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The Effectiveness of Cognitive Conflict-Based Chemistry Learning in Reducing Students' Misconceptions of Acid-Base Materials

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Abstract: A misconception is a problem that is often encountered in the world of education caused by several things, including students' initial prejudices, incompetent teachers, unclear textbooks, different contexts of the student experience, and teaching methods that only contain lectures. This study is intended to answer the problem regarding the effectiveness of cognitive conflict-based chemistry learning in reducing students' misconceptions about acid-base material. This research is quasi-experimental research with One group Pre-test and Post-test Design. The population in this study was all class XI IPA. The sample in this study was class XI IPA I. The instrument used in this study was a student's concept understanding test. The data collection method used is a multiple-choice reasoned test method. Changes in misconceptions were analyzed descriptively and statistically. A descriptive analysis was conducted to see changes in students' concepts. Statistical analysis using the T-test. Based on the research, it was found that the indicators of questions that experienced misconceptions were: Arrhenius acid-base theory (32.05%), Arrhenius acid-base classification (56.40%), Bronsted Lowry theory (43.59%), writing down the acid-base reaction equation according to Bronsted Lowry and Lewis acid-base theory (59.00%), distinguish between Arrhenius, Bronsted Lowry and Lewis acid-base theories (49.00%), the nature of acidic and basic solutions (47.00), degree of acidity/pH (79.00%), determination of strong acid (79.00%), determination of strong base (46.00%), degree of ionization in acid and base determination (46.00%) and application of the concept of pH in pollution (66.00%). Understanding of students' initial conceptions, namely students who are classified as knowing the concept of 23.18%, misconceptions of 53.95%, and not knowing the concept of 22.87%, while the understanding of the final conception of students is students who are classified as knowing concepts of 76, 20%, a misconception of 15.49% and not knowing the concept of 8.31%. Based on these data, it can be concluded that the cognitive conflict learning method is effective in reducing students' misconceptions.

Keywords: Cognitive conflicts; Misconceptions; Acid-base

Introduction

Chemistry is a science that contains abstract concepts. Learning chemistry as one of the sciences should put more emphasis on understanding aspects, especially symbolic, macroscopic, and microscopic aspects. Mastery of chemistry does not only use memorization but requires a deeper understanding. Based on the understanding of the chemical concept, some of the problems that often occur are the inability of students to interpret concepts in chemistry. This inability allows the emergence of difficulties for students in studying chemistry and errors in understanding chemical concepts. These misconceptions are known as misconceptions.

A misconception is one of the big problems in education. The misconception is a wrong understanding of a concept experienced by someone (Maison et al., 2020). Misconceptions in cases misconceptions that occur are usually difficult to change (Irani et al., 2020)

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from concepts that have been correctly agreed upon according to experts (Suwono et al., 2021). This happens because students are rarely allowed to construct concepts during learning (Hanifah and Wida, 2019). Misconceptions can be caused by several factors including the initial pre-conceptions of students, teachers who do not master the material (incompetent), unclear textbooks, different contexts of students' experiences, and teaching methods only contain lectures (Suparno, 2005). Learning activities of students only through rote without paying attention to the concept. Therefore, the causes of misconceptions must be minimized, so that students can understand the concept correctly.

One of the misconceptions in chemistry lessons is acid and base (Harizal, 2012; Lestari, et al, 2020). this is based on the study of literature and observations made by researchers. The concept of acid and base learns about acid-base theories, acid-base strength, measurement, and calculation of pH and acid-base reactions. The acid base is one of the materials in chemistry lessons that often have misconceptions. Therefore, we need a way to reduce misconceptions that occur about chemical materials.

Based on the results of the preliminary study at MA Matholi'ul Huda, it was found that many students did not master the chemistry concepts that had been taught. This school has good facilities and infrastructure, but students' understanding of chemistry lessons is not evenly distributed. Educators explain the material in detail, but educators rarely invite students to express their understanding. Students have not been required to find out the truth of the material themselves, even though students have different initial concepts. An incorrect initial concept will encourage misconceptions.

The misconceptions experienced by these students illustrate that the learning process has not been carried out optimally. This is reinforced by the results of observations which show that the learning process in the classroom is still centered on the teacher and pays little attention to the process of forming knowledge in students. The learning process that is still centered on the teacher causes students to rarely know and understand the observational framework that produces the concept so students tend to memorize the concepts that the teacher provides without understanding them.

Based on this description, a learning process is needed that can facilitate changes in students' concepts so that students have good conceptual mastery. One alternative learning that can be chosen is cognitive conflict-based learning (ma'rifah: 2012). Cognitive conflict-based learning was developed from Piaget's view of constructivism theory. This theory says that students must build their knowledge from new experiences. Concept change is part of the learning mechanism that students need to build knowledge about events or principles until they are restructured. Cognitive conflict is an important factor in conceptual change theory. Cognitive conflict can be produced by an imbalanced situation in the form of dissatisfaction caused by the conflict between what is seen and what is owned in the cognitive structure. As a result, students will change their views to match the new knowledge until a balance is produced. According to Baser, this learning can encourage changes in students' concepts in a positive direction which will lead to good concept mastery so that misconceptions can be resolved (Juhji, 2017).

Cognitive conflict-based learning is very appropriate to be applied in chemistry learning. Cognitive conflict-based learning includes practical activities and discussions about chemical concepts that they think are wrong. Students can express their understanding, and obtain a concept from the chemistry material being taught so that the misconceptions that exist in students can be reduced. Research on misconceptions so far has only focused on analysis and identification. Chiu et al. (1988b) and Demircioglu et al. (2005) investigated the causes of the emergence of misconceptions in the study of acids and bases. Several other researchers also use certain strategies in reducing misconceptions (Maulana, 2010). One of the learning strategies that can be chosen is cognitive conflict. Based on this research, is intended to answer problems regarding the effectiveness of cognitive conflict-based chemistry learning in reducing students' misconceptions about acid-base material.

Method

This research is quasi-experimental research with One group Pre-test and Post-test Design. The research phase begins with an analysis of misconceptions through the literature and initial observations followed by giving a pre-test and evaluating it to find out where the misconceptions are. Furthermore, giving treatment with cognitive conflict learning. The final stage is giving a post-test and evaluating it to determine the effectiveness of the learning provided. The research design is presented in tTable 1.

Table 1. One group pre-test post-test design

Pre-Test	Treatment	Post-Test
O_1	X	O_2

(Source; Sugiyono, 2007)

Information:

O_1 = Initial conception understanding test (pre-test) before students receive learning.

X = Treatment, namely learning with cognitive conflict strategies.

O_2 = Final conception understanding test (post-test) after students receive learning with cognitive conflict strategies.

The instrument used in this research is the student's concept understanding test. The data collection method used is a multiple-choice test method to measure the understanding of students' initial and final conceptions. Understanding of students' conceptions is identified based on the data below:
A = correct answer and correct concept
B = correct answer and wrong concept
C = correct answer and correct concept

Changes in misconceptions were analyzed descriptively and statistically. A descriptive analysis was conducted to see changes in students' concepts. Statistical analysis used the T-test to determine the significance of the differences in misconceptions before and after learning cognitive conflict strategies. T test using SPSS program. The results of sig (α) in the SPSS table are compared with the value at the real level. If the count level of significance, then H_0 is rejected. If count > significance level then H_0 is accepted.

The Hypothesis is H_0: there is no difference in misconceptions between before and after learning cognitive conflict strategies; Ha: there are differences in misconceptions between before and after learning with cognitive conflict strategies.

Result and Discussion

The results of the pre-test and post-test from the analysis of the degree of misconception for students are known through their understanding. The average understanding of students is presented in Figure 1.

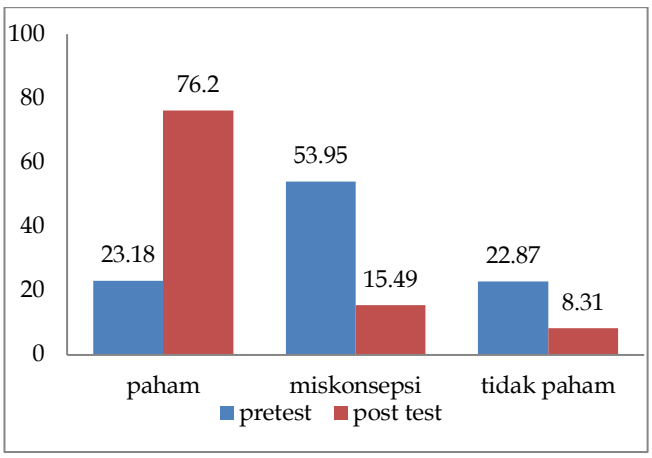

Figure 1. Students' understanding during pre-test-post-test

Based on Figure 1, it can be seen that there are differences in students' understanding during the pre-test and post-test. The initial understanding of students is that students who are classified as knowing concepts are 23.18%, misconceptions are 53.95%, and do not know concepts are 22.87%. while the understanding of the final conception of students, namely students who are classified as knowing the concept at 76.20%, misconceptions at 15.49% and not knowing the concept at 8.31%. The recapitulation of students' misconceptions occurs in several indicators, including the following: Arrhenius acid-base theory (32.05%), Arrhenius classification of acids and bases (56.4%), Bronsted Lowry theory (43.59%), writing reaction equations acid-base according to Bronsted Lowry, Lewis acid-base theory (59.00%), distinguishes Arrhenius, Bronsted Lowry and Lewis acid-base theory (49.00%), the nature of acidic and basic solutions (47.00%), acidity/pH (79.00%), determination strong acid (79.00%), determination of strong base (46.00%), degree of ionization in acid and base determination (46.00%) and application of the concept of pH in pollution (66.00%). Based on these data, it can be seen that the highest degree of misconception is the indicator of the degree of acidity (79.00%) and the determination of strong acid (79.00%).

Based on the results of the significance test of the differences in misconceptions before and after learning with cognitive conflict strategies on the T-test with a value of sig (2-tailed = 0.000) < (0.05), then H0 is rejected. This shows that there is a significant difference in misconceptions before and after learning cognitive conflict strategies. Based on these results strengthen the statement that learning using cognitive conflict strategies is effective in reducing students' misconceptions about acid-base material. Good understanding is one of the effects of reducing misconceptions. This is known from the results of the analysis of the effectiveness of reducing the degree of misconception.

In this study, students experienced assimilation and accommodation (Dahar, 1996). Students form new concepts after following the learning process. However, the concept that students have is not necessarily the same as the actual concept. For example, HCl with a very small concentration of 10^{-8}-10^{-14}. On average, students answered with their initial knowledge, namely HCl with a concentration of 10^{-8} has a pH = 8. If the solution has a pH > 7 then the solution is basic. However, HCl is a strong acid, so in the slightest concentration, HCl will remain acidic. At this stage, students build new information known as assimilation, as research conducted by Suparno (2005). If the initial concept is believed to be wrong, then students experience an anomaly situation. Students are allowed to experiment to prove the correct concept. Experimental activities make students know that HCl in small concentrations will remain acidic. This is due to the influence of the solvent/water, so the pH remains 7. This stage is called accommodation, as research conducted by Ma'rifah (2012).

Accommodation is the stage where students move to new concepts by modifying existing cognitive structures to match the new data that is assimilated so that there is a change in the concept in their minds. Accommodation is used to solve the contradictions that exist in students. New concepts that are embedded in students will be a valuable learning experience because they find scientific concepts directly (Kang, 2010: 393). The cognitive structure of students can undergo reorganization to adjust to the information they have just received (accommodation). This means that misconceptions that have been integrated into the minds of students can be corrected by utilizing the accommodation process. The hope is that students will reorganize the cognitive structure so that there is a shift of wrong misconceptions toward the correct ones. The misconceptions that students bring after learning will also be reduced by remedial activities so that the learning process will be more meaningful.

Based on the results of research and discussion, shows that the use of cognitive conflict learning strategies can increase the average learning outcomes in chemistry learning so that cognitive conflict learning strategies are effective in reducing students' misconceptions about acid-base material. The participation of students also increases because of their curiosity about the truth of the knowledge they have. The impact is that understanding of the material increases so that it can solve existing problems, and existing misconceptions can be reduced. Based on these results, it is expected that students will love learning chemistry more so that the assumption that chemistry is difficult can be destroyed. Thus, student learning outcomes will increase and misconceptions can be reduced. This corresponds to research conducted by Kang et al (2010) and Lee et al (2002) and is supported by research conducted by Ma'rifah (2012).

Conclusion

Based on the results of the study, it can be concluded that learning using cognitive conflict strategies shows that students' misconceptions, in general, can be reduced with an average percentage of misconceptions of 53.95% on the student's initial understanding test (pre-test) to 15.49% on the understanding test. the final conception of students (post-test). The results were tested using the T-test with a value of sig (2-tailed = 0.000) < (0.05) so that there was a significant difference in misconceptions between before and after remedial learning with cognitive conflict strategies. This shows that the cognitive conflict strategy can reduce students' misconceptions about acid-base material

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