

## Comparison of the Conceptual Change of Analogies and Conceptual Change Texts in Eliminating Students' Alternative Conceptions for Acids and Bases

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### Keywords

Conceptual Change;  
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text;  
Analogy;  
Acid base

### Abstract

The purpose of this study is to compare the efficiency of conceptual change text and analogy on the determination and remediation of eight grade students 'alternative concepts of within 'acids- bases' topic in 'particulate structure of matter' unit. This is a quasi-experimental research and pilot application was implemented with 50 students (25 students as analogy group, 25 students as conceptual change text (CCT) group) in 2014-2015 academic years. Groups were random determined. Courses were conducted by researcher in one of the groups teaching with analogy, in other group teaching with CCT. Acid-Base Concept Test (ABCT) comprising of two-tiered multiple choice items was used to collect data which Demirci used in her study in 2011. ABCT was applied to the both of groups as pre- and post- tests. The results were analyzed using SPSS 17.0 package program. The arithmetic mean of analogy group marks was;  $X = 36,91 / 25$ , the CCT group's arithmetic mean was;  $X = 31,96 / 25$  before application. Independent t- test were applied on ABCT pretest points and there had been statistically no difference between analogy and CCT groups in terms of pretest points before the instruction. ( $t(48) = 1,453$  :  $p > 0,05$ ) After two week the instruction, ABCT was applied to the both analogy and CCT group as posttests. It was observed that there was a significant difference in both of groups after the instruction. ( $t(48) = 5,834$  :  $p < 0,05$ ) When the data which were obtained from the post-test after application are evaluated, the arithmetic mean of the analogy group ( $X = 60,92 / 25$ ) increased approximately 24 points, and the arithmetic mean of the CCT group ( $X = 50,16 / 25$ ) increased approximately 18,2 points. In conclusion, analogies and conceptual change texts have a great effect on students' conceptual change about alternative concepts in acids bases topic, that the analogies were more effective than the conceptual change texts.

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## Introduction

Since concepts that are an important part of sciences are abstract, most concepts are more difficult to learn than other courses and different concepts can easily be formed in the student's mind. As a part of everyday life, and the acids and bases involved in the structure of many materials we use, it is first started to be given to students at the 8th grade level of primary education. Acids and bases are one of the most basic subjects of the subject, and this is something students will encounter in their future learning. The concepts in this level are generally based on basic concepts of acid and base, their characteristics, their recognition and their relation to daily life. It is important for the students to understand because of their relationship with daily life. Whether students from different countries, both abroad and in the domestic literature, have understood these concepts and studied the alternative concepts they have (Ross & Munby, 1991; Hand & Treagust, 1991; Morgil, Yılmaz, Şen & Yavuz, 2002; Demircioğlu, Demircioğlu & Ayas, 2004; Küçük, Çepni & Gökdere, 2005; Atasoy, Küçük & Akdeniz, 2011; Çetingül & Geban, 2011; Yıldırım, Ayas & Küçük, 2013; Demirci, 2011; Çelikler & Harman, 2015). Significant learning can only be achieved when new information is configured with pre-existing information. Identifying and eliminating different concepts from the scientific knowledge that students have before the beginning of the teaching process is one of the basic elements for meaningful learning. When we look at the literature, it has been found that traditional methods are inadequate to derive different concepts from these scientific information, that is, alternative concepts (Üce & Sariçayır, 2002; Çepni, Küçük & Bacanak, 2003; Köse, 2004; Çepni, Özsevgeç & Bayri, 2007; Akgün & Aydın, 2009).

In eliminating alternative concepts, information that is in the minds of the learners must be felt to be inadequate to account for new events, and information that is scientifically inaccurate must be changed to ensure compliance with new information. This process is called conceptual change process (Smith, Blakeslee & Anderson, 1993). One of the teaching methods based on the conceptual change approach is the analogy and the other is the conceptual change texts. The conceptual change texts primarily create displeasure in students, allowing students to become aware of alternative concepts that they possess, and explain why they are wrong with examples and justifications, offering scientifically accepted knowledge by making them feel insufficient to explain the new events they encountered (Ünal, 2007). Analogies provide an understanding of the new concept by revealing similarities and differences between the known concept and the new concept in order to make the students understand scientific concepts conceivably and plausibly (Duit, 1991).

In this study, it is aimed to investigate the comparison of the conceptual change texts and analogies which are prepared according to the conceptual change approach which is used to correct alternative concepts and to compare student effects and existing alternative concepts

## Methods

### *Model of research*

Semi-experimental design with dual experiment group was used to determine the alternative concepts in the science and technology lesson 'Material and Features' unit 'Acid and Bases' of the students in elementary school in the eighth grade and to compare the effects of conceptual change texts and analogies on the elimination of existing alternative concepts. Semi-empirical

control groups are selected randomly from the randomly generated ready-made classes as experimental and control groups. Pre-test is applied to groups before application. When the experiment group is specifically intervened, no experimental study is performed on the control group. After the application, posttest is applied to the groups. The effectiveness of the technique used on the groups is investigated by looking at the pre-test made before the application and the last test made after the application (Çepni, 2012). However, in this study, because of the effectiveness of the two different methods for the conceptual change approach on the groups, a quasi-experimental design with double experimental group was used. The method applied to randomly assigned experimental groups can be schematized as follows:

Table 1. Method applied in experimental groups

| Group         | Pre test | Application | Last test |
|---------------|----------|-------------|-----------|
| Analogy group | T1       | X           | T2        |
| CCt group     | T1       | X           | T2        |

### *Research Group*

The study was carried out with a total of 50 students (25 analogy groups, 25 CCT groups) studying in the 8th class in the Denizli provincial center town of a Middle School in the academic year of 2014-2015. One of the present 8th grades was randomly determined as the other group of CCT (conceptual change text) group.

### *Data Collection Tools*

The results of the research were obtained by the acid base concept test consisting of two-step multiple-choice questions used to determine alternative concepts of acid and bases in the 8th grade primary school students, analogies and conceptual change texts used in the course. In the 1980s, Treagust (1988) developed a two-step diagnostic test that showed positive aspects of multiple-choice tests and minimized adverse effects. The two-stage tests consist of two phases, as the name suggests. The first stage is the same as multiple-choice tests. In the second phase, the student is asked to explain the reason for the option chosen in the first step. The second stage of the test may consist of multiple-choice or multiple-choice open-ended multiple-choice questions, often including alternative concepts identified in the literature search or in the direction of the data obtained from student interviews. In addition, this second chapter can be organized in an open-ended structure (Karataş et al. 2003) in order to better measure students' reasoning ability and to determine whether there are alternative concepts from previously determined alternative concepts. Karataş et al. (2003) noted the two-stage test variants as follows.

Table 2. Two-stage diagnostic test variants

| Types of Two-Stage Tests                    | 1 . Stage       | 2. Stage                       |
|---|-----------------|--------------------------------|
| 1. Multiple-choice two-stage tests          | Multiple-choice | Multiple-choice (+Open-ended)  |
| 2. Two-stage tests requiring classification | True False      | Multiple-choice (+Open-ended ) |
| 3. Open-ended two-stage tests               | Multiple-choice | Open-ended                     |

Analyses of two-step multiple-choice diagnostic tests (tests of type 1 and 2 in Table 2) are usually provided by students' tabulation of the answers they provide for the initial stages of each problem and the percentages of the reasons they have chosen for these answers. Student responses tabled in this way look at the combination of the first stage and the second stage (Karataş et al. 2003).

In this study, Demirci (2011) used a two-stage Acid Base Concept Test (ABCT) with 23 items, cronbach alpha reliability of 0.875, and conceptual change texts used by Demirci (2011) in the study of Treagust, taking into consideration the test development steps. Some of the analogies used in the study were quoted from the work of various researchers, and some were prepared by the researcher.

Related to 'Acids have H + ion in the structure, bases have OH - ion in the structure' and strong acids and bases 'Footballer and Goalkeeper' analogy and related to acids and bases characteristics and the replacement of the Litmus Paper Color 'Little Red Riding Hood and the 'Blue-Eyed Wolf' analogy were obtained from the study of Kobal (2011). The analogy of 'Composites league final match' related to neutrality was taken from the book of science and technology textbook of the 8th grade primary education of primary school. The analogy of egg and sperm fertilization, which is similar to the phenomenon of neutralization, is obtained from the study of Ekici et al. (2007).

The analogy of 'Saw 8', which is related to the fact that acids and bases can be distinguished from litmus paper, 'pHMetre Train' analogy related to the pH relation of acids and bases, 'Experimentally shows the interaction of bases with acids', this interaction is called 'neutralization reaction' Analytical 'in a country named' Reaction ', which is related to the achievement of 'what is the result of neutralization '. They explain why they should be careful when using acid-base solutions; The analogy related to the acquisition of danger signs for chemical substances' is quoted from the textbook of Science and Technology in Primary 8th grade.

### *Analysis of Data*

The questions to be used in determining the level of conceptual change in the students are classified according to their content. This classification is given on the table.

Table 3. Analysis of the questions

| Question Number                  | Content                       |
|----------------------------------|-------------------------------|
| 1, 5, 6, 7, 19                   | Acid Base Description         |
| 2,3, 4,8, 9,11, 15,17, 18,20, 23 | Properties of Acids and Bases |
| 10, 14, 16, 22                   | Neutralization and pH         |
| 21                               | Indicator                     |
| 12                               | Acid rains                    |
| 13                               | Acidity of the soil           |

In ABCT, which is used as pre-test and post-test in the study, the answers given by the students were examined one by one, and how the student answers were categorized and the scores of these categories were determined. In the evaluation, Karataş et al. , 2003; Demircioğlu,

2003 and Çakmak, 2009 were utilized and it was noted that the maximum score to be given to the second stage is more than the maximum score to be given to the first stage because it is more important than the right option. The scoring key used in the analysis of the given student responses is presented in Table 4.

Table 4. ABKBT 's Rating Score Used in Data Analysis

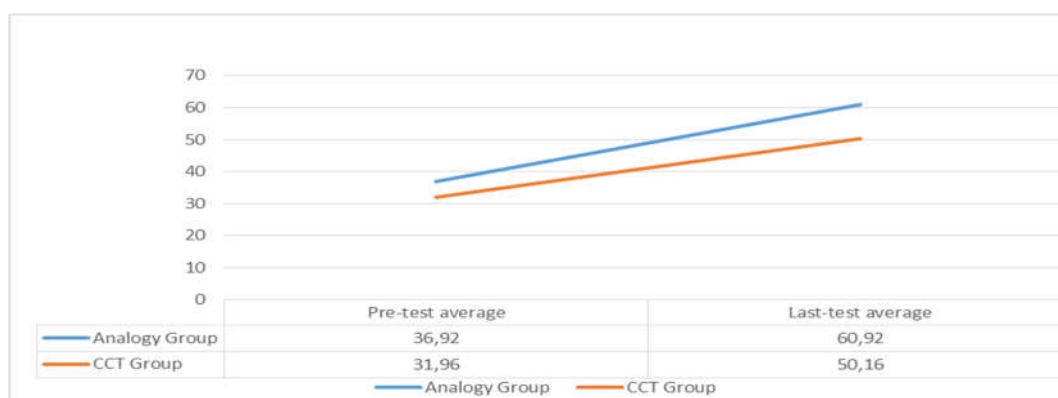
| 1. Scoring stage                  | 2. Scoring stage                         | Evaluation Criteria | Point |
|-----------------------------------|--|---------------------|-------|
| The Right Choice 1                | The Right reason 2                       | RC – RR             | 3     |
| The wrong Choice 0<br>Blank (B) 0 | Misleading Cause(YN)<br>0<br>Blank (B) 0 | WC – MC             | 2     |
|                                   |  | B-RC                |       |
|                                   |  | RC– MC              | 1     |
|                                   |  | RC-B                |       |
|                                   |  | WC – MC             |       |
| WC-B                              |  |                     |       |
| B-MC                              |  |                     |       |
| B-B                               |  |                     |       |
| MAX= 23*3=69 point                |  |                     |       |

As can be seen from Table 4, They will get 3 If the students respond to each test item in the category 'the right option is the right reason' , They will get 2 'Wrong option - if they answer correctly in the category' empty-true cause ' , They will get 1 If they answer in the 'right option-luck cause', 'right option-empty' category ; They will get 0 points if they answer in the category 'wrong option - misleading cause', 'wrong option - empty', 'empty-misleading cause', or 'empty-empty' category.

Students with a score of 0 have no preliminary knowledge, students with a score of 1 have an alternative concept because they can not explain the justification part of the question correctly, students with a score of 2 actually have conceptual meaning but have experienced concept confusion and students with a score of 3 have a higher level of conceptual understanding

Two-stage multiple-choice test the pre and post-instructional outcomes were analyzed in SPSS 17 program. Independent groups were t-tested and pre test and post test scores were compared to determine whether there was a significant difference between the group

## Data



Scheme 1: Pre-test and last -test average of the students in analogy and KDM groups.

When the graph was examined, the ABKT pre-test averages of the students in the analog group were 36.92, but this value increased to 60.92 in the last test. For the KDM group students, this value increased from 31.96 to 50.16. According to this, an increase in the conceptual level of the students in both groups is seen to be higher in the analogy group.

Independent groups t-test was performed between the ABCT pre-test scores of the students in both groups and the results are given in table 5.

Table 5. Independent groups t-test results on ABCT pre-test scores of students in the analogy and KDM groups

| GROUPS        | N  | Mean  | St. Deviation | Sd | t     | p    |
|---------------|----|-------|---------------|----|-------|------|
| Analogy Group | 25 | 36,92 | 11,88458      | 48 | 1,453 | ,153 |
| CCT Group     | 25 | 31,96 | 12,25248      |    |       |      |

Independent groups t-test was done between ABCT final test scores of the students in the analogy and CCT groups and the results are given in table 6.

Table 6. Independent groups t-test results on ABCT post test scores of students in the analogy and CCT groups

| GROUPS        | N  | Mean  | St. Deviation | Sd | t     | P    |
|---------------|----|-------|---------------|----|-------|------|
| Analogy Group | 25 | 60,92 | 5,68565       | 48 | 5,834 | ,000 |
| CCT Group     | 25 | 50,16 | 7,26108       |    |       |      |

In Table 6 it is seen that the value of p is 000. In this case, it seems that there is a significant difference between analogies and KDM groups in terms of ABCT post test scores.  $t(48) = 5,834$ :  $p$  and  $lt; 0.05$

## Discussion

When the data obtained from the pre-test and the post-test were evaluated after the application, it was found that the average of the arithmetic average of the analogy group ( $X = 60,92 / 25$ ) and the arithmetic mean of the CCT group ( $X = 50,16 / 25$ ) point increase. On the other hand, in the last tests, it is understood that the average difference between the analogies and the CCT groups is also statistically significant. ( $t(48) = 5,834; p < 0,05$ ) These data show the effect of analogies and conceptual change texts on the conceptual change of alternative concepts existing in students. This result is consistent with the results of Glynn and Takahashi (1998), Demircioğlu and Özmen (2003), Demircioğlu et al. (2004), Tamer (2006), Azizoglu, Aslan and Pekcan (2015). However, it was concluded that the conceptual change of the analogy group in which the analogies were applied was statistically more successful than the CCT group in which the conceptual change texts were applied. When the relevant literature is examined, it is seen that Okur (2009) is compatible with the studies of Sevim (2013).

There are a number of studies that have explored the effectiveness of using conceptual change texts, resulting in alternative concepts being removed and students being effective on their achievements (Çetingül & Geban, 2005, Köse, Ayas & Usak, 2006, Ünal, 2007, Sevim, 2007). There are also studies in which the effectiveness of using analogies is searched and the results are expressed in terms of the achievement of alternative concepts and the success of the students. (Bilgin & Geban, 2001; Sağırılı, 2002; Duru, 2002; Kaptan & Arslan, 2002; Günay Bilaloğlu, 2006; Demirci Güler, 2007; Karadoğu, 2007; Cerit, 2008; Aykutlu Çıldır, 2009; Kayhan, 2009; Kobal, 2011; Kahraman Gökharman, 2013; Sevim, 2013 ; Kobal, Şahin & Kara, 2013 ; Azizoğlu, Aslan & Pekcan, 2015). This study is in accordance with the above mentioned studies because of the statistical significance of the mean difference between the groups in the final tests (Kahraman Gökharman, 2013; Sevim, 2013; Kobal, Şahin & Kara, 2013.; Azizoğlu, Aslan & Pekcan, 2015).

In this study, in which the conceptual change is in effect, the effectiveness of analogies and conceptual change texts is compared. In this study, it is concluded that the conceptual change of the group to which analogies are applied is statistically more successful than the conceptual change text. When the related literature is examined, it is seen that this result is compatible with the studies done by Sevim (2013) and Okur (2009).

When we look at the conceptual change in the alternative concepts of acid and base definitions, it is seen that some of them are completely removed, others of which the proportion of others is decreased. For example, 'acids contain H element in their compound structures and they give OH ions to aqueous solutions.' 'In aqueous solutions, the bases that form H + ions are bases, while those that form OH - ions are acids.' 'Acids contain hydroxide ions (OH-). Therefore, CH<sub>3</sub>COOH is acidic.' 'All bases must contain the hydroxyl group (OH) in the compound structure. For this reason, NH<sub>4</sub>OH, KOH, CH<sub>3</sub>COOH and NaOH compounds are basic.' While the alternative concepts have been completely removed from the analogy group, the KDM group has not fully recovered and the rate has decreased. The bases contain the hydroxide ion (OH-). Therefore, CH<sub>3</sub>COOH has a compound base. The proportion of the alternative concept has not changed in both groups. Other alternative concepts decreased in both groups. The lack of anecdotal knowledge of students at the molecular level in the definition of acid and base is thought to be not as effective as analogies in alternative concepts related to acid base definition in conceptual change of CCTs. In his Sevim (2007) study, he stated that the CCTs did not adequately simulate micro-level events as a macro in their minds. In this point, it is thought

that in establishing the source - target relation in the teaching with analogy, the fact that the source is known by the students from previous experiences is effective in the analogous success of the analogies in the conceptual change.

## Results

1. Preliminary test point average of the students in the group of the analogy was 36.92 while the mean of the pre-test scores of the KDM group students was found 31, 96. The independent groups t-test was found to be 153 in order to determine whether there was a significant difference between the pre-test scores of the students in the analogy and KDM groups, and there was no significant difference between the groups in terms of pretest ( $t(48) = 1,453; p > 0.05$ ).

2. The mean pre-test scores in the group of the anthropological group were 36.92, while in the final test this value increased to 60.92. When the pre-test post-test averages of the analogy group were compared, p value was found to be 000, and a significant difference was found between pre-test and post-test point averages ( $t(24) = -13,965; p < 0,05$ ). As we have seen, the analogy method has been effective in increasing the success and providing conceptual change. When we look at the literature, the analogy method (Bilgin & Geban, 2001, Sağır, 2002, Duru, 2002, Günay Bilaloğlu, 2006, Akyüz, 2007, Kılıç, 2007, Demirci Güler, 2007, Çalık et al., 2008); Aykutlu Çıldır, 2009; Kayhan, 2009; Wichaidit, Dechsri & Chaivisuthangkura, 2011; Kobal, Sahin & Kara, 2013; Kahraman Gokharman, 2013; Sevim, 2013; Azizoğlu, Aslan & Pekcan (2015) have also succeeded in increasing the success and providing the conceptual change.

3. The average pre-test scores of the KDM group students increased from 31.96 to 50.16 in the final test. In the arithmetic mean of the KDM group ( $X = 50,16 / 25$ ), an increase of 18.2 points has occurred. The p value was found to be 000 ( $t(24) = -11,208770; p < 0,05$ ), when there was a significant difference between the KDM group pre-test post test score averages. As can be seen, conceptual change texts have been effective in enhancing success and conceptual change. When we look at the literature, we can see that the conceptual change texts (Geban & Bayır, 2000, Pınarbaşı & Canpolat, 2002, Önder & Geban, 2006, Sevim, 2007, Okur, 2009, Özmen et al., 2009) provide conceptual change.

4. In our study, many alternative concepts were found in the literature about acid and base in both groups. For example; 'All the substances with H atoms in the structure are acid.' 'It is acid because it gives H ion to NH<sub>3</sub> aqueous solution' (Demirci, 2011), 'Hydrogen The materials containing the ion are the acid, the substances containing the hydroxide ion are the bases.' "(Ross & Munby, 1991; Yahşi, 2006; Çetingül & Geban, 2011; Demirci, 2011). 'All acids are useful.', 'All acids are harmful' (Demirci ve Özmen, 2012); 'NH<sub>3</sub> is acidic because it contains H + ion'. 'A substance with an acid property cannot be renewed' (Erol, 2010); 'Acidic solutions are more hazardous than basic solutions' (Cross et al., 1986); 'All acids are liquid' 'Acids taste bitter.' 'Strong base is very sour.' 'All cleaning substances are some.' (Çelikler & Harman, 2015); 'In all neutralization events, acids and bases completely destroy each other's effects', 'neutralization results in no H + nor OH- ions in the environment ', 'acids do not come into contact with acids as they increase in pH, bases do not come in. ', 'pH values of salts are absent.' (Ayas, Demircioğlu & Demircioğlu, 2005); 'Acidic solution converts red turnus to blue' (Bradley & Mosimege, 1998).



5. In case of conceptual change of analogies and conceptual change texts prepared in accordance with the conceptual change approach in terms of the concepts of students and bases which students have in terms of conceptual change approach and when the effect is compared in the case of increasing the success rate of the analogy group, 60,92 with the increase of the last test average of the analogy group to 60,92, And the average of the test was increased to 50,16 with an increase of 18,2 points. When the final test scores are compared, it is seen that the p value is 000. In this case, there is a significant difference between the analogy and the CCT groups in terms of the post test scores ( $t(48) = 5,834 : p < 0,05$ ).

6. The conceptual change texts are influential in that they have a preliminary knowledge of the learners and in the alternative concepts that exist in macro level concepts. For example, 'All the substances with acidity are bitter and peppery.', 'Although some substances with acidity are sour, most of the acids are bitter.', 'Though muriatic acid is a strong acid, it can stand in a plastic container. This indicates that the acids are definitely not burning or piercing. ', 'All acids are edible and drinkable. 'Acid is not a matter of acidity and basicity in the taste of fruits and vegetables such as lemon, plum, apple, grapefruit,' 'Acetic acid has a sharp smell, and another acid, hydrogen All of the acids are stinky smell. ', 'It is not odorless acid. Therefore, it can be understood that a substance is a scent that is acidic '. 'Red / purple cabbage juice is pink with acid dropping, blue coloring with base dropping; Is a proof that the acids are pink / red, and the bases are blue. 'Alternative concepts are the result of students' day-to-day experience and preliminary knowledge, so that the CCTs have preliminary knowledge of the learners and the conceptual change in alternative concepts at the macro level. This result is parallel to the study results of Sevim (2007).

7. Analogies are more effective than conceptual change texts in alternative concepts arising from lack of prior knowledge of students. For example, "Acids contain H in the compound structures and give OH ions to the aqueous solutions." "All substances containing OH- ions are acid," "H + ions in aqueous solutions are bases, The substances that contain H atoms in the compound structure, not the solutions, are acid. ', Neutralization reaction will be neutral in the resultant medium; The pH value of the products (ie salt and water) will be 7 ', 'the salt will not be a pH value since the neutralizing acid and base will completely destroy each other's effect; That is, pH = 0 ', 'HCl is a stronger acid than nitrate. The pH value of HCl must be higher than the pH value of the syringe since the acidic property increases as the pH increases. ', 0 'indicates that there is no acidity at all. However, HCl is a strong acid. For this reason, the pH value must be a different number from 0 (zero) ', 'An acidic and basic environment is formed by the interaction of acid and base ', 'Acid forms a physical mixture with the base and no chemical reaction takes place ', 'Only pH paper and phenolphthalein markers ', 'Markers such as acids and bases are only paper materials used in experiments and in laboratories. Hence, only the pH paper is the indicator within the given range. The analogy technique used to provide conceptual change in alternative concepts such as 'only two of the given items are in the laboratories' provides the students to understand the concepts of the subject by embodying the abstract concepts in their minds. Glynn and Takahashi (1998) also stated that the use of analogy in the study they work makes positive in their minds, and affects positively the increase in success.

8. Conceptual change texts can also be ineffective in conceptual change. CCTs did not provide adequate conceptual change in the student's situation when there is no prior knowledge of the students. For example, NH<sub>3</sub> is not a base because it does not have a hydroxyl group (OH group) in its structure. ', 'Strong acids are dangerous, but strong bases are not dangerous. For this reason, caution should be exercised only when working with acids. ', 'Vitriol and the salt spirit

are the bases and bases turn the blue litmus paper into red', and 'K +', which is the result of the neutralization reaction, does not contain H<sup>+</sup> and OH<sup>-</sup> ions, 'The pH of the strong acid is 0-1, and the pH of the strong base is 13-14, so the pH of the formed salt is 7.' All acids are strong. That's why they hurt us. The stinging nettle and the ant bite also give a burning pain, so '0' (pH value) indicates that there is no acidity. However, HCl is a strong acid. For this reason, the pH value must be a different number from 0 (zero)'. There are no pH values of the salts formed in the neutralization reactions, 'Acid forms a physical mixture with the base, no chemical reaction occurs'. While CCTs provide conceptual change in some students in some alternative concepts, some have been ineffective in conceptual change. It was seen that the activities prepared in Şahin, Bülbül and Durukan (2013) studies were not effective in providing the conceptual change in all of the students, and this situation was thought to be caused by the short time applications in their studies.

9. Situations in which the animations are ineffective in conceptual change have also been identified. Although the success rate is higher than that of the KDM group in the group in which the analogy method is applied, the pH of the strong acid is 13-14 because the pH of the strong acid is 0-1, and the pH of the formed salt is 7'. Acids are harmless. Therefore, acid rain does not have any effect on historical artifacts. In order for analogies to be effective, it is thought that more attention must be paid to the limitations of the analogy to the features of the source concept used in the analogy, the unlike aspects of the target concept. In the study of Geban, Ertepinar, Topal and Önal (1998), in the group with acid base, the analogy method was explained in the other group using the traditional method and it was determined that there was no significant difference between the groups in success.

The subject of acid and basics is an abstract concept that covers the process from primary education to tertiary education. For this reason, teachers can make the concept of acid and bases more understandable by using the methods of analogies and conceptual change texts.

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