Using a conceptual change text as a tool to teach the nature of science in an explicit reflective approach

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Abstract

The aim of this study is to develop conceptual change texts in the teaching of aspects of the nature of science and to introduce the development of texts. The socio-cultural and the subjective aspects were taken into consideration in the conceptual change texts, which are presented in the study. The conceptual change texts were prepared to be used in a 7th grade class in a secondary school during the light unit in a science and technology lesson. The prepared conceptual change texts were piloted in a secondary school in Trabzon in 2008-2009 education year. 22 students participated in pilot study. Some defects were identified and the necessary adjustments were made at the end of pilot. For example, some corrections were made in the section about the reasons of wrong ideas. In the last section of conceptual change texts, coming to a conclusion questions were added to lead the direction to the intended point. It was observed that conceptual change texts were applicable in the class with the unit acquisition.

Keywords: The nature of science, conceptual change text, light

Introduction

One of the most important aims of science teaching is to create a scientifically literate society. The fast developments existing in the field of science, the products which are produced according to the scientific developments coming into nearly in every field and help shape our lives have increased the importance of scientific literacy. The goal of all students' as scientifically literate forms the centre of various science education reform documents such as Association for the Advancement of Science (AAAS, 1993), the National Research Council (NRC, 1996) and science curriculum of a lot of individual countries (e.g. England, The USA, Canada, Australia, New Zealand, Zambia, and Turkey). The nature of science is handled as the most important component of scientific literacy, and understanding the nature of science is more important than knowing basic science concepts, principles and laws (Solomon, 2001). Understanding the nature of science contributes to science teaching from a lot of angles. For example, the students who know how scientists obtained scientific knowledge are able to solve the problems they come across in their daily life with scientific methods (Driver et al., 1996). Currently, it is accepted that tight bonds should be built between school knowledge and daily life, and it is believed that teaching the nature of science is worth spending resources on even for this benefit alone. People come across a lot of scientific knowledge while reading news, watching TV and listening to the radio. Some scientific knowledge such as global warming, environmental pollution, lack of energy sources, nuclear energy, studies on root cells, cloning and genetically modified food, etc. are discussed all over the world. An educated individual is expected to have a general knowledge about these topics. Understanding the nature of science affects the individuals' interpretation of scientific knowledge, their realization of social problems and decision-making in discussions (Sadler, Chambers and Zeidler, 2004). Scientific knowledge after 1990s is referred to as the information age. A lot of people from past to present and different societies contributed to science. Each scientific study that was conducted lit the way for the subsequent studies. The life we have is the product of scientific studies. Understanding these qualities of science requires appreciation as a component of a modern society (Driver et al., 1996). Science can't be done alone. Although scientists complete their studies on a particular topic individually, they have to present the results obtained to a scientific community. Results that are not approved by a scientific community do not hold validity. Due to all these reasons, the scientists follow rules that are accepted by the scientific community in every stage of their studies. Understanding the nature of science improves understanding the norms of the scientific community and it provides norms in alignment with the general values of the society (Driver et al, 1996; NRC, 1996; McComas, 2000). In addition to all these, learning the nature of science affects learning the other science subjects (Chin, 2005). The students who do not understand that scientific knowledge is temporary, who believe that science introduces facts about the earth and who do not realize that scientific knowledge is not only made up of the results of observations tend to memorize the knowledge they are presented instead of thinking of them (Akerson, Morrison and McDuffie, 2006).

Although consensus of views is not reached on the definition of the nature of science, the aspects of the nature of science that the students at the K–12 level acquire are determined in the reform documents of science teaching and the studies conducted in this field. The studies conducted revealed that the students at different learning levels (Griffiths and Barman, 1992; Flegg and Burke, 1995; Dawkins and Dickerson, 2003; Huang, Tsai, and Chang, 2005; Kang, Scharman and Noh 2005; Arslan, Doğan-Bora and Çakıroğlu, 2006; Küçük and Çepni, 2006; Muşlu and Macaroğlu-Akgül, 2006), the teachers and the prospective teachers (Abd-El-Khalick, Bell, and Lederman, 1998; Yakmacı, 1998; Murcia and Schibeci, 1999; Gücüm, 2000; Tairab, 2001; Erdoğan 2004; Bora, 2005; Chin, 2005; İrez, 2006) had a naive/inadequate view of the nature of science, and they had misconceptions about concepts. The aspects of the nature of science are introduced in the table below, and the expressions related to these aspects that are in the mind, but in reality are myths, are summarized.

Table I: Aspects of the Nature of Science and Incorrect Ideas

Nature of Science aspect	Explanation to be accepted	Misconceptions
A general view on science	Science investigates the natural world in detail in order to gain information about it. Science cannot answer all the questions. For this reason, science is a special way of knowing (İrez, 2004).	Science introduces the facts about the earth (Dotger, 2006; Abd-El-Khalick and Lederman, 2000b), so science is a cluster of information whose accuracy is proven (Sutherland and Dennick, 2001). Furthermore, science and technology are the same concepts. A lot of people believe that TV, computers, rockets, fridges, etc. are science (Mc Comas, 2000). For example, the invention of the telescope after the invention of the lenses is a science.
Temporary	Scientific knowledge is both reliable (people can trust scientific knowledge) and temporary. Errors can be overcome or deficiencies can be completed by having new data about a specific topic. Sometimes, interpretation of present data with a new viewpoint can change the available knowledge (Akerson, Morrison and Mcduffie, 2006). In this context, scientific knowledge is not absolute facts, but the best explanations that are accepted today.	Scientific knowledge is absolute, and it doesn't change. Some researches reveal that students (Freidman, 2006; Khishfe and Abd-El-Khalick, 2002), prospective teachers and teachers (Murcia and Schibeci, 1999; Abd-El-Khalick and Lederman, 2000b) and even PhD students (İrez, 2006) have inadequate concepts about science. They believe that science is temporary. For example, it was proven that light is an energy source and this knowledge never changes.
Experimental	To validate the scientific knowledge, true data is needed. Scientific knowledge occurs as a result of the observations related to natural phenomenon and depends on the observation and measurement results. (AAAS Project 2061).	Experiments are done to only prove the accuracy of the scientific knowledge (Abd-El-Khalick and Lederman, 2000b). For example, experiments are important in science if you do an experiment in public, everybody believes you. Another example is that you can make everybody believe that white is made up of all the colours by using a light prism.
Imagination and creativity	Scientists use their minds and dreams to invent explanations. Scientists have to fill in the missing	Scientific knowledge must be objective. Scientific knowledge is obtained by an experiment or an

	parts of the puzzle to make data more understandable and to set a final picture in order to see what the event is like when they have limited data. Imagination and creativity are important in this process. (Abd-El Khalick, Bell & Lederman, 1998; Küçük, 2006).	observation and the result is to achieve objectivity. Imagination and creativity prevent the results from being objective (Abell, Martini and George, 2001; Khishfe and Abd-El-Khalick, 2002; Murcia and Schibeci, 1999). For example, scientists calculated the speed of the light mathematically as 300.000km/s by doing a lot of experiments in very big laboratories.
Subjective	It is nearly impossible for the scientific knowledge to be completely objective. Socio-cultural values, pre-concepts and paradigms adopted affect scientists' results (McComas, 1996; McComas, 2000). For example, there are different views about global warming, the formation of universe and the extinction of dinosaurs.	Scientists gather data carefully, analyse and follow a process to come to a conclusion. For this reason, scientists who work on the same topic do similar experiments, and obtain similar data that can't acquire different results. (McComas, 2000). For example, technology has developed rapidly. If scientists have the same technical equipment, such as microscopes and telescopes, they can reach the same results as each other.
Socio-cultural	There is a relationship between science and society. While scientific changes cause the society to develop and change, scientists are affected by the needs, traditions and customs and religion of the society they live in. Having this perspective, firstly we should appreciate to those societies and the people who contribute to science. Moreover, this perspective supports the image that the scientists won't be objective. In teaching science of socio-cultural nature, the materials used are related to scientific developments; while the subject matter is generally being taught, the studies of the scientists who contributed to this field, the life stories of the scientists and the society and the culture where they lived and so on is also taken into account. These materials can be used	Students easily accept the fact that scientific developments are generally effective for society. However, there are misunderstandings about the changes, which resists the effects society has on the science. Studies that scientists conduct are independent from society. Race, religion, traditions and customs of the society where the scientist live do not affect their studies that are conducted. For example, Edison invented the light bulb, and society was out of tbe dark. However, Edison was not affected by the society he lived in. He invented the light bulb while working long hours in the laboratory.

	differently. For example, studies on scientists help to prepare texts that tell the structure of the society, and the effect this structure has on the works of the scientist and his life. In such educational practises, students are generally passive. If there is a condition to be repeated in educational environment, there are practises where the students set up a hypothesis collect data and test it, have discussions, and the process is student centred. Such practices as special case studies (Wong et al., 2008) and cartoons (Costa da Silva, Correia and Infante-Malachias, 2009) are used in order to attract the attention of the students, to better activate their learning environment, and in other words, to obtain more positive results from learning.	
Observation and inference	Scientists obtain new data through experiments and comprehensive observations. The data obtained requires interpretation. Scientists make implications about their pre-conceptions by using their cognitive processes such as implication. Observations are attained directly through the senses, but implications are not reached directly through the senses. For example, measuring the average global warming and carbon dioxide levels represents the observation of scientists. Depending on these observations, the scientists' proposed results about the amount of carbon dioxide and global warming in the future are implications (Abd-El Khalick, Bell & Lederman, 1998; Küçük, 2006).	Scientists need to see or feel the thing which they work on to learn something about nature. (Khishfe and Abd-El-Khalick, 2002; Akerson, Morrıson and Mcduffie, 2006). Scientists observe the sky by using telescopes, and they share the results of the observations with us.
Nature of law and theory	Theory and laws are different forms of scientific knowledge and serve different functions. Laws are generalizations about the natural phenomenon are observed. Theories are the explanations of these	Laws are made through direct observations, and their accuracy can be proved easily. (Dagher, Brickhouse, Shipman and Letts, 2004). Theories are immature laws and they become laws when

	generalizations. Theories do not become laws depending on the evidence, but they increase evidence and make theories more reliable. (Dagher, Brickhouse, Shipman and Letts, 2004).	enough proof is obtained (Griffiths and Barman, 1992; Abd-El-Khalick and Lederman, 2000b; Yalvaç, Tekkaya, Çakıroğlu and Kahyaoğlu, 2007). Theories change, but laws are absolute facts and they do not change. (Griffiths and Barman, 1992; Abd-El-Khalick and Lederman, 2000b; Gürses, Doğar and Yalçın, 2005).

Because the nature of science is not understood well enough, it has brought up the issue of how effectively this subject will be taught. Implicit, explicit reflective and historical approaches are the three basic approaches that are used in teaching the nature of science. Research reveals that (Abd-El-Khalick and Lederman, 2000a; Abd-El-Khalick and Lederman, 2000b; Khishfe and Abd-El-Khalick; 2002) the most effective method of teaching the nature of science is the explicit reflective approach. However, this approach is insufficient in teaching some of the aspects of the nature of science. For example, Çelik and Bayrakçeken (2006) aimed at making the teacher acquire a constructive point of view about the nature of science in a science, technology and community course. The nature of science was taught with the explicit reflective approach that was based on research in the course. But, the course affected the prospective teacher's definition of science in a negative way. After the course, it was determined that the participants defined science as a cluster of knowledge and the teacher confused science with technology. The course did not turn out to be effective in understanding the nature of the models. In a study conducted by Akerson, Morrison and Mcduffie (2006), a course was organized for pre-service elementary teachers where they were taught the nature of science by explicit reflective method, and its effects were evaluated. The students' concept of science before the course, at the end of the course and 5 months after the course were compared. It was found that the students' point of view towards science showed great improvement, but they couldn't retain the new concepts they acquired 5 months after the course, and they returned to their old concepts. Consequently, new expansions are needed to increase the effectiveness of the explicit reflective approach. All teaching theories accept that pre-knowledge, concepts and experience effective in learning new information. The students, just as in the other science subjects, come to the classes with various experiences and points of view that they formed related to their experiences about science. Thus, before starting to practise the activities, which aim at developing the understanding of the nature of science, the students are required to review their own perspectives they have acquired and discover their misunderstandings (Kang, Scharman and Noh, 2005). It is suggested that the explicit reflective approach is used within the conceptual change philosophy (Abd-El-Khalick and Lederman, 2000a; Abd-El-Khalick and Lederman, 2000b; Khishfe and Abd-El-Khalick, 2002).

Educational researchers have shown interest in conceptual change since 1970s. The theorists made some explanations about what conceptual change was and how it was achieved. The simplest explanation of conceptual change is defined as the change of students' insistent views that do not match the explanations of a scientifically accepted event. Hewson (1992) defined change in three forms. Firstly, students leave the pre-conceptions they acquired completely, and they acquire the desired concepts. Secondly, the pre-conceptions the students acquired might have both incorrect and acceptable aspects. In such circumstances, correcting the incorrect part is also a conceptual change. Finally, students have limited experiences about the concept that lead to their misconceptions. When completing absent concepts, creating a new cognitive organization is also regarded as a conceptual change. Various strategies such as concept maps, analogies, prediction-explanation-observation and cognitive contrast are used to provide conceptual change. When literature was analysed, some techniques and models of conceptual change were tried with the nature of science education. For example, Biernacka (2006) used the Common Knowledge Construction Model, Mumba et al. (2009) used the four-stage model suggested by Posner et al. (1982) during the teaching of the nature of science. Kattoula et al. (2009) prepared research-based concept maps about the nature of science. They used these concept maps both in teaching the nature of science and collecting data. Kienhues et al. (2008) used sentences that have the potential to change the epistemological beliefs in the refutational texts which are prepared to correct conceptual errors about genetics. For example it was emphasised that DNA fingerprinting methods wouldn't give certain results, and the errors that can appear in DNA fingerprinting, resulted from refutational texts. However conceptual change texts oriented on the aspects of the nature of science and the explicit reflective approach were not found in the literature.

Conceptual change texts are texts that activate the students' misconceptions, present common misconceptions, and try to make the learner comprehend explanations that are scientifically accepted. According to Guzzetti (2000), conceptual change texts are one of the best strategies to provide conceptual change and make permanent conceptual changes. Conceptual change texts were prepared and used for different subject matter ppreciation such as blood circulation (Alkhawaldeh, 2007), resolution balance (Önder and Geban, 2006) energy in chemical reactions (Taştan, Yalçınkaya and Boz, 2008), electro-chemical batteries (Yürük, 2007) and cellular respiration (Al Khawaldeh and Al Olaimat, 2009). Conceptual change texts contribute positively to correct conceptual mistakes in all subject areas. When the relevant literature is reviewed, it can be seen that the preparation process of conceptual change text is not thoroughly introduced. Moreover, the teachers who want to overcome their own misconceptions experience difficulties during the practise and development of conceptual change texts (Akpınar, Turan and Tekataş, 2004; Yip, 2004; Taşlı, 2005). The aim of this study was to prepare conceptual change texts to teach the aspects of the nature of science within the context of the light unit at the 7th grade elementary level. This was introduced during the development of the texts and the pilot process of the implementation.

Methodology

Conceptual change texts were developed in the following stages:

1. The science and technology curriculum was analyzed the topic for study was prepared according to conceptual change texts. Conceptual change texts that were presented within the context of the article were prepared in compatibility with the objectives of magnifying lenses, which was the last section in the light unit.

2. What aspects of the nature of science were going to be covered by conceptual change texts was decided. The literature on science education, science education reform documents and science and technology curriculum were analysed to determine which elements of the nature of the science should be taught. Conceptual change texts given in this article aimed at teaching the socio-cultural aspect (this conceptual change text was called "Despite the Observations Done by Telescope") and subjective and distinction between observation and inference aspect of nature science (this conceptual change text was called "Incident Scene Investigation").

3. The literature related to the conceptual change approach, with an emphasis on conceptual change texts, was analysed. Therefore, the important features of conceptual change texts were determined. The prepared format was decided. The conceptual errors about the elements of the nature of science, to be dealt with in the study and reflected in conceptual change texts, were determined through literature research and the experience of the researchers.

4. Because the conceptual change texts are going to be prepared within the context of light unit in the science and technology curriculum, all the sections of the course curriculum related to the light unit was analysed. What the students learned about light and what they are required to learn in the 7th grade was determined. Within the context of the article, conceptual change text,"Despite the Observations Done by Telescope," looks at the astronomical studies conducted by Galileo and the "Incident Scene Investigation" looks at forest fires.

5. Drafts of conceptual change texts were prepared.

6. Drafted materials were presented to the experts for their feedback. One of the experts studied the nature of science when obtaining his PhD. The other expert worked as an advisor for two PhDs on the nature of science. The experts' views contributed to the compatibility of specially developed conceptual change texts taking into account the explicit reflective approach and the philosophical basis of the conceptual change approach. Realizing scientific accuracy was a goal.

7. Conceptual change texts were revised according the experts feedback. The experts believe that the conceptual change texts created for the study were compatible with the explicit reflective approach philosophy. They emphasised that the teacher should deal with the elements of the nature explicitly and intentionally in the approach's explicit section. They also stated that reflection means that the students can explain what they have learned about the elements of the nature of science and can put forward their views. It was suggested that some precautions should be taken in order not to ignore the reflective part of the explicit reflective approach in the classroom. The section "Let's Get to a Conclusion" was added to the conceptual change texts in the light of these suggestions.

8. The teacher who implemented the conceptual change texts was informed about the nature of science, approaches used in the teaching of the nature of science and how to use the conceptual change approach and conceptual change texts.

9. The pilot conceptual change texts were prepared in 2008–2009. 22 students participated in pilot program. Conceptual change texts were used in the classroom during the related teaching.

10. With the experiences obtained from the pilot, conceptual change texts were finalized. For example, the expressions and the pictures the students didn't understand were determined and necessary changes were made. The pilot clearly showed the negative points of conceptual change texts. For example, in the "Incident Scene Investigation" conceptual change text, it was understood that the questions in the "Let's Get to a Conclusion" section needed to be restructured. This conceptual change text deals with two elements of the nature of science, which are subjectivity and the distinction between observation and inference. In this conceptual change text, the students put forward different conclusions from the same pictures; so in the "Let's Get to a Conclusion" section, it was observed that the distinction between the observation and the inference should be dealt with later after considering that subjectivity may result from the differences of inferences. Therefore, the questions and their order in the "Let's Get to a Conclusion" section were reorganized. One of the important points that attracted attention during pilot was the table of right and wrong ideas. In the conceptual change texts that were prepared, there are tables that outlined wrong ideas and how these wrong ideas occur; and there are tables that give the correct ideas and their causes. These tables created a time constraint during the practise. Therefore, the most important and noteworthy causes of the right and wrong ideas were summarized in one sentence for the sake of the time. In this way, the length of the text decreased and time was saved.

Introduction of conceptual change texts

It is possible to develop conceptual change texts in different forms. The conceptual change texts that were prepared should have certain requirements to meet specific goals. Posner et al (1982) defined these requirements as:

1. Dissatisfaction: The students and the scientists do not need to change their cognitive structures because their existing concepts prove useful. Therefore, in order to realize the conceptual change, there must be existing concepts in the unresolved problems. In this way, the person should be disturbed by his/her present state of mind, and he/she should feel the need to change.

2. Intelligibility: The new concept must be presented clearly, simply and with understanding; what is said must be relevant with other concepts so that the students understand. Analogy, tables, Venn diagrams, metaphors and so on can be used for comprehension.

3. Plausibility: The new knowledge must be reasonable, acceptable, plausible and coherent and must fit with the student's prior knowledge. The new concept must prove useful in the solution of the problem.

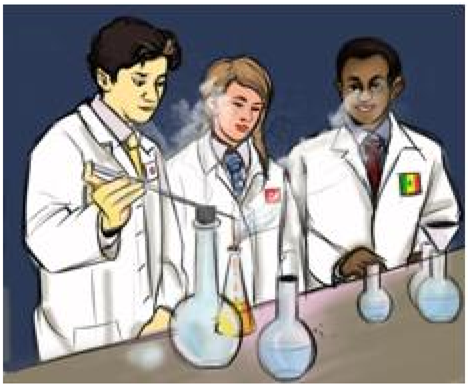
4. Fruitfulness: The new concepts must be used in the solution of the encountered problem, and it must have the ability to draw the students to new research and discoveries. One of the ways to fulfil this requirement is to mention what kinds of benefits the information brings to the scientists. For example, teachers can explainthat any theory that is put forward about an atom forms the basis for the following theory; for example nuclear energy was produced by the studies conducted about the atom and equipment like microscopes and telescopes were invented with the discovery of lenses. These findings have contributed to humanity for the cure and diagnosis of illnesses as well as the space explorations.

Researchers tried to meet this criteria using the conceptual change texts. An example was used to explain which sections were developed conceptual change texts were developed from and what conditions of the texts were to be achieved in each.

Section 1: In this section, students are asked a question, and they are asked to write the answers in the given blanks. There are also pictures to attract the attention of the students. The students' answers given in this section reveal their misconceptions. The first part of the conceptual change text is called, "Despite the Observations by Telescope," and is given below.

Conceptual Change Text: Despite the Observations by Telescope

All the communities in the world deal with science. Human beings whose religious beliefs, lifestyles, culture and traditions are different from each other contribute to science. For example, Dutch, American, Greek and Muslim scientists conducted studies on the qualities of light. Do the culture, traditions and customs, lifestyle and beliefs of a society affect a scientist's scientific knowledge? Write your answer in the blanks.



Answer:..
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Section 2: The table shows common misconceptions and the reasons of these misconceptions form. This is the second part of the conceptual change texts. Sulky emoticons were used to represent the incorrect ideas in this table. The incorrectness of the views is stated below the table. In the first two sections of the conceptual change texts students were made aware of their ideas; they checked whether their ideas were wrong or not, they were disturbed by their way of thinking and they were made ready to change their ideas. The second part of conceptual change text, called "Despite the Observations by Telescope," is given below.

Wrong ideas	
	According to many people, science **is not affected by beliefs, traditions and the lifestyle of a society** because when science is affected by social life, we believe that every society has its own science. So we can defend this idea because we wouldn't be able to talk about shared knowledge that is accepted worldwide.
	We think that scientific **knowledge is perceived in the same way all over the world by everybody.**

These views are wrong scientifically.

Section 3: This section outlines the correct answer to the question and explains why it is true. The table uses smiley face expressions in this section. Intelligibility should be provided. The third part of conceptual change text called, "Despite the Observations by Telescope," is given below.

The correct answer to the question is given below.

Right ideas	
	Science is affected by the traditions, religion, lifestyle, needs, natural disasters and epidemic illnesses. **For example, scientific developments that differ from the religious beliefs of a society may not be accepted.**

Section 4: Reading texts in this section include examples from science, history and activities to prove correct concepts. This section was prepared to make the right ideas seem reasonable, so that students accept them. In order to prevent students from being passive, the conceptual change texts used experiments and activities. The fourth part of conceptual change text, called "Despite the Observations Done by Telescope," is given below.

It is possible to explain our correct views with an example. In the Medieval Ages, the European societies were living under pressure from the church. During this period it was believed that the Earth didn't move but the Sun, and the other stars went around the Earth. According to this belief, the Earth didn't go around the Sun, but the Sun went around the Earth. In the same period, a scientist called Galileo did space observations by using telescope for the first time. As a result of these observations, he explained that the Earth went around the Sun. Because Galileo's ideas went against what was said in the Bible, he was called into court by the church. Galileo apologized to court because of his ideas. However, time justified Galileo. It is known today that the Earth and the other planets go around the sun.

Section 5: In this section, there are questions about the scientific concepts that are dealt with and the nature of science which they are related to. When the students answer these questions, they discover the intended results on their own by completing the activities and reading the texts. This situation supports the plausibility criteria of conceptual change. The last questions of the "Let's Get to a Conclusion" section ask for examples that parallel the correct answer. With these questions, both the fruitfulness criteria of the conceptual change approach and the reflective part of the direct reflection approach are fulfilled. The fifth part of the conceptual change text, called "Despite the Observations Done by Telescope," is given below.

Let's get to conclusion

1. What was the movement of the Sun and the Earth like in 1600s according to the Bible?

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2. In the same period what was the movement of the Sun and the Earth like according to Galileo?

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3. How did Galileo gather information about the movement of the Earth and the Sun?

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4. Why was Galileo punished?

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5. Does science effect the belief, tradition, customs and lifestyle, etc.? Please explain with examples.

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Practice of Conceptual Change

Conceptual change texts were photocopied. Each copy was divided into sections. The students worked with conceptual change texts individually, then the teacher discussed the texts using an overhead projector and had the entire class participate. Each practice of the conceptual change lasted nearly 15-20 minutes.

The first section of the conceptual change texts was distributed to the students. Students' recall their own ideas without being affected by the right and wrong answers that take place in the second and third sections. After all the students had written their answers, students who volunteered shared their answers with the class.

The other sections of the conceptual change texts were distributed to the students. The wrong ideas and their reasons were read. The reasoning of why the concepts were wrong was emphasized, and the right ideas and their reasons were read. Students then moved to the fourth section to prove the right ideas. Students were asked to read the text silently for this section. In the last section, an activity was done with the participation of the whole class. The questions of the "Let's Get to a Conclusion" section were answered with the whole class participating. Especially with the last questions, a discussion gave a lot of students an opportunity to speak. The "Incident Case Investigation" conceptual change text is in the appendix.

Conclusion

The points determined in the literature were taken into consideration in this study in order to make the nature of science conceptual change texts more effective. For example, it is required that the students are aware of their own ideas, and they must notice the differences between the structure of thought they have and the explanations accepted scientifically in conceptual change. The first three sections of the conceptual change texts were designed according to this purpose. Emphasizing the right and wrong ideas in separate tables with happy and sad facial expressions attracted the attention of the students. After a few conceptual change texts were practised, it was observed that the students were looking forward to seeing their right and wrong ideas after they had completed writing them. In other words, the students felt the need to control the accuracy of their ideas. What attracted attention at this stage was that after the students had written their own ideas, they abstained from sharing their ideas with the whole class. The students were anxious that what they had written would be wrong and their peers would criticise them. Moreover, after they had answered the first part of the conceptual change text, while sharing the ideas in the class, it was observed that some of the students who were listening to their peers were very much influenced by the student sharing his ideas whose academic achievement was high, and they tried to change their ideas to fit the explanations their peer. In this context, during the practise of the conceptual change texts, it can be said that the students required encouragement while on the verge of expressing themselves.

According to Hynd (2001), making students believe in the newly presented situation in conceptual change texts was achieved in three ways. The first one is one-way form. The message is presented in this form, but discussions of opposite views are not made. The second form is two-way, non-refutable form. In this form, two ways of examining the subject are presented, and the writer prefers one of them. However, it is not emphasized why the wrong idea is wrong. The third form is discussion of refutation. Both right and wrong ideas take place in the conceptual change texts prepared for this study, and the justifications of right and wrong ideas are given and the why the right idea was preferred is also discussed. This study provided evidence on how to maket he third form more effective in conceptual change. For example, in the conceptual change text "Despite the Observations Done by Telescope,"some of the students said that technology had developed a lot in today's world and because of this, countries having the similar technology would reach the similar scientific results. Although the tables including right/wrong ideas and their justifications were effective in changing these unwanted ideas, the most important effect was observed in the "Let's Get to a Conclusion" section. In this context, the refutations in the conceptual change texts should be enriched by questions that the students can discover why their ideas are right by themselves, and this can increase the effectiveness of conceptual change texts. It is stated in the literature that conceptual change texts in such forms are accepted more by the students (Guzzetti, 2000; Hynd, 2001). Guzzetti (2000) emphasizes that for the texts to provide conceptual change, it is not enough to read the text, but after the texts are read discussions must be made in regard to the scientific explanations given in the text. Attention is drawn to the examples of conceptual change texts that prove the correct view. Discussion questions are not to be made from these examples. Conclusion questions were prepared at the end of conceptual change texts in order to provide the determined conditions. The students were asked to give examples of similar conditions that they had dealt with.

Guzzetti et al. (1995) stated that the effects of conceptual change texts are limited for the students who have difficulty in reading and writing. Consequently, visual materials were used in every section of conceptual change texts that were prepared. Thus, attention of the students and their attempts them to read the texts was emphasized. It was also emphasized that conceptual change texts have the possibility to easily change into teacher-centred applications, and in order to overcome this, it is suggested that the students do research on their own, make experiments and obtain results by preparing texts (Hynd, 2001). In the fourth section of conceptual change texts used in this study, the practises to try to activate the students learning were designed. Moreover, with the section of "Let's Get to a Conclusion," the students were given opportunities to discover the correct ideas. In this context, making students more active, both mentally and physically in conceptual change texts, can contribute to obtaining more positive results. Of course, it was not expected that all the students would change their views after using one or two conceptual change texts. Therefore, conceptual change texts that deal with the nature of science and are compatible with the objectives of various subjects can be prepared for different units. Science subject knowledge and conceptual mistakes of the nature of science should be taken together in conceptual change texts. In this way while subject knowledge is taught, it is provided that the students have adopted enough views about the nature of science.

Conceptual change texts that only deal with aspects of the nature of science were introduced in this study. The effects of these texts were not analysed systematically and comparisons with the other teaching approaches were not made. The effects of conceptual change texts in teaching the nature of science can be analysed with future experimental studies.

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Appendix

Appendix-1 Conceptual Change Text Incident Scene Investigation

A lot of remarks have been made recently about global warming, climate changes and potential big earthquakes in our country. I wonder whether the scientists working on the same topics might have different views? Why? Writeyour views in the blanks given below.

Anwer:..
....
....
....
....

	Wrong views
	We think that the scientists working on the same topic should obtain similar data. In light of similar data, **we believe that two people should obtain the same or similar results with each other**.

Our views are scientifically wrong. The right answer of the question is given below.

	Right views
	Even if the scientists working on the same topic **conduct the same experiments and obtain similar data, they can suggest different results**. **Besides the views suggested might be incompatible with each other** because scientists obtain results by interpreting the data that they have acquired as a result of observation and experiment. The imagination and prior knowledge of the scientists are effective with the interpretation of data.

We can prove the correctness of our ideas with an activity. Examine the picture given below carefully. Write what you see in the picture in the space provided.

....
....
....
....
....
....
....

All of a sudden the fume rises and the flames start to surround everywhere. The citizens and the fire brigade try to put out the fire.

The authorities try to determine the reasons of the fire. The clues and photos collected from the scene of the incident after the fire are given below.

Suppose that you are an authority working in a team who is investigating the reasons of the fire. The journalists expect an explanation from you. What would you tell to the journalists was the reason of the fire? Why?

The reason of the fire:……………………………………………………

Because:……………………………………………………………………

Let's get to conclusion

1. Are you sure about the reasons of the fire? Why?

………………………………………………………………………………………

2. Are there any other different ideas about the reasons of fire?

………………………………………………………………………………………

3. Although you have the same data (looking at the same pictures), how can you explain different results?

………………………………………………………………………………………

4. Although the scientists have the same data about a subject, can they obtain different results? Please explain it with examples.

………………………………………………………………………………………