EFFECTS OF TEACHING MATERIAL BASED ON 5E MODEL REMOVED PRE-SERVICE TEACHERS' MISCONCEPTIONS ABOUT ACIDS-BASES[1)]

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Abstract. The aim of this study is to determine effect of teaching material based on 5E model on pre-service teachers' conceptual change 'acid-bases' subject. This research was carried out with 25 sophomore pre-service teachers at Artvin Çoruh University Faculty of Education who were enrolled to science laboratory practices course in 2006–2007 instructional term-fall semesters. In this study, one-group pretest-posttest design was used. The study consisted of three phases; in the first part, a concept test with ten open ended questions was employed to determine student's misconceptions about 'acid-bases' subject. In the second part, an activity based on 5E model was developed and implemented as a teaching intervention. In the last part, the concept test was re-administered after the teaching intervention. It was found that pre-service teachers had many misconceptions about acid and bases as found in

literature. Moreover, teaching material based on the 5E model is concluded to be quite effective solving misconceptions.

Keywords: acids and bases, pre-service teachers, conceptual change, constructivist approach, 5E model, misconceptions

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Introduction

In recent years rapid developments in science made it hard to keep up with the changes in the field. To keep pace, researchers firstly try to understand the dimension of a concept instead of learning all of them. Concept learning has a strong influence on preventing complexity and confusion in students' minds in order to help classify or categorize the information in their memories (Çepni et al., 2005). Ayas et al. (1997) and Çepni et al. (2005) emphasize that two basic methods that are related to concept learning. These are inductive and deductive methods. In the deductive method, the teacher wants his/her students to find suitable or unsuitable examples for a concept when she/he is giving a description or definition of the concept. In the inductive method, the teacher allows his/her students to make generalizations with the best examples. In this method, the students should determine the quality of the description and distinction by examining the relevant or irrelevant examples of the concept (Çepni et al., 2005).

There are some factors that affect the concept learning method. One of the most important factors that affect the concept learning is the students' preknowledge before instruction (Özmen & Demircioglu, 2003). A lot of research designates that students come to the classroom with various preknowledge and concepts, which are different from scientific surroundings related to scientific events. Pre-knowledge fixed in students' mind prevents from their learning scientific principles and concepts in a correct way (Anderson, 1986; Griffiths & Preston, 1992). Because of this, student's preknowledge and misconception should be revealed and instructive activities

should be planned according to this situation (Coştu et al., 2007). In this context, the primary stage of concept instruction and the determination of misconceptions as a result of students' pre-knowledge are important.

A literature review has determined that there are misconceptions in a lot of science subjects such as chemical bonding, chemical change, mole, gases, nature of solutions, chemical reactions, acid-bases and particulate nature of matter including acids and bases. In national and international literature, research about the acids and bases is focused on students who are different grades and various levels, such as primary school, high school and university (Cros et al., 1986; Cros et al., 1988; Hand & Treagust, 1991; Ross & Munby, 1991; Schmidt, 1991; Nakhleh & Krajcik, 1993, 1994; Botton, 1995; Bradley & Mosimege, 1998; Toplis, 1998; Sisovic & Bojovic, 2000; Demircioğlu et al., 2001, 2002, 2004; Demircioğlu, 2003, 2009; Demircioğlu et al, 2005; Demerouti et., 2004; Özmen & Yıldırım, 2005; Özmen et al., 2009). Some of this research related to students' understanding of concepts after instruction activities, and some parts of the research related to how to present these subjects more efficiently using different learning methods. Besides, most of the researchers determined misconceptions related to acid and bases. Researchers pointed out that students in different levels have difficulty in understanding the concept of acids and bases concepts and students have some misconception related to ionic nature of acids and bases, general feature of acid and base, features of strong and weak acid-bases, pH and pOH concepts, neutralization, features of salts that occur as a result of acid and bases reaction. Taking care of this, it is very important to remove different levels students' misconceptions about acid and bases. According to Christianson & Fisher (1999), identifying students' alternative conceptions are very important; however, finding ways to eliminate or overcome these conceptions is more important.

In recent years, different methods are used to overcome misconceptions. One way to close the gap between alternative conceptions and scientists' con-

ceptualization is to use conceptual change learning models (Hewson, 1981; Hewson & Hewson, 1983; Posner et al., 1982). In general, conceptual change has been described as a part of learning mechanism that requires the learners to change their conceptions about a phenomenon or principle either through restructuring or integrating new information into their existing schemata (Hewson, 1996). The conceptual change approach was developed by Posner et al. (1982) and Hewson (1981). Posner et al.'s (1982) conceptual change model asserts that a concept has to be built upon students' prior ideas about that concept (Hewson, 1981). Posner et al. (1982) suggested four conditions: (1) students must become dissatisfied with their existing conceptions (dissatisfaction); (2) the new concept must be clear and understandable for students (intelligibility); (3) the current problem should be solved by using the new concept (plausibility); (4) similar future problems can be solved by using the new concept (fruitfulness). Generally there are a lot of teaching methods such as analogies, concept mapping, worksheets, hands on activities and conceptual change texts based on conceptual change model. Most of them were developed to use Piaget's ideas and principles of constructivist learning theory **(**Hewson & Hewson, 1983; Hynd et al., 1994; Stofflett, 1994; Posner et al., 1982). Since constructivism not only stresses students' pre-exist knowledge but also engages students actively, much more research has paid more attention on students' alternative conceptions, and conceptual change (Kurnaz & Çalık, 2008). It is said that most conceptual change models consider the basic principle of constructivism that knowledge is actively constructed by the learner.

The constructivist approach defends that students do not take the knowledge as given to them by teachers, but they rather restructure that knowledge themselves (Bodner, 1986, 1990). When the constructivist approach is applied to create meaningful learning, a suitable environment needs to be provided to help students to develop their own knowledge by testing

their own experience (Çepni et al., 2000; Özmen, 2004). Beliefs and attitudes from a student's family, environment or culture will constitute principles for their future learning (Osborne & Wittrock, 1983). Also, it is thought that the biggest effect on learning new knowledge and concepts is pre-existing knowledge in contradiction with scientific knowledge (Bodner, 1986, 1990; Driver, 1991; Head, 1982; Hand & Treagust, 1991; Karataş, 2003). Students' pre-existing knowledge or misconceptions negatively affect their next learning. Therefore, giving students new knowledge related to previous knowledge accumulation and correcting misconceptions is thought to be necessity (Coştu et al, 2003). Students have an active role on the learning process including activities such as discussion, experiences, advocating ideas, developing hypothesis, interrogation and sharing ideas (Çardak at al., 2008) Also, students do not accept knowledge as it is, rather they create or explore the knowledge (Perkins, 1999). So constructivist approach is useful for removing misconception.

The constructivist approach has learning models such as 4E, 5E and 7E models available for using in a learning environment. The 5E model, which was developed by Bybee who was a leader of Biological Science Curriculum Study (BSC), is the most popular version (Keser 2003; Kurnaz & Çalık, 2008). The 5E model consists of activities that increase student's inquiry and curiosity, answers the expectation of the subject and includes active use of information and skill (Özsevgec, 2006). The 5E model includes students in activities at every stage and also encourages them to form their own concepts (Ergin, 2006). Furthermore, this model is used as the embodiment of the constructivist approach and is composed of activities that increases students' concerns, supports their expectations related to the topic and includes active use of their knowledge and skills (Çardak et al, 2008). Studies conducted using the 5E instructional model reveal that the model increases the success of students, elevates their conceptual understandings and positively changes their

attitudes (Baker & Piburn, 1997; Kör, 2006; Özsevgec et al., 2006; Saglam, 2006; Çardak et al, 2008**).**

So, the aim of this study is to determine the effect of teaching material based on 5E model on pre-service teachers' conceptual change 'acid and bases' subject.

Methods

Experimental research methods were used in order to measure variables and the differences reveal between reason and result (Çepni, 2005). In this study, a one-group pretest-posttest design was used. Pretest-posttest designs are widely used for the purpose of comparing groups and/or measuring change resulting from experimental treatments (Cressweel, 2002). It was tried to determine to measure the change resulting from experimental treatments in this study. This research was carried out with 25 sophomore pre-service teachers at Artvin Çoruh University Faculty of Education who were enrolled to science laboratory practices course in 2006–2007 instructional term-fall semesters. The sample of this study consists of 11 men and 14 women pre-service teachers. These pre-service teachers learned about the acids and bases topic at primary school, high school and university. All of them succeed in learning about the acids and bases topic.

The study consisted of three phases; in the first part, concept tests with ten open-ended questions were employed to determine on students' misconceptions about acids and bases. In the second part, an activity based on the 5E model was developed and implemented as a teaching intervention by the researcher within four weeks. Preparing instructional material based on the 5E model gave knowledge as general features of acids and bases, features of strong and weak acid-bases, pH and pOH concepts and features of salts that occur as a result of acids and bases reaction. In the last part, the concept test

was re-administered after the teaching intervention. This experimental process was completed nearly within six weeks.

Process of developing instructional material

The instructional material was based on the constructivist approach's 5E models in order to remove pre-service teachers' misconception about acids and bases. Instructional material was focused on (a) general feature of acid and base, (b) features of strong and weak acid-bases, (c) PH and POH concepts and (d) features of salt which occur as a result of acid and bases reaction. Consequently, four instructional materials were developed by researcher. Each subject was tried to teach instructional materials based on 5E model. The 5E models consist of five phases including engagement, exploration, explanation, elaboration and evaluation.

In the engagement stage, it was firstly required that teacher assesses the pre-service teachers' prior knowledge and helps them to become engaged in a new concept through the use of short activities. Pre-service teachers were asked some questions about acids, bases, strong and weak acids and bases, the concept of PH and POH and types of salt in order to determine on pre-service teachers' pre-knowledge and misconception. The researcher told a story about the relationship among properties of acids and bases, the results of a reaction between acids and bases and acidic and basic salt reactions. After this story was told, students were asked some questions about it.

In the exploration stage, pre-service teachers were divided into five groups, five pre-service teachers in each group. Students tried some experiments about the properties of acids and basses, strong and weak acids and basses, determinations of PH and POH, reactions between acids and basses, strong acids and strong basses, strong acids and weak basses, strong basses and weak acids and features of salt and its varying types. Every group discussed with the others groups

In the explanation stage, after each group completed activities, they were asked some questions related to experiments at the exploration stage in order to present their structured knowledge claims and share their ideas with their peers through a class discussion. Then, the teacher confirms/disconfirms the students' gained knowledge claims, so that the students can compare their newly structured ideas with those presented by the teacher.

In the elaboration stage, it was required that teachers challenge and extend pre-service teachers' conceptual understanding and skills and that student test their understanding of the concept and/or apply it to a real world situation. In this stage, Pre-service teachers were given problems related to acids and bases subject. Then, asked solution problems. Pre-service teachers were wanted to answer problems correctly by researchers.

In the evaluation stage, the students were given a performance task. In this performance task, students were asked to write a dialogue related to learn about acids and bases. Students were asked to construct a concept map. For this, students were given ten concepts: acids, bases, strong acids, strong bases, weak acids, weak bases, pH and pOH, acidic salt, basic salt and neutral salt. Students were asked to outline what they had learned in order to become conscious of their learning.

One of four instructional materials related to general feature of acid and bases was given in Appendix.

Data collection tool

In literature, there are a lot of methods to determine misconception. These methods are; concept mapping, prediction-observation-explanation, interview about instances and events, interview about concept and drawing, word association, fortune lines, diagnostic test (Çepni et al., 2005; White & Gunstone, 1992; Schmidt, 1997; Ayas et al., 2001). In this research, it was used a diagnostic test to determine pre-service teachers' misconceptions about

acid and bases. Pre-service teachers were asked ten open-ended questions in order to determine pre-service teachers' misconception about general features of acid and bases, features of strong and weak acid-bases, definition of PH and POH conception, features of salt which occur as a result of reaction between acids and bases. Providing content reliability of this concept test was examined by three experts, two chemistry teachers and one Turkish teacher. Then, according to feedback, the concept test was reorganized.

The ten questions in the concept test are: (1) what do you understand about acids and bases concept? Explain using examples; (2) have do you heard of "strong and weak acid" concepts? If yes, explain what these concepts mean; (3) what do you know about strong and weak bases? Explain what you know; (4) what do you understand about PH and POH concepts? (5) Ali thinks that strong acids contain so many hydrogen ions and weak acids contain very few hydrogen ions. In your opinion, is Ali's view correct or incorrect? Explain with reasons; (6) Mehmet understands that bases that contains OH ion but not contain any H ion. Do you agree with Mehmet's opinion? If you agree, why? If you disagree, why? Please explain; (7) when a solution of strong bases is poured solution of weak acid, it consists of salt that occurs as a result of reaction. When we pour strong bases on this salt again, is there any reaction? Explain your reasoning; (8) when a solution of weak bases is poured on a solution of a strong acid, it consists of salt that occurs as a result of reaction. When we pour strong bases on this salt again, is there any reaction? Explain your reasoning; (9) when a solution of strong bases is poured solution of strong acid, it consists of salt that occurs as the result of reaction. When we pour strong bases on this salt again, is there any reaction? Explain your reasoning; (10) Ahmet thinks that strong acid is sourer than weak acid. Do you agree with Ahmet's idea? If you agree, why? If you disagree, why? Please explain.

Data analysis

In this phase the prospective teachers' answers to ten open-ended questions applied pre and posttest were analyzed by the researchers. The researchers tried to determine misconceptions about acids and bases. The open-ended questions were analyzed under the following categories and headings, which were suggested by Ayas & Özmen (1998), Ayas (1995) and Demircioğlu et al. (2001). A sound understanding included all components of the validated response. Partial Understanding included responses where at least one of the components of validated the response, but not all the components. Partial understanding with specific misconception included an understanding of the concept, but also made a statement that demonstrated a misunderstanding. Responses labeled no understanding included illogical or incorrect information or repeated the question, contained irrelevant information or an unclear response or the student left the response blank. These criteria provided an opportunity to classify students' responses and make comparisons about their level of understanding. Next, the frequency and percentage were determined.

Findings

Researcher analyzed the pre-service teachers' answers to the questions in the concept test applied as pre and posttest in order to determine changes to the pre-service teachers' misconceptions about acids and basses. Table 1 shows the findings from these analyses.

Table 1. Frequencies and percentages of pre-service teachers' answers in four categories

	Pre-test								**Post-test**							
	SU	**%**	**PU**	**%**	**PUSM**	**%**	**NU**	**%**	**SU**	**%**	**PU**	**%**	**PUSM**	**%**	**NU**	**%**
1	6	24	4	16	14	56	1	4	22	88	3	12	-	-	-	-
2	1	4	2	8	22	88	-	-	24	96	1	4	-	-	-	-
3	1	4	1	4	16	64	7	28	23	92	2	8	-	-	-	-
4	1	4	11	44	6	24	7	28	21	84	4	16	-	-	-	-
5	-	-	1	4	22	88	2	8	19	76	3	12	2	8	1	4

6	-	-	5	20	9	36	11	44	15	60	5	20	1	4	4	16
7	1	4	4	16	8	32	12	48	17	68	1	4	2	8	5	20
8	1	4	3	12	6	24	15	60	15	60	1	4	2	8	7	28
9	1	4	2	8	6	24	17	68	13	52	1	4	3	12	8	32
10	-	-	4	16	12	48	9	36	18	72	2	8	4	16	1	4

SU= Sound Understanding PU= Partial Understanding PUSM= Partial Understanding with Specific Misconception, NU=No Understanding

When investigated Table 1, determined that pre-service teachers' answers were different between the pre and posttest. In the pre-test, pre-service teachers' answers to the ten questions were divided into four categories. It was seen that pre-service teachers' answers were between 0 % and 24 % for sound understanding, between 4 % and 44 % for partial understanding, between 24 % and 88 % for partial understanding with specific misconception and between 0 % and 68 % for no understanding. Furthermore, in the post- test, pre-service teachers' answers were between 52 % and 96 % for a sound understanding, between 4 % and 29 % for partial understanding, between 0 % and 16 % for partial understanding with specific misconception and between 0% and 32 % for no understanding. According to these results it was understood that pre-service teachers' misconceptions and misunderstanding were related to acid and bases increased.

In this study, pre-service teachers' misconceptions were identified in the pretest and posttest. It was seen that whether or not these misconceptions were removed. According to the pre and post test results, researcher consists of tables to include frequencies and percentages of misconceptions about general features of acids and bases, features of strong and weak acids-bases, the definitions of pH and pOH conceptions and features of salt that occur as a result of the reaction between acids and bases.

The results of misconceptions about general features of acids and bases were given in Table 2.

Table 2. Frequency and percentage of pre-service teachers' misconceptions about general features of acids and bases

	Pre-test		Post-test	
	f	**%**	**f**	**%**
Bases have only OH ions but not H ions	8	32	1	4
While bases changes blue litmus to red, acid changes red litmus to blue.	6	24	-	-
Acids burns and melts everything	3	12	-	-
While the taste of acids are bitter, taste of bases are sour.	2	8	-	-
Any substance that contains the H atom is an acid, an OH molecule is a base.	2	8	-	-
All acids and bases are harmful and poisonous	2	8	-	-
While acid have OH ions, basses do not have H ions	1	4	-	-

When investigated as shown in Table 2, in pre-test determined that 32 % of pre-service teachers have a misconception that "bases have only OH ions but not H ions" and 32 % of pre-service teachers have a misconception that "while bases changes blue litmus to red, acid changes red litmus to blue." It was also revealed that 32 % of pre-service teachers think that "Acid burns and melts everything". In post-test, it was determined that 4 % of pre-service teachers have a misconception that "bases have only OH ions but not H ions", the others misconceptions were removed.

Secondly, results of the misconceptions about general features of strong and weak acid-bases are given in Table 3.

Table 3. Frequency and percentages of pre-service teachers' misconceptions about features of strong and weak acid-bases

	Pre-test		Post-test	
	f	**%**	**f**	**%**
Strong bases contain more OH ions than weak bases	6	24	-	-
Strong acids contain more H ions than weak acids	5	20	-	-
Strong acids do not easily react	3	12	-	-
Weak acids do not easily react	3	12	-	-
Strong acids are sourer than weak acids	3	12	-	-
Strong acids burn more than weak acids	2	8	-	-
NH_3 and CH_3COOH are strong acids	2	8	-	-
The PH of weak acid is between 0 and 7	1	4	-	-
The PH of strong acid is between 7 and 14	1	4	-	-
The POH of weak bases is between 0 and	1	4	-	-

The POH of strong bases is between 7 and 14	1	4	-	-
While a strong acid has strong bonding among molecules, a weak acid has weak bonds among molecules.	1	4	-	-
CH_3 is a strong acid	1	4	-	-
CH_3COOH is a strong base	1	4	-	-
Strong bases don not convey to electricity	1	4	-	-
While strong bases have strong bonds among molecules, weak bases have weak bonds among molecules	1	4	-	-
C_2H_5OH is a weak base	1	4	-	-

As seen Table 3, in pre-test it was determined that 24 % of pre-service teachers have a misconception that "strong bases contain more OH ions than weak bases." and 20 % of pre-service teachers have a misconception that "strong acids contain more H ions than weak acids." Besides it was revealed that while 12 % of pre-service teachers think that "strong acids do not easily react." 12 % of pre-service teachers think that "weak acids do not easily react." Furthermore, 12 % of pre-service teachers have a misconception that "strong acids are sourer than weak acids". In post-test, it was determined that pre-service teachers' misconceptions form the pretest was completely removed.

Third, a result of misconceptions about definition of PH and POH conception is given in Table 4.

Table 4. Frequency and percentages of pre-service teachers' misconceptions about definition of PH and POH conception

	Pre-test		**Post-test**	
	f	**%**	**f**	**%**
PH is a measure of acidity.	2	8	-	-
POH is a measure of bassist.	2	8	-	-
As the value of PH increases, acidity increases	1	4	-	-
As the value of POH increases, bassist increases	1	4	-	-

As it was seen Table 4, according to results of pre-test, 8 % of pre-service teachers have a misconception that "PH is a measure of acidity.", 8 % of pre-service teachers have a misconception that "POH is a measure of bassist." 4 % of pre-service teachers think that "as the value of PH increases, acidi-

ty increases." 4 % of pre-service teachers think that "as the value of pOH increases, bassist increases". In posttest, it was determined that pre-service teachers' misconceptions in the pretest were completely removed.

Fourth, results of misconceptions about features of salt occur as a result of reaction between acids and bases is given in Table 5.

Table 5. Frequency and percentage of pre-service teachers' misconceptions about features of salt that occurs as a result of a reaction between acids and bases

	Pre-test		**Post-test**	
	f	**%**	**f**	**%**
Salt consists of a reaction between strong base and weak acid don't react again to strong acids	4	16	1	4
Salt consists of a reaction between strong acid and strong bases which react again to acids or bases.	3	12	-	-
Salt consists of a reaction between strong acid and weak bases don't react again to strong bases.	2	8	-	-
Salt consists of a reaction between strong acid and strong bases react again to strong acids or bases	2	8	1	4
Acids have a solution feature	2	8	1	4
Neutral salts react with acids and bases	2	8	-	-
Salt consists of a reaction between strong acid and weak base only react again to weak bases.	1	4	-	-
Salt consists of a reaction between strong acid and weak bases. But it doesn't react again to weak base.	1	4	-	-
Salt consists of a reaction between strong acid and weak base. This salt is a neutral salt.	1	4	-	-

According to results of pre-test, it was revealed that 16 % of pre-service teachers have a misconception that "salt consists of a reaction between strong base and weak acid don't react again to strong acids" and 12 % of pre-service teachers have a misconception that "salt consists of a reaction between strong acid and strong bases which react again to acids or bases" 8 % of pre-service teachers think that "salt consists of a reaction between strong acid and weak bases don't react again to strong bases." 8 % of pre-service teachers think that "salt consists of a reaction between strong acid and strong bases react again to strong acids or bases". In post-test, it was determined that most of the pre-service teachers' misconceptions in pre- test were removed.

After the instructional material was applied, it was seen that pre-service teachers' misconceptions about acid and bases were decreased and these teachers effectively learned about this topic.

Discussion and conclusion

The main purpose of the present study was to investigate the effectiveness of teaching material based on 5E model on pre-service teachers' conceptual change 'acid and bases' subject. In this study, concept test with ten open and questions were administered before the study in order to determine students' prior knowledge, because students' prior knowledge is important in the integration and construction of new knowledge in their existent cognitive structures (Önder & Geban 2006). In this study, it was revealed that pre-service teachers have some misconceptions about acid and bases subject the same as others studies. It was seen that these misconceptions related to general features of acid and bases, features of strong and weak acids-bases, definition of PH and POH conception and features of salt which occurs as a result of reaction between acids and bases

When it was seen pre-service teachers' misconceptions related to general features of acids and bases, pre-service teachers have misconceptions that bases turn blue litmus paper red, and acids turns red litmus paper blue; and that acids burn and melt everything and bases have only OH ions but not H ions. These misconceptions were identified in the studies of Cros et al., 1986; Cros et al., 1988; Ozmen & Demircioğlu, 2002; Morgil et al., 2002; Demircioğlu et al., 2005; Hand & Treagust, 1991; Demircioğlu, 2010; Nakhleh & Krajcik, 1994. It is thought that students have these misconceptions related to general features of acid and bases because of mistaking usage of these concepts in daily life. If acid and bases concepts were related to everyday life during teaching, their retention in the learner's mind was greater. This idea was supported by Demircioğlu et al. (2005). After teaching material

based on 5E models were implied, it was seen Table 2, most of pre-service teachers' misconceptions about general features of acid and bases. This result arises from giving samples related acid and bases to students in daily life during application of teaching material based on 5E model. Besides, students see and do experiments related features of acid and bases in classroom and it was allowed that students construct their knowledge and concepts. Anyway, in constructivist approach, it is suggested that learners construct their knowledge and concepts in the direction of their abilities and experiences (Osborne & Cosgrove, 1983).

Besides, before teaching materials based on 5E model were applied, pre-service teachers have misconceptions related to features of strong and weak acids-bases. Pre-service teachers have misconceptions that strong bases contain more OH ions than weak bases, strong acids contain more H ions than weak acids, strong acids do not easily react, weak acids do not easily react; strong acids are sourer than weak acids and strong acids burn more than weak acids. These misconceptions were seen in many studies including: Bradley & Mosimege, 1998; Hand & Treagust, 1991; Schmidt, 1991; Demircioğlu et al., 2005; Çetingül & Geban, 2005; Nakhleh & Krajcik, 1994 and Demircioğlu, 2010. Furthermore, pre-service teachers' misconceptions related to definition of pH and pOH conception that pH is a measure of acidity, pOH is a measure of bassist, as the value of pH increases, acidity increases and as the value of pOH increases, bassist increases. In literature, the same of these misconceptions were seen studies of Cros et al., 1986; Cros et al., 1988; Hand & Treagust, 1991; Ross & Munby, 1991; Demircioğlu et al., 2002; Morgil et al., 2002; Köseoğlu et al., 2002 and Demircioğlu et al., 2005. Strong and weak acid-bases and pH and pOH conception are very abstract concept. So, students have difficulty in learning of these concepts. Generally, Students have many misconceptions about these concepts. For this, when these concepts were teached by teachers, it was tried that these concepts were concretized. So, it is

important that instructional material which helps to student for concretion of concepts was used in the classroom. In this respect, it is revealed that using instructional material based on 5E model in this study help to student for concretion of strong and weak acid-bases and pH and pOH concepts. This result is said that it was seen Table 3 and Table 4. Besides, it is said that instructional material based on 5E model effectively, because students overcome misconception related to strong and weak acid-bases and pH and pOH concepts.

In addition to these, pre-service teachers' misconceptions about features of salt occur as a result of a reaction between acids and bases. Pre-service teachers have misconceptions that salt consists of a reaction between strong base and weak acid don't react again to strong acids, salt consists of a reaction between strong acid and strong bases which react again to acids or bases, salt consists of a reaction between strong acid and weak bases don't react again to strong bases and salt consists of a reaction between strong acid and strong bases react again to strong acids or bases. These misconceptions were similar to Schmidt (1991), Demircioğlu et al. (2002), Ozmen & Demircioğlu (2003).

After teaching material based on 5E models was used, Table 3, 4, 5 shows that all of the pre-service teachers' misconceptions about the general features of acid and bases, features of strong and weak acids and bases, the definition of pH and pOH conception and features of salt that occurs as a result of a reaction between acids and bases were removed. Most of pre-service teachers learned to these topics and increased their knowledge (as seen Table 1). Similarly, studies conducted using the 5E instructional model, evidence repeatedly reveals that the model increases the success of students, elevates conceptual understandings, removes misconceptions and positively changes their attitudes (Baker & Piburn, 1997; Kor, 2006; Ozsevgec et al., 2006; Saglam, 2006; Çardak et al., 2008). The 5E model includes students in activities at every stage and also encourages them to form their own concepts (Engin,

2006). Furthermore, this model that is embodiment of the constructivist approach and is composed of activities that increases students' concerns, supports their expectations related to the topic and includes active use of their knowledge and skills (Çardak et al., 2008).

NOTES

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APPENDIX

In engagement stage

In this stage, it was required that teacher assesses the pre-service teachers' prior knowledge and helps them to become engaged in a new concept through the use of short activities. So, firstly, it was told a short story about acid and bases subject to pre-service teachers by researcher. This story was given below.

There is a village in the bottom of mountain in Artvin. This village has two rivers. These rivers are surrounding to village. One of these rivers reserves right place of village called A river. Another river reserves on the left place of village called B river. A river has some features. For example; water of A river has bitter taste, has slippery features, some material change colour from red to blue in this river. But, water of B river has sour taste, has sharply smell, and some material change colour from blue to red in this river. When water of these rivers is compound, it consists of white precipitate.

After this story was told; pre-service teachers were asked to some questions related with this story: (1) in your opinions, what can be water of A river; (2) In your opinions, what can be water of B river; (3) What can be a white precipitate, which consists of the time these rivers' water is compound; (4) Have do you heard any material change colour from red to blue or from blue to red in some matter.

In exploration stage

In stage, pre-service teachers were divided into five groups; in each group has five pre-service teachers. Then students tried to some experiments about properties of acid and bases.

Pre-service teachers was given some matters such as soap, tap water, rain water, soda water, vinegar, lemon juice, wine, coca-cola, milk, aspirin, shampoo, strawberry, apple, plum, tomato and distilled water. Also, it was given a roll litmus paper, a strip red cabbage paper, 2 – 3 glass pots, 2 glass rods to them. Then, pre-service teachers were asked to investigate effect of these materials on litmus paper and red cabbage paper and filled to table in below.

Matters	Colour of litmus paper	Colour of red cabbage paper	Taste of matters
Soap			
Tap water			
Rain water			
Soda water			
Vinegar			
Lemon juice			
Coca-cola			
Milk			
Aspirin			
Shampoo			
Strawberry			
Apple			
Plum			
Tomato			
Distilled water			

In this step, pre-service teachers implement the related activities in their small group by means of directions and questions such as ‘What did you observe in chancing of litmus paper colour? Please explain your reason’, ‘What did you observe on chancing of red cabbage paper colour? Please explain your reason’, ‘How taste matters have? Please explain’.

In this experimental process, researcher monitors pre-service teachers and their interactions with each other, so that she or he enables students to conduct an interpretive discussion. Besides, pre-service teachers can explain unclear points but refrains from any clue.

In explanation stage

At explanation stage, after each group completed activities, they was asked to some questions related to experiments such as 'How acid has an effect on changing litmus paper colour and red cabbage paper colour', 'How bases have an effect on changing litmus paper colour and red cabbage paper colour', 'Which matters acid and bases are' and 'How relation there are taste and litmus paper colour or red cabbage paper colour? Please explain' in order to present their structured knowledge claims and share their ideas with their peers through a class discussion. Then, the teacher confirms/disconfirms pre-service teachers' gained knowledge claims, so that the students compare their newly structured ideas with those presented by the teacher.

In elaboration stage

At the stage, it was required that teachers challenge and extend pre-service teachers' conceptual understanding and skills and their understanding of the concept and/or apply it to a real world situation. So, Pre-service teachers were given three clean liquid in three per-glasses. Then, they were told to one of these liquid is acid, the other is bases and another is water. But pre-service teachers don't know that which liquid is acid or bases or water. They were asked to divide these liquids correctly and find which liquid is acid or bases or water.

In evaluation stage

At the evaluation stage, the students were given a performance task. In this performance task, pre-service teachers were asked to write a dialogue related to learn about acid and bases topic. Besides, pre-service teachers were asked to construct a concept map. For this, students were given nine terms as acid, bases, litmus paper, blue, red, sour, sharply smell and slippery. Furthermore, making pre-service teachers become conscious of their learning, they are asked to outline what they have learned.

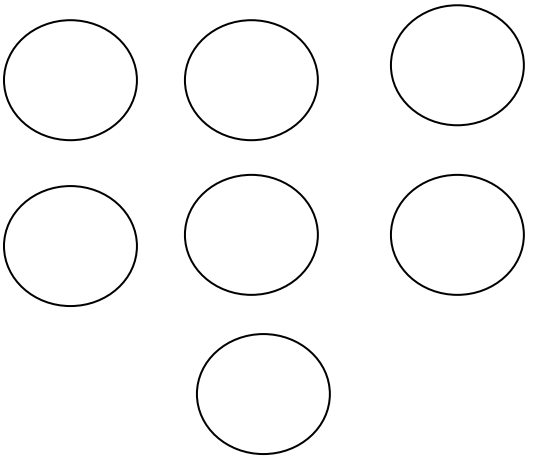
Performance task

Yesterday, Mustafa didn't go to school as a result of being ill. So, he didn't learn acid and bases subject which was told by teachers yesterday. This day, Mustafa is going to school and he asks to explain knowledge related to acid and bases topic. Now, you are wanted to write a composition related to description and features of acid and bases and effects of acid and bases on litmus paper.

Concept map

Directions: Now, draw a concept map using the 7 terms in the box below. They are related to acid and bases subject. Write the terms in the bubbles below. Then draw lines with arrow-heads on them between the bubbles to show which terms are related to each other. Then write one or a few words on each line to tell how the terms are related in your thinking. Remember, there isn't one "right answer." Everybody's map will be different. Just show the way YOU think about these things. Draw all the relationships that seem important to you.

1. Acid
2. Bases
3. Litmus Paper
4. Sour
5. Bitter
6. Sharply smell
7. Slippery



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