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The effect of constructivist approach on students' understanding of the concepts related to hydrolysis

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Abstract

The aim of the study is investigating the effect of constructivist approach on students' understanding of the concepts related to hydrolysis subject, comparing constructivist approach with traditional teaching method and determining the differences between student success in constructivist approach and traditional teaching method. Totally 100 students have participated in the study. The age average of the students is 18–21. The control and the treatment group have been determined randomly. Traditional teaching applications have been conducted with control group and constructivist teaching applications have been conducted with treatment group. Hydrolysis Concept Test has been administered as pre test to control and treatment groups to determine the understanding level of the students related to hydrolyzes concepts. The data has been analyzed by using statistical analysis techniques. The results have displayed that the constructivist teaching applications has had contributions on students' understanding of the concepts related to the hydrolysis subject.

Keywords: Constructivist approach; students' understanding; hydrolysis subject;

1. Introduction

Cognitive researches display that most of the people have misunderstandings about nature. According to Yeany (1986), Constructivist Learning Model can be used for connecting all of the dominant researches in science education (Yager, 1991). Perkins (1999), express that even most of the college students have higher grades, they have misunderstandings. According to Perkins (1999), teachers are particularly responsible for these misunderstandings. According to cognitive psychologists, students who only listens the lecture or read the text can not learn the permanent knowledge. Permanent knowledge can be formed through applying new information and connecting new information with each other.

According to Colburn (2000), constructivist philosophers propose that individuals structure their own life philosophy and knowledge by themselves. At the center of the constructivism lies the idea that the learner structures the knowledge and applies it (Perkins, 1999). Learning by structuring proposes that human brain is not a flash disk or an empty container that waits for filling. The children don't wait for someone to fill their brains. They structure the knowledge actively in their brains and reconstruct it. With another words, constructivist learning is learning by

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individually and with social activities and as a result of these activities making conclusions (Brunning et. al., 1999). Yager (1991) asked the question of "How do science teachers use constructivist approach?" and answers this question under some chapters:

- the activities which should be conducted by the teachers
- the characteristics of science classes
- the characteristics of science education programs and
- Some ideas which explain in-service teacher education activities.

2. Aim of the study

The aim of the study is investigating the effect of constructivist approach on students' understanding of the concepts related to hydrolysis subject, comparing constructivist approach with traditional teaching method and determining the differences between student success in constructivist approach and traditional teaching method.

3. Model of the study

In this study, the quasi experimental design has been used (Gay, 1987). Totally 100 students have participated in the study. 50 of the students have been in control group and 50 of the students have been in treatment group. The research has been conducted in the content of Analytical Chemistry Course. The independent variables were two different types of treatment; instruction based on constructivist approach and traditionally designed chemistry instruction. The dependent variable has been students' understanding of hydrolysis concepts. The study has been limited with the hydrolysis subject.

4. Instruments

Hydrolysis Concept Test (HCT) is a concept test which consisted of 10 questions has been prepared for the study. Five of these questions have been taken from "General Chemistry Principles and Modern Applications (8^{th} Edition)" and five of them prepared by the researcher (Petrucci, Harwood and Herring, 2002).

5. The Application

5.1. Forming the groups

The study has been conducted in four weeks time. One of the groups has been chosen as treatment group and taught by constructivist teaching method and the other group has been chosen as control group and taught by traditional teaching method. Students both in treatment group and control group have has similar grades in their past chemistry courses. Both of the groups have taught by the same teacher. Lecture content for groups contains acids, bases, salts, ions, and reactions of the ions with water, K_a, K_b values and the meaning of these values, pH changes through the reactions of ions with water.

5.2. The applications conducted with the control group

Teacher has used strategies appropriate for traditional teaching method in the applications with control group. Some texts have been given to the students and teacher has lectured in the class. The teacher has used discussion, asking-answering methods and at the same time gave students a worksheet related to the subject. The worksheet has contained questions related to hydrolysis subject. In the process, the teacher has answered the questions of the students and helped them. Later, the teacher has collected the worksheets and gave them back to the students after evaluating their answers and correcting their mistakes.

5.3. The Applications conducted with the treatment group

The applications conducted in the treatment group according to the constructivist teaching strategy which used by Yager in 1991. The process followed and applications conducted in the study have been given below:

5.3.1. Engage

Firstly, the teacher has asked some questions related to the hydrolysis subject to determine the pre-knowledge of the students and increase student-student interaction. These questions "What is HCl?", "What is CH_3COOH?", "What is NaOH?", and "What is NH_3?" have been asked. Generally students have answered that these substances are strong or weak acids and bases. Secondly, students have discussed what the salts of these acids and bases are. Without thinking, students have given these examples: NaCl and KCl for HCl , NaCl and $NaClO_4$ for NaOH, , $NaCH_3COO$ and KCH_3COO for CH_3COOH, NH_4Cl for NH_3. Then, students have been asked for the pH of these salts and the points they consider while determining the pH. It has been seen that students have no problem while determining the pH of the salts like NaCl and KCl. However, they have had problems while discussing the pH of the salts which formed by the reaction between a strong acid and a weak base or a strong base and a weak acid. To focus students' interest on hydrolysis concept, interesting questions have been asked and a conspicuous example has been given. At each stage, students have written their ideas on their worksheets.

It has been difficult for the students to write the hydrolysis reactions of the ions. Because, up to now they have only met the acids and bases like HCl, HNO_3, NH_3, NaOH or KOH. Therefore, it has been difficult for students to understand that the ions could have acidic or basic characters and to write down their reactions which show their acidic or basic characters in aqueous solutions. At the end of the engage stage, it has been determined that students haven't had any other knowledge about the hydrolysis of salts except of the definition "it is a reaction of a substance with water". By the inquiry at this stage, students have been confused and their interest has been increased. Students have asked themselves "Can the ions react with water? If they can, what is the name of this reaction?", "may I explain these reactions with my present knowledge?". These questions have been important for beginning to understand the subject.

5.3.2. Explore and explain

At this stage, students have discussed the present knowledge that helps them to understand hydrolysis concept in groups. At this stage, students have tried to answer some questions that occurred in their minds through some activities called "let's search-think" and "let's discover". As an introduction to the main subject, she has asked the question "What is a salt?" Firstly, students have discussed in groups and the group speaker has explained their answer to the teacher and their classmates. Following to the students' responses to the question, the teacher has explained the concepts. She has asked about the pH values of the salts. Most of the student groups have expressed that they have been neutral. Because, about salts they only think of the salts they used while cooking. Since acid and base concepts have been taught, students have been asked if they know any salts except of NaCl. Students have discussed in small groups and tried to give some examples to salts. At this stage of the study, it has been determined that the students group have used a strategy that given below. By this way, the students have reached the answer that NaCH3COOH, NH_4Cl and NH_4CH_3COOH may be also salts. However, at the beginning they could only give NaCl as an example for salts. As a result of the application, students have constructed new information about salts and the forming of the salts by using their knowledge about the subject. Then, the teacher conducted an experiment related to the subject.

The students answered teacher's questions and discussed the results. While explaining the concepts, the teacher has corrected students' misunderstandings and explained why their understanding has been incorrect. It has been very helpful for students conducting the discovery experiments by themselves and using the laboratory equipments to evaluate their learning. The teacher has given some "Let's think and find" homework to the students. Students have searched for the subject in details while doing this homework.

5.3.3. Elaborate

At this stage, students have been requested to describe some daily events related to the subject and give some examples from daily life. Students have had to search fort his request. At the same time, the teacher has given some interesting examples from daily life related to hydrolysis. Since hydrolysis has been an abstract concept, the teacher has paid attention to give the examples from daily life.

5.3.4. Evaluate

Following to the application, both the studies of treatment group and control group have been evaluated and the results of the "Hydrolysis Concept Test" have been assessed.

6. Findings

The responses of the students to the measurement tools have been evaluated and the findings have been given below. Independent samples t-test has been conducted to answer the question "Is there any statistically meaningful difference between students' understandings and success related to the hydrolysis concepts in the classes which taught by traditional teaching method and which taught by constructivist teaching method?" Table 1 displays the results of the independent samples t-test results.

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Table 1. The independent samples t-test result that compares the achievement test scores of treatment and control groups

		Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)	Mean Difference
Achievement pre test	Treatment Group	4.36	1.19	0.16				
	Control Group	4.12	1.04	0.14	1.07	98	0.28	0.24
Achievement Post Test	Treatment Group	7.26	1.00	0.14				
	Control Group	5.14	0.72	0.10	12.06	98	0.00	2.12

All (N= 50)

Table 1 displays that there is no significant difference between pre test results of treatment and control groups ($p > 0.01$); but there is a significant difference between the post test results of treatment and control groups in favor of the treatment group. When Table I examined, it can be seen that as a result of the applications, both the success of the treatment and control groups have been increased. But when the achievement increase of the two groups compared, it can be seen that the achievement increase of the treatment group is higher.

7. Discussion and suggestions

The achievement of the treatment group that taught through constructivist learning activities has been higher than the achievement of the control group that taught through traditional teaching activities. The difference has been statistically significant in favor of the treatment group.

The first question in the test is related to a statement "NaOCl" is a salt. In pre test, 72 % of the students of the treatment group and 67 % of the students of the control group have checked "true" choice for the first question and given the correct answer. But when they have explained why they chose this answer, it has been seen that they have a misconception related to the subject. In the explaining part, 67 % of the students of the treatment group and 70 % of the students of control group have checked the "it is a product of a strong base with a weak acid". But while forming a salt, expressing the strength of the acid or base (weak or strong) is not a necessity. When students' responses to this question in post test examined, the percent of the correct answers of the both two groups has been increased but the increase of the correct answers of the treatment group is higher.

In the second question, is has been asked for if $NH4NO_3$ has acidic or basic character. When the experiment and control group students' responses to this question in pre test examined, it has been seen that the percents of the students who checked as "it is acidic" and checked the correct explanation (since ammonium hydrolyzes) has been very low (39 % in treatment group and 40 % in control group). When the responses of the students have been examined, it has been seen that some of the students have thought that ammonium ion transfers a proton. Furthermore, some of the students thought that nitrate ion hydrolyses. These answers have displayed that students have misconceptions related to what kind of ions can hydrolyze and how they can hydrolyze. When students' responses to this question in post test examined, the percent of correct explanation in treatment group has been increased from 23 % to 72 % and the correct explanation percent in control group has not changed.

In the pre test for the third question for the statement "NaCl dissociates and the products of dissociation hydrolyze" , the percent of the students who checked the "False" choice and so gave the correct answer in the treatment group 48 % and in control group 46 %. These responses have displayed students' misconceptions that ions derived from strong acids and bases hydrolyze, once more. The responses have displayed that student haven't understood the meaning of the hydrolysis of the salts. When the post test results examined, it has been seen that the percent of the correct answers and correct explanations have been increased. The applications conducted with treatment group and the inquiries which support students' discoveries have had important contributions on students' post test results and this misconception has been eliminated partially.

The fourth question asks for the equilibrium constant (K_a and K In the pre test, 35 % of the students of treatment group and 39 % of the students of the control group has checked the "K_b" choice and given the correct answer. When the responses of the students investigated, they have had difficulties while determining the ions derived from weak and strong acids and bases as before. Nearly half of the students has thought that Na^+ ion forms the equilibrium. Similarly, these students haven't had clear knowledge if Na^+ ion has acidic of basic character. In pre test, the percents of the students who know that NO_2^- ion forms the equilibrium and this ion has basic character in treatment group 25 % and in control group 19 %. The percent of the students who have explained that NO_2^- ion forms the equilibrium and has acidic character in treatment group 23 % and in control group 22 %. The responses have displayed that, students still have had difficulties while recognizing the ions derived from strong and weak acids and bases. At this point, students have thought that HNO_2 is a strong acid since nitric acid is a strong acid and they have had difficulties while recognizing the weak tür. However, when the post test results investigated, it has been seen that the percent of the correct answers has been increased.

The fifth question asks for if the statement "The H_3O^+ concentration of 1.10^{3-} M $Na_2HPO_4^-$ is lower than the H_3O^+ concentration of 1.10^{3-} M NaH_2PO_4" is true of false. Most of the students both in treatment group and control group have thought for the equilibrium of the anion with water while choosing K_a. However, these anions are formed in previous equilibriums. Students have answered the question without considering this. When the post test results investigated, it has been seen that the percentage of the correct answers for this question has been increased.

When students' responses to the sixth question in pre test investigated, it has been seen that students have difficulties while recognizing the ions that come from strong and weak acids and bases. Most of the students have given correct answers for NaCl since it is a well known salt. However, the percent of the students who have stated that $Ba(NO_3)_2$ is a salt of strong acid-strong base has been 18 %. In pre test, students' answers for NH_4Br and $KC_2H_3O_2$ have displayed that they have had difficulties while recognizing the ions that come from weak and strong acids and bases. When students' responses to the sixth question in post test investigated, correct answer percent for determining the ions derived from weak and strong acids and bases has been increased.

The seventh question asks for the classification of some salts as "strong acid-strong base salt," a "strong acid-weak base salt," a "weak acid-strong base salt," or a "weak acid-weak base". Students' responses to this question in

pre test have displayed that students have had problems while determining the ions derived form strong and weak acids and bases, once more. Similar to the responses of sixth question, nearly all of the students have answered that KCl and $NaN0_3$ which are well-known salts are strong acid-strong base salts. But, they can not give correct answers for the other salts which aren't as well known as others. For example, students have had confusions about K_3PO_4 salt.

Eight and ninth questions have been asked for determining students' knowledge about the ions which hydrolyze. When students' responses to these questions in pre test investigated, it has been seen that most of the students have thought that the ions that come from strong acids and bases hydrolyze (NaCl and $Ba(NO_3)_2$). Also some of the students have had no ideas about the subject. When post test results investigated, it has been seen that students' knowledge about the subject that the ions which come from strong acids and basis can not hydrolyze has been increased.

With tenth question, students have been requested to answer if the given salt solutions are acidic, basic or neutral. The results of the pre test have displayed that students have confused about the pH of the salts which formed by a weak and strong acids or bases. The results of the post test have displayed that the correct answer percent about determining the pH of the salts has been increased.

7.1. Suggestions

Through the findings of the study, we can suggest that: This study has been conducted with university students. Similar studies can be conducted with primary and secondary schools and even with pre-schools. Similar applications can be conducted related to other chemistry subjects. Constructivist applications can be conducted with different students groups such as gifted and disabled students. Researches should be conducted for searching appropriate methods and techniques which can be used in constructivist applications. Teaching materials and lecture plans should be developed for using constructivist approach in education. Some revolutions should be done in the curriculums for adapting constructivist approach to primary and secondary school programs. Some educational opportunities should be provided for in-service teachers to inform them about constructivist approach and the usage of constructivist approach. Teachers can use constructivist approach in their classes and by this way their students can actively participate in the lectures. A rich learning environment should be provided for using constructivist approach effectively.

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