify any changes in students' conceptions. So far, the logical approach appears, and there is evidence that stimulation of cognitive conflict is a necessary condition for conceptual change.

4. Conclusion

Based on the exposure of the research, the conclusion can be stated as follows:

1) Profile of students about the acid-base concept contains a lot of misunderstanding.
2) Diagnostic instruments can reveal a number of students' misconceptions about the concept of acids and bases.
3) The cognitive conflict strategy is effective to reduce misunderstandings and promote a conceptual change of the concept of acid-base chemistry.

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