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# Pre-service Science Teachers' Views on Conceptual Change Strategies and Practices Carried out

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ABSTRACT

This research was conducted to determine pre-service science teachers' views related to misconceptions and conceptual change strategies at an urban university in Aegean Region, Turkey. It was a 5-week study with 28 students. Before the implementation, students were given a test which consisted of open-ended questions aiming to determine the pre-service science teachers' ideas about misconceptions and conceptual change strategies. On the first week of the study, students were given information on how to identify and remove the misconceptions by using conceptual change strategies. Different kinds of activities based on conceptual change strategies were also presented to them. Seven groups were formed with 28 people and they were asked to prepare activities based on conceptual change strategies related to a unit in middle school science curriculum. They chose a unit and prepared activities for two weeks. Secondly, they presented their activities in the classrom during two weeks. After presentations, a test which had the same questions with the 1st test was given to the pre-service science teachers. Also the 2nd test had three different questions, which was related to their opinions about the applications from the 1st test. The results of tests were analyzed qualitatively. Before the study, pre-service science teachers didn't know how to identify and remove misconceptions exactly. Thanks to this study, they learned conceptual change strategies and their applications. After the study, they said that they liked the activities based on conceptual change strategies.



Keywords:
Pre-service science teachers, conceptual change

## 1. Introduction

One of the main objectives of science education is to make students learn concepts meaningfully. Science subjects include many concepts and the relationships between these concepts; and internalizing the ideas that these concepts represent and using these concepts with their correct meaning is necessary in order to reach the upper steps of Science teaching. Misconceptions in students could cause to future problems in Science teaching. In order to make meaningful learning possible, these misconceptions should be removed. Conceptual change strategies can be used for removing students' misconceptions in science education. Provided that science teachers teach scientific concepts correctly, students can be expected to learn meaningfully. Therefore, pre-service science teachers should learn conceptual change strategies and how to apply them. According to the conceptual change model developed by Posner, Strike, Hewson & Gertzog (1982), first of all, there should be dissatisfaction with the existing conceptions; secondly, a new conception must be intelligible; thirdly, a new conception must appear initially plausible; and finally, a new concept should be fruitful (useful). If the new concept entails all these four features it is easily learned. Yet, if the new concept is in contradiction with existing concepts, it is acceptable and meaningful (Chiu, Chou & Liu, 2002;

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Duit & Treagust, 2003). Learners actively construct new knowledge by making use of their existing knowledge and experiences (Windschitl, 2002). The constructivist approach accepts that the learner constructs the knowledge him/herself both individually and socially. The objective of the Science and Technology course is to enable the students to understand the concepts and correlate them with the natural events which surround themselves. Therefore, the concept maps, mind maps, conceptual change texts, analogies, models and concept cartoons on which the mental constructions and organizations are shown, are significant as being tools that support the constructivist approach.

**1.1. Concept Maps**

Concept maps are defined as the schematic drawings which are used for showing the meaningful relations among the concepts in a proposition form (Novak & Gowin, 1984). The concept map is a practical technique as it helps students relate their previous knowledge with the new knowledge (Gürdal, Şahin & Çağlar, 2001). It is known that a concept can be remembered more easily if it is kept in mind both verbally and visually (Yalın, 2004). In science teaching, concept maps can be used in organizing the knowledge, discussing the meanings of concepts, identifying the misconceptions and remediating them, developing advanced level thinking skills and evaluating the things learnt (Atasoy, 2002; Ölmez & Geban, 2001). Students can use this mind tool as an organizational strategy to identify important concepts of a content domain and the interrelations among them (Dabbagh, 2001). Concept mapping is helpful in understanding what a concept entails and in promoting meaningful learning (Tekkaya, 2003). In general, it is a tool that is used to facilitate meaningful learning and help students to represent their knowledge in a visual form (Habok, 2012).

**1.2. Mind Maps**

Mind mapping is a visual technique that enables students to express their ideas and share their knowledge freely. By means of key concepts and codes on the subject and making use of pictures and figures, this technique gets both lobes of the brain active. Presenting the ideas that come to students' minds on a schema related to a specific structure of knowledge makes it easier for students to correlate them with the other structures of knowledge and see all the dimensions of the knowledge concerned as a whole (Keskinkılıç, 2009).

As the learner reflects all s/he knows on the subject on a piece of paper, it is possible to observe the concepts and relations among them as a whole. Mind maps cover a significant place in identifying students' misconceptions as they are the visual expressions of the schemas that the students have constructed in their minds. Because mind maps are the visual expressions of the schemas which students construct in their minds, mind maps are of great importance in identifying the students' misconceptions. Basically, making of a mind map starts with the expression of the main topic by a picture or image, then branches that go outwards from the main idea are drawn. On every branch, a keyword representing the topic or phrase is written to see the branches that are related to eachother (Ladge, 2002).

**1.3. Conceptual Change Texts**

In conceptual change texts, firstly students are given the misconceptions related to the subject and then they are scientifically explained why those misconceptions are wrong (Tekkaya, 2003). In conceptual change texts, students are asked a question in order to activate their misconceptions on the subject. Then students are shown their misconceptions and explained why their comprehension of the concepts is wrong. Students are given examples with scientific explanations of the subject and concepts so that the conceptual change would occur. Conceptual change texts are usually handed in to the students during the presentation of the subject and they are asked to analyze the texts either on their own or in groups. After making sure that students complete their reading and analysis of the text, they are expected to start a class discussion on the subject and have an exact and correct comprehension of the concepts (Ayas, Çepni & Ayvacı, 2005).

**1.4. Analogies**

Scientist use analogies to concentrate attention on specific aspects in order to explain something unfamiliar using something familiar. Analogies can help students identify what their misconceptions are, change their viewpoints and accept the concepts that are scientifically correct. In science teaching, the use of analogies can enable meaningful learning while teaching concepts and facts that are partly difficult to understand (Atav, Erdem, Yılmaz & Gücüm, 2004).

### 1.5. Models

A model is the name given to the supplementary teaching materials used in science teaching to make an object be better understood because the object is either too big or too small for students to comprehend. Models are especially important in science, because many real objects, systems, processes, or mental phenomena that scientists deal with cannot be observed and manipulated directly (Rotbain, Marbach-Ad & Stavy, 2006).
Models can be used in concretizing the abstract concepts and simplifying complex subjects (Şahin, Öztuna & Sağlamer, 2001). It is necessary to understand and create some specific similiar relations to form a model.

### 1.6. Concept Cartoons

Concept cartoons were created by Brenda Keogh & Stuart Naylor in 1991. Concept cartoons are among the useful tools that can be used to show different viewpoints to students and motivate them to start a discussion with the use of scientific method (Naylor, Keogh & Downing, 2007). The concept cartoon makes it possible to find out the students' previous way of thinking on a subject before teaching and remove their misconceptions (Saka, Akdeniz, Bayrak & Asilsoy, 2006). It is an effective technique that is used for both identifying and removing misconceptions. In teaching with concept cartoons, some alternative viewpoints on a scientific fact are drawn/reflected on a poster/piece of paper in a cartoon character form, however only one of the alternative viewpoints is scientifically correct. Ideas are represented by means of cartoon characters and then discussed in the classroom to find out the scientifically correct one. In this discussion, each character defends a different idea.

This study aims to identify misconceptions among 4th grade university students who will graduate as Science teachers and to reveal their ideas about removing misconceptions by ensuring conceptual change. The study also aims to reveal the efficiency of the practices carried out with pre-service teachers on conceptual change techniques together with pre-service Science teachers. During Special Teaching Methods course, a 5-week-practice was carried out towards developing conceptual change activities and the use of conceptual change strategies in Science classes. The aim of this was to help pre-service teachers understand the importance of conceptual change and have positive opinions towards using conceptual change activities during their classes after they start their job as a teacher.

## 2. Method

### 2.1. Participants

This research was conducted to determine the pre-service science teachers' views related to misconceptions and conceptual change strategies at at a urban university in Aegean Region. This study took five weeks and 28 students (21 female, 7 male) joined the study. Each group had three female and one male student. Also these groups were heterogeneousin terms of academic achievement inSpecial Teaching Methods I course.This 5-week study was carried out during Special Teaching Methods II course.

### 2.2. Research Design

This is a qualitative study. First, a qualitative assessment tool entailing 5 open-ended questions was administered to pre-service teachers in order to find out their ideas and prior knowledge on identifying misconceptions. For one week, trainings on definition and classification of misconceptions, the importance of identifying misconceptions, misconceptions in science teaching among students (i.e Sugar dissolves in water." "As the temperature of a substance increases, so does its mass."), how to remove misconceptions and conceptual change strategies were provided. For a 2-week period, 28 pre-service teachers-in groups of 4-prepared activities based on conceptual change strategies on a certain Science unit they chose and in another 2-week period, the pre-service teachers presented the activities they prepared. Later, the open-ended questions that were initially asked to the pre-service teachers were administered again together with other open-ended questions about the implementation carried out.

### 2.3. Data Collection

The data in the study were collected using open-ended questions on conceptual change strategies. Expert opinions from three academics working in the field of science education were taken for the open-ended questions prepared. Organized based on the expert opinions, this assessment tool was implemented on four pre-service science teachers to finalize it. Five open-ended questions on conceptual change strategies were administered on students. Before the implementation, pre-service science teachers were given the test which contains open-ended questions to determine their ideas about misconceptions and conceptual change strategies. The open-ended questions are given as follows:

1. What is your understanding of the term "misconceptions"? As a pre-service science teacher, do you think it is important for the teacher to know the misconceptions of his/her students? Why? How do you think you can identify the misconceptions of middle school students?

2. What is your understanding of the term conceptual change? How do you think that a learner can have the conceptual change on a subject?

3. What sort of special features should the new concept bear in order to realize the conceptual change and learning of the subject by the student?

4. Do you think it is important to remove the students' misconceptions? Why?

5. What kind of studies do you think can be done in order to remove students' misconceptions? What techniques can be used in removing misconceptions?

On the first week of the study, pre-service science teachers were explained about misconceptions on science subjects, determining and removing the misconceptions by using conceptual change strategies. The examples of activities related to concept mapping, mind mapping, conceptual change texts, analogies, models and concept cartoons on the unit of "Cell Division and Heredity" based on conceptual change strategies were also presented to them. 28 people formed seven groups of four people each and they were asked to prepare activities based on conceptual change strategies related to a unit in middle school science program. They chose a unit and prepared activities during two weeks and they presented their activities in classrom environment for two weeks.

After presentations, a test which had the same questions with the 1$^{st}$test was given to the pre-service science teachers.After this test was administered, three open-ended questions were carried out to the students in order to find out their opinions on the practices carried out. The open-ended questions related to practices carried out are given as follows:

6. What do you think about the applications which are related to the conceptual change approach and techniques?

7. Which technique do you like best while you are preparing activities using conceptual change techniques? What makes you like this technique best? (Which conceptual change technique did you use to prepare your activity?)."

8. When you become a teacher, do you think that you would use conceptual change techniques in your classes? What benefits do you think the activities would provide by using these techniques?

**2.4. Data Analysis**

The results of the tests were analyzed qualitatively. The descriptive analyses of the data collected via open-ended questions were made; the data were reduced, categorized and put into tables. The decoding of the semi-structured interviews, recorded using a voice recorder was controlled by an independent academician, as well as the researcher to ensure the correctness of the decoding. The data from the open-ended questions were examined by one more Science academician; and themes and codes of these were formedby two experts; and the reliability percent between the two was found as 91%. As for Miles & Huberman (1994), the analysis of

the data collected from an interview follows three consecutive steps, each affected by another; reduction of data, data display and drawing conclusions and validation. In order to reduce the data, raw data are coded based on certain categories (Patton, 1990). Within the framework of these categories, the data was coded, the essential parts were extracted and the remaining parts were discarded. Besides, in order to reflect the pre-service science teachers' opinions, direct quotations were included.

**3. Results**

Pre-service science teachers' answers to the open-ended questions at the beginning of the study (1st test)/at the end of the study (2nd test)and the frequencies related to them are given in this section of the study. The answers and related frequencies that students haveon thefirst question are shown in Table 1.

**Table 1.** Students' Views related to 1st Question

| Themes | | 1st test (f) | 2ndtest (f) |
|---|---|---|---|
| The definition of misconceptions | Wrong knowledge about the subject | 12 | 14 |
| | Lack of knowledge about the subject | 6 | 5 |
| | A concept is used out of its real meaning | 5 | 3 |
| | A concept is misunderstood or understood in a different way | 2 | 7 |
| | The concepts about the subjects are put in wrong schemas by students. | 1 | 5 |
| | The students confuse their knowledge about a concept with other concepts | 3 | 4 |
| | Wrong acquisitions gained by daily experience or previous knowledge | 3 | 3 |
| | Wrong construction of concepts in mind | 2 | 5 |
| The importance of knowing the students' misconceptions | The clash of the students' previously acquired knowledge and daily experience with the scientific knowledge | 4 | 11 |
| | Teaching strategies, methods and techniques are chosen accordingly | 5 | 9 |
| | To remove misconceptions | 1 | 6 |
| | To avoid an imcomplete or wrong learning of the subject | 9 | 7 |
| | To avoid difficulties in understanding the subject/constructing the knowledge | 2 | 1 |
| | Because it is the teacher's duty to provide feedback and remove misconceptions | 1 | 2 |
| | To realize meaningful learning | 2 | 8 |
| | To prevent a possible mental confusion or cognitive imbalance on the subject | 4 | 7 |
| | To assure students' self-confidence | - | 2 |
| | To avoid waste of time | 1 | 3 |
| | To realize an effective teaching | _ | 2 |
| How the misconceptions are identified | Asking questions/ question-answer technique | 18 | 20 |
| | The students are asked to use concepts in a sentence | 2 | _ |
| | The students are asked to give definitions of concepts | 5 | _ |
| | Activities | 2 | 1 |
| | Scenario | 3 | - |
| | Plays | 1 | - |
| | Words matching | 2 | 2 |
| | Active learning | 2 | - |
| | Discussion | 1 | 1 |
| | Brain storming | 2 | - |
| | Drama | 1 | - |

| | | |
|---|---|---|
| Experiment | 2 | 1 |
| Observation | 2 | - |
| Constructed grid | - | 1 |
| Concept maps | 7 | 17 |
| Concept cartoons | - | 9 |
| Mind maps | 2 | 9 |
| Conceptual change texts | - | 7 |
| Analogy | - | 6 |
| Model | - | 4 |

When Table 1 is examined, it is seen that pre-service teachers have more scientifically correct answers on the definition of misconceptions and the importance of knowing students' misconceptions in the 2ndtest.

It was indicated that misconceptions could be identified with question-answer technique; and it was stated in the 2ndtest that it could also be identified using concept maps, concept cartoons, mind maps, conceptual change texts, analogy and models. Examples of pre-service teacher expressions in the 2ndtest are given below:

*Misconceptions are the wrong knowledge of concepts on a subject, and wrong organization of information in wrong schemes. It is important to know the misconceptions of students because new information is constructed over the previous ones. If there are problems in the foundation of a building, it will collapse in time* (12th pre-service science teacher).
*In the first class when we start a new unit, I can ask students what certain concepts mean to them and ask them to draw concept maps related to the subject. I can also ask them to create mind maps and examine these maps and identify misconceptions. After they learn the subject and question meaningful learning, I can ask students evaluate their own mind maps and thus, make them see their own misconceptions. I think this will be effective in the process of meaningful learning* (25th pre-service science teacher).
*We can identify students' misconceptions via such techniques as concept maps, mind maps, concept cartoons and models* (17th pre-service science teacher).

The answers and related frequencies that students have on the second question are shown in Table 2.

**Table 2.** Students' Views related to 2nd Question

| Themes | | 1sttest (f) | 2ndtest (f) |
|---|---|---|---|
| The definition of conceptual change | Internalizationand adaptation | 5 | - |
| | Removing the learner's misconceptions and correcting them | 13 | 18 |
| | Replacing old concepts by new ones | 3 | 6 |
| | Different meanings are put on something already known | 4 | - |
| | Learning new concepts | 1 | - |
| | Reconstruction of knowledge related to a concept | 1 | 1 |
| | To replace a mental schema by another one | 2 | 1 |

When Table 2 is analyzed, it is seen that in the 2ndtest, pre-service teachers have more scientifically correct answers on the definition of conceptual change and the features that the new concept should have in order for conceptual change to occur. Examples of pre-service teacher expressions in the 2ndtest are given below:

*Conceptual change is the changing of old knowledge of the students' with the new one through various methods* (17th pre-service science teacher).
*For conceptual change to occur, people should first come across with a condition that does not fit with their existing shemas in their minds. At this point, there will be an imbalance. And then, they will make evaluations on the new case and will organize their existing schemas again. For example, a child's "Birds fly" schema will change to "Some birds fly" after they learn ostrich"*(18th pre-service science teacher).

The answers and related frequencies that students have on the third question are shown in Table 3.

**Table 3.** Students' Views related to 3rd Question

| Themes | | 1st test (f) | 2nd test (f) |
|---|---|---|---|
| The features which the new concept must carry for the conceptual change to occur | Be realistic | 2 | 1 |
| | Be easy to remember | 1 | - |
| | Be useful | 2 | 18 |
| | Be easily understandable | 5 | 15 |
| | Be persuasive | 2 | 2 |
| | It must be related to the previous concepts | 1 | - |
| | It must be suitable for the level of the students | 1 | - |
| | Be stable | 2 | 1 |
| | Be acceptable. | 2 | 14 |
| | Be correctable | 1 | 8 |
| | Be verifiable | 2 | 6 |
| | Be clear and concise | 4 | 7 |
| | Be logical | 5 | 17 |
| | Must draw attention | 2 | 3 |
| | Must be aware of the lacking and wrong parts of the previous knowledge | 2 | - |
| | Must be suitable for the daily life. | - | 2 |

When Table 3 is examined, it is seen that pre-service teachers have more scientifically correct answers on the features which the new concept must carry for the conceptual change to occur in the 2nd test. Examples of pre-service teacher expressions in the 2nd test are given below:

*The new concept should be easy to keep in mind. It should be relevant to real-life. The student should be able to use this information. It should be practical. It should not contradict with certain concepts and should provide benefits to the student* (2nd pre-service science teacher).

*The new concept should be logical* (15th pre-service science teacher).

The answers and related frequencies that students have on the third question are shown in Table 4.

**Table 4.** Students' Views related to 4th Question

| Theme | | 1st test (f) | 2nd test (f) |
|---|---|---|---|
| The importance of removing students' misconceptions | Understanding and learning the lesson | 5 | 3 |
| | In solving the problem | 1 | 4 |
| | To use the knowledge in future | 1 | 1 |
| | For meaningful learning | 4 | 15 |
| | To prevent wrong learning and construction | 10 | 21 |
| | To prevent misconceptions from blocking the new knowledge | 1 | 3 |
| | To increase the students' academic success | 1 | 4 |
| | To prevent the mental confusion | 5 | 12 |
| | To provide more effective education and learning. | 1 | 8 |
| | For the realizaion of exact and correct learning | 2 | 6 |
| | For permanent learning | 3 | 10 |

All pre-service teachers indicated that removing the misconceptions of the students was important. When Table 4 is examined, it is seen that in the 2nd test all pre-service teachers have more scientifically correct answers

regarding the importance of removing students' misconceptions. Most of the pre-service teacher (f=21) indicated that removing misconceptions was important to prevent wrong learning and constructing. Examples of pre-service teacher statement in the 2ndtest are given below:

*It is important to remove students' misconceptions. Because adding new information on existing wrong knowledge is like useless and makes learning more difficult* (15th pre-service science teacher).
*It is important to remove misconceptions. As it is known, our teaching programme has a helical structure organized with the principle of continuity of the subjects. For example, a student who did not learn the meaning and importance of substance or learn it wrong will never learn the granulous structure of the substance* (19th pre-service science teacher).
*It is important to remove misconceptions. Because these misconceptions inhibit new information and the child would not be open to change. Wrong knowledge will direct to wrong ways and creates barriers for new cases* (22nd pre-service science teacher).
The answers and related frequencies that students have on the fourth question are shown in Table 5.

**Table 5.** Students' Views related to 5th Question

| Theme | | 1sttest (f) | 2ndtest (f) |
|---|---|---|---|
| The techniques which are removed the misconceptions | Concept cartoons | - | 14 |
| | Conceptual change texts | - | 10 |
| | Concept maps | 1 | 12 |
| | Mind maps | - | 8 |
| | Analogy | - | 12 |
| | Model | - | 9 |

When Table 5 is examined, it is seen that in the 2ndtest, pre-service teachers have more scientifically correct answers related to the techniques used to remove misconceptions and their use. Pre-service teachers stated that they used these techniques at the beginning of lesson for determining students' misconceptions and at the end of lesson for evaluation and feedback. Examples of pre-service teachers' statement in the 2ndtest are given below:

*Conceptual change text, concept cartoons and analogies could be used* (20th pre-service science teacher).
*I believe that concept cartoons will attract students' interest more and will make students see the subject as a game and make understanding easier. Also, concept and mind maps could be used* (27th pre-service science teacher).

The answers and related frequencies that students have on the fifth question are shown in Table 6.

**Table 6.** Students' Views related to 6th Question

| Theme | Codes | f |
|---|---|---|
| The ideas about the presentation and applicatios | Efficient | 7 |
| | Fun | 3 |
| | Explanatory | 6 |
| | Nice | 3 |
| | Comprehensible | 5 |
| | Useful | 8 |

When Table 6 is examined, it is seen that pre-service teachers found the practices towards conceptual change techniques efficient, fun, explanatory, nice, comprehensible and useful. Examples of pre-service teacher statements are given below:

*I did not know much about this subject before. I can say that things that I wonder have been clear now. It was nice and efficient* (18th pre-service science teacher).

*I see this practice useful. I did not know what to do to remove misconceptions and now I learned. It is possible to make a class fun with different strategies* (24th pre-service science teacher).

The answers, related frequencies that students have on the sixth question are shown in Table 7.

**Table 7.** Students' Views related to 7th Question

| Theme | | Codes | f |
|---|---|---|---|
| The best technique is liked | Conceptual change text | Useful | 2 |
| | | It identifies the misconceptions that occur. | 1 |
| | Analogy | Meaningful | 1 |
| | | It increases the remaining. | 1 |
| | | Misconceptions can be removed easily. | 1 |
| | | It improves the power of imagination. | 1 |
| | | It increases the creativity. | 1 |
| | | Enjoyable | 1 |
| | | Permanent | 1 |
| | Concept cartoon | The aim is clear, short. | 3 |
| | | Attractive | 1 |
| | | Fun | 3 |
| | | Useful | 3 |
| | | Easy to remember | 1 |
| | | It increases the creativity | 1 |
| | | Visual | 1 |
| | Model | Student centered | 1 |
| | | Visual | 1 |
| | | Permanent | 1 |
| | | It is effective to understand concept or any subject. | 1 |
| | Mind map | It improves the creativity | 2 |
| | | Useful | 1 |

When Table 7 is examined, it is seen that while pre-service teachers prepare conceptual change activities they liked concept cartoons, analogies, models, mind maps and conceptual change texts most. Examples of pre-service teacher statements are given below:

*Cartoon and analogies. Because cartoons are both fun and visual and also because these activities are based on creativity, it was fun to generate ideas* (12th pre-service science teacher).
*What I liked most was "the trip of food" analogyy activity. We used analogy technique. We associated digestive system with workers doing road work and created the material* (18thpre-service science teacher).
*I liked concept cartoon most. Because it enables to remove misconceptions without any tools and in an enjoyable way. It is a practical technique. It can be used in every school* (19th pre-service science teacher).

The answers, related frequencies that students have on the seventh question are shown in Table 8.

**Table 8.** Students' Views related to 8th Question

| Theme | Codes | f |
|---|---|---|
| The benefits of conceptual change activities | To remove misconceptions | 18 |
| | To provide meaningful learning | 10 |
| | It helps to identify misconceptions. | 8 |
| | To make students more active | 7 |
| | To help students learn more easily | 4 |
| | It is enjoyable. | 4 |
| | It saves time. | 2 |
| | It draws attention of the students. | 10 |
| | To provide permanent learning. | 12 |
| | It makes teacher and students creative. | 8 |

All pre-service teachers indicated that they were thinking to use conceptual change techniques in their classes after they start working. When Table 8 is examined, it is seen that most of the teachers stated that these techniques will enable identifying, removing misconceptions and ensure meaningful learning. Examples of pre-service teacher statements are given below:

*…While preparing activities, I thought that I was a student and recognized that it would be useful. I think that when they are attractive, they are also easy to remember and fun* (12th pre-service teacher).
*…Identifying misconceptions of students and removing them will increase the efficiency of instruction. And this will make both the teacher and the student creative*(19th pre-service science teacher).
*…I think that they are techniques that save students from memorizing, make them think and ensure permanent learning* (27th pre-service science teacher).

**4. Discussion and Conclusions**

The aim of the study, carried out with pre-service Science Teachers, was to reveal the efficiency of the practices related to conceptual change techniques. This study also includes pre-service science teachers' views about misconceptions, conceptual change strategies and identifying and removing misconceptions. The descriptive analysis of the data collected from open-ended questions in the assessment tool administered to the pre-service science teachers indicated that most of them did not know conceptual change approach precisely as well as how to identify misconceptions. Before the study, the participants didn't know how to identify and remove misconceptions exactly. During the study, they prepared conceptual change activities aiming at removing misconceptions such as "In a cold place, metal materials are colder than wooden materials though being in the same environment.", "Temperature is transferred.", "Hard substances transmit heat more slowly.", "Heat is transmitted the most rapidly in air." Thanks to this study, they learned conceptual change strategies and their applications. After the study, they said that they liked the activities based on conceptual change strategies and they also expressed that they would use conceptual change strategies in their classes in future.Recognizing that students have misconceptions and knowing the ways to remove these misconceptions is the first step taken towards meaningful and permanent learning (Chiu, Guo & Treagust, 2007). Science Curriculum is a helical programme; and those subjects or concepts that are not learned meaningfully will make it difficult to learn other concepts and subjects in the next years. Therefore, it is important that teachers identify the misconceptions of their students relating to Science subjects and use conceptual change approach towards removing these misconceptions for meaningful and permanent learning. Learning Science concepts clearly will make it easier to learn the future subjects (Hewson & Hewson, 2003). Learning basic concepts in a wrong way will cause to the wrong learning of the knowledge to be constructed (Bayram, Sökmen & Savcı, 1997). Using techniques based on conceptual change strategies, the efficiency of which has been proved in studies (Şahin, 2002; Holland, Holland & Davies, 2004; Sağırlı & Macaroğlu-Akgül, 2004; Öner & Arslan, 2005; Candan, Türkmen & Çardak, 2006; Yaşar, 2006; Şaşmaz-Ören, Ormancı, Babacan, Çiçek & Koparan, 2010) will be more effective in removing misconceptions. Conceptual change strategies ensure meaningful learning and replacement of misconceptions by scientifically-accepted concepts (Geban & Ertepınar, 2001). Using concept maps and conceptual change texts in teaching Science is among the leading techniques in removing misconceptions (Ölmez & Geban, 2001). Analogies, mind maps, concepts cartoons and models could also be

used to remove misconceptions. Identifying students' misconceptions in Science classes and using methods and techniques based on conceptual change strategies to remove these misconceptions (conceptual change texts, concept maps, mind maps, concept cartoons, analogies, models etc.) will ensure meaningful learning. Identifying student misconceptions on a subject by making literature review, implementing concept tests on students, asking open-ended questions and semi-structured interview questions or by making them prepare concept maps; and organizing activities towards removing students' misconceptions are necessary for meaningful learning. Teaching concepts meaningfully is of great importance for science education. It is necessary for meaningful learning to identify, remove and correct students' misconceptions. This study helped the pre-service science teachers learn conceptual change strategies and they prepared and presented conceptual change texts, concept cartoons, , concept maps, mind maps, analogies and models. Informing pre-service science teachers on identifying misconceptions and on the strategies that could be used to remove misconceptions; and preparing sample activities on this topic will ensure that the students they will teach will learn meaningfully.

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