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Effects of conceptual change text based instruction on ecology, attitudes toward biology and environment

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The purpose of this study is to investigate the effects of the conceptual change text based instruction on ninth grade students' understanding of ecological concepts, and attitudes toward biology and environment. Participants were 82 ninth grade students in a public high school in the Northwestern Turkey. A treatment was employed over a five-week period with quasi-experimental design. While two classes were called control group, two classes were called experimental group. Each teacher had one control group and one experimental group. Two teaching methods were used and randomly assigned to one class of each teacher. While the control group received traditional instruction, the experimental group received conceptual change texts based instruction. Ecology Concepts Test, Attitude Scale towards Biology and Attitude Scale towards Environment were administered to the participants as pre- and post-tests. Data of interview and observation were also collected to support the study results. The results showed that the effect of the conceptual change texts based instruction was better than the traditional instruction on understanding of ecological concepts. However, there was no statistically significant effect of the treatment on the participants' attitudes toward biology and environment.

Key words: Ecology, ecological concepts, misconceptions, conceptual change text based instruction, attitude, biology, environment, secondary education.

INTRODUCTION

Students are taught as if they had no prior ideas and experiences about science concepts being studied previously. However, students' minds are not empty; they are full of prior ideas and have several daily life experiences related to scientific phenomena before coming to science courses. Students may have both scientifically acceptable ideas and some alternative conceptions in the same content area in science (Palmer, 1999). Students' alternative ideas can be also referred to as alternative frameworks (Driver, 1981) or misconceptions (Gilbert and

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Watts, 1983). They are considered as fairly different from scientific views accepted. Misconceptions are resistant to change with scientific ones and students may reject accepting new ideas (Hynd et al., 2015; Tippett, 2010) and they are obstacles for students in learning and to make meaningful understanding of some concepts in science. Students' alternative conceptions in science can be originated from different sources; such as prior knowledge, daily life experiences, language, culture, teacher, textbooks and instruction. The term of previous ideas are also used by Duit (2009) instead of alternative conceptions since it refers to ideas that are not transformed by teaching.

During the past few years, much effort has been put on studies of student's misconceptions in various biology subject matters. Students may find that some biological concepts such as genetics, photosynthesis and food web are abstract, difficult, confusing and complicated. Misconceptions are obstacles for students realizing biological concepts therefore; students may not construct meaningful learning in some topics of biology. Some research were based on misconceptions of some biological concepts: the concepts of cellular respiration (Çakır et al., 2001), amino acids and translation (Fisher, 1985), human circulatory system (Sungur, 2000), natural selection (Anderson et al., 2002), evolution (Jensen and Finley, 1995), photosynthesis and respiration (Çapa, 2000; Ören et al., 2010), photosynthesis and inheritance (Çakıroğlu and Boone, 2002), genetics and ecology (Bahar et al., 1999; Okebukola, 1990), genetics-cell division, mitosis and meiosis (Çimer, 2012; Dikmenli, 2010; Murniza et al., 2012; Williams et al., 2011), ecosystem and ecology (Griffiths and Grant, 1985; Okeke and Wood-Robinson, 1980), nutrient cycling in ecosystems (Hogan and Fisherkeller, 1996), food chains (Gallegos et al., 1994), food chain and food web (Webb and Bolt, 1990), greenhouse effect, reducing CO_2 emissions and ozone layer depletion (Andersson and Wallin, 2000), seed plants (Yakışan et al., 2007), classification of vertebrates (Çinici, 2011), diversity of organisms and classification (Türkmen et al., 2002).

In biology teaching, ecology is one of the central concepts in biology, but is an abstract concept in biology. The concepts of food chain, food web and decomposition can be considered as three essential ecological concepts.

In Turkey, students are usually introduced to ecology in fourth and fifth grades in primary school with examples of living things and nonliving things, environment that we live in, living areas, food chains, environmental pollution, environmental conservation in the unit of 'Investigate the World of Living Things' in the thematic unit of learning: living things and life. In seventh grade, students are introduced to unit of human and environment in the thematic unit of learning: living things and life. This unit contains world, biotic and abiotic factors of environment, producer, consumer and decomposer, feeding relationships and energy flow, energy pyramid, ecosystems, food chains, food webs and matter cycles. Biology is a four-year course in which ecology is covered during the first semester of the first year in high school. In ninth grade, ecology unit covers biotic and abiotic factors of environment, producer, consumer and decomposer relationships in matter and energy flow, symbiotic relationships, food chain and food web, cycles of materials, population, community, ecosystem, environmental pollution, environmental conservation and erosion. In short, ecological concepts are taught gradually and students are expected to apply them to their everyday life in several grades in Turkey.

The more children become familiar with a word associated with environment, the more it is easy for them to understand it. Although children have come across any environmental words in everyday life or at school, they might not have completely internalized the concepts since they still have a very concrete way of thinking. They might not correlate these words with their everyday life words and these concepts might be high level of abstract for them. In order to increase environmental interest for the children aged 7-9 years-old, creative and interesting teaching would help children to build up the knowledge, skills, values and attitudes for a better understanding of the environment (Barraza and Cuarón, 2004).

However, misconceptions of ecological concepts that students had were main obstacles for realizing ecological concepts and getting a better understanding. Researchers determined that many students had misconceptions in ecological concepts (Adeneyi, 1985; Çetin, 1998; Çetin, 2003; Eyster and Tashiro, 1997; Hellden, 1992a; Gallegos et al., 1994; Khatete, 1995; Leach, 1995; Soylu, 2006). For instance, Adeyini (1985) studied students' alternative conceptions on food chain, decomposition, energy flow, energy pyramid and the carbon cycle with junior secondary school students. The findings of the study showed that a few of them still appeared after the instruction. Similarly, the results of the studies of Helden (1992b) and Khatete (1995) revealed that students have some misconceptions about decomposition even after the instruction. Çetin (1998) reported that seventh grade students had difficulty in explaining the origin of flow of energy in a food chain and some students considered the producer or consumer responsible for the decay in an ecosystem. Soylu (2006) indicated that eight grade students had many misconceptions of ecosystem, population, community, decomposers, food chain, food web, energy pyramid, and energy flow. Furthermore, Dimitriou and Christidou (2007) suggested that most of 7-13 year-old Greek students have a generalized conceptualization of air pollution, but are not capable of identifying the interrelations between these components, especially in regards to the impacts of air pollution on the environment. They confused major environmental problems such as ozone depletion, global warming, air pollution and acid rain. Children were also lack a physicochemical mechanism for air pollution and processes between gases.

Misconceptions should be overcome through instruction (Beeth, 1998) however; students' misconceptions in science cannot be eliminated easily by traditional methods. Traditional instruction does not help to encourage students to work together, to share ideas and information freely with each other. Traditional methods mainly use lecture strategy rather than several instruments to extend students' intellectual capabilities and have not brought more successful results for expected aims of science education. One possible solution to this problem is to make students more active learners in science classrooms. Students should be able to apply what they learn in school to their daily life situations. Weaver (1998) pointed out that students found topics more interesting when they have some relevance to their daily lives or experience.

One alternative way of changing the instruction from teacher-centered to student-centered is to use constructivist approach. Constructivism is mainly linked to students' alternative conceptions and their own experiences. Students shape their formal knowledge based on their existing ideas and experiences at school. When the new information or experiences are presented to the students in the classroom, they will either reject or reformulate their existing cognitive structures whether their knowledge and experiences are connected to their background information. Finally, students' own perceptions and new ideas should be integrated as a useful part of their memory. In contrast, the memorized facts or information that do not depend upon students' existing experiences would be forgotten easily. Therefore, the new ideas or concepts should be attached to students' old experiences accordingly. In that case, it will help students construct the meaningful information in their existing mental framework. Knowledge construction is processed in long term memory (Baddeley, 1992). Several properties such as students' knowledge, experiences, how students organize the knowledge, their perceptions, their ideas and their interaction with environment may affect the process of developing knowledge structure (Bağcı Kılıç, 2001; Durmuş, 2001). Teacher should help the students in budding new insights and connecting them with their prior knowledge. S/he should organize information around conceptual clusters of problems, questions in order to engage students' interest on a topic that has a broad concept. Ideas should be given as broad concepts first and then they should be broken down into parts. Students should be supported to ask questions, carry out experiments and come to their own conclusions (Hanley, 1994).

To provide conceptual change and meaningful learning of science concepts, there is a need for using effective ways for overcoming misconceptions found in science. One of the most effective strategies for eliminating students' misconceptions and increasing students' understandings of science concepts in science is 'conceptual change approach' (Posner et al., 1982). To overcome students' alternative conceptions, large amount of researches have explored the effects of teaching techniques used in conceptual change approach in science such as concept maps (Jegede et al., 1990; Novak, 1990; Wallace and Mintzes, 1990), conceptual change texts (Alparslan et al., 2003; Çakır et al., 2001; Çakır et al., 2002; Sharon and Chambers, 1997; Yürük and Geban, 2001), refutation texts (Hynd et al., 1994; Tippett, 2010), analogy (Stavy, 1991), cooperative learning strategy (Hertz-Lazarowitz and Baird, 1994; Jansen and Finley, 1995; Lazarowitz et al., 1999; Lonning, 1993), storytelling (Banister and Ryan, 2001), portfolio (Valdez, 2001) and teaching experiments (Niaz, 2002), drawing-writing (Ersoy and Türkkan, 2010; Işık and Çetin, 2014; Özsoy, 2012; Kurt and Ekici, 2013a; Kurt and Ekici, 2013b; Taşkın and Şahin, 2008; Yalçınkaya, 2013; Yürük et al., 2011); computer simulations (Smetana and Randy, 2012; Trundle and Randy, 2010).

Conceptual change texts are one of the powerful tools in science education. Conceptual change text based instruction increases the students' science achievement (Chambers and Andre, 1997; Mirjamaija, 2001; Sungur, 2000; Sungur et al., 2001). For instance, conceptual change texts base instruction led to better conceptual understanding of electrical concepts than the traditional didactic text (Chambers and Andre, 1997). Conceptual change texts and concept maps based instruction were significantly effective to students' understanding of human circulatory system than the traditional methods (Sungur, 2000). Additionally, Özkan (2001) said that conceptual change text based instruction showed a statistically significant effect on seventh grade students' ecology achievement.

Purpose of the study

The purpose of the study was to investigate the effects of the conceptual change text based instruction over the traditional instruction on ninth grade students' understanding of ecological concepts, attitudes toward biology and attitudes toward environment. The research questions are as follows:

1. What are the effects of the conceptual change text based instruction over the traditional instruction on ninth grade students' achievement and understanding of ecological concepts?
2. What are the effects of the conceptual change text based instruction over the traditional instruction on ninth grade students' attitudes toward biology?
3. What are the effects of the conceptual change text based instruction over the traditional instruction on ninth grade students' attitudes toward environment?

METHOD

Both quantitative and qualitative methodologies were used in this study (Büyüköztürk et al., 2013; Yıldırım and Şimşek, 2006).

Participants

This study was employed over a five-week period of 45 min per course. Participants were 82 ninth grade students with the age ranging from 15 to 16 years, attending four classes of two female teachers in a public high school in the Northwestern Turkey. The class size was 20-25 for each class. The levels of academic performance of four classes were similar. The socioeconomic status of the students in both groups was similar, with the majority of the students coming from middle class families. Each teacher had two classes: one experimental class and one control class. There were total 37 students in the control group (CG) and total 45 students in the experimental group (EG). Two teaching methods were used in the study and they were randomly assigned to one class of each teacher. The EG was taught using conceptual change text based instruction (CCTI). It was also accompanied by demonstrations within small group work. The CG was taught using traditional instruction. The teachers were trained about the CCTI before the ecology treatment since they had familiar with the ecology content, but have no experience with the CCTI.

Data collection and data analyses

In this study the data were collected through four sources: Ecology Concepts Test (ECT), Attitude Scale towards Biology (ASB), Attitude Scale towards Environment (ASE), classroom observations and interviews with teachers and students.

Ecology Concepts Test: It was developed by the researchers to identify students' misconceptions and levels of understanding of ecology. To develop the ECT, the researchers examined the ninth grade biology curriculum including instructional objectives proposed by the Ministry of Education and a ninth grade biology textbook approved by the Ministry of Education. The ECT included some revised ecology questions (Çetin, 1998). Some ecology questions from elementary science textbooks, ninth grade biology textbooks and university ecology textbooks, the questions related to ecology asked in the University Entrance Exam, the relevant literature about ecological concepts were also used to write questions. The ECT covered the main concepts of the study, including the biotic and abiotic factors of environment, producer, consumer and decomposer relationships in matter and energy flow, symbiotic relationships, food chain and food web, cycles of materials, population, community, ecosystem, environmental pollution, environmental conservation and erosion.

A pilot test containing 25 questions was applied to 165 ninth grade students at eight public high schools in the Northwestern Turkey. The format and content validation of the items in the ECT were performed by a group of experts in biology, biology education, measurement and evaluation, after the piloting the ECT. Finally, the classroom teachers also analyzed the relatedness of the test items to the instructional objectives. Finally, the test included 17 questions: 10 multiple-choice questions requiring explanations and seven open-ended questions. The test has two parts: While the first part examined students' content knowledge, with four alternatives, the second part required justification for the first part. Students need to have both the fist and the second part correct to be awarded a correct response. Distribution of the items in the ECT according to the key concept areas of ecology can be seen in Appendix 1. These key concept areas were; biotic and abiotic factors, food chain, biological organization, cycles of materials and environmental pollution. Sample items from the ECT are presented in Appendix 2. It was assumed that the level of the questions in the ECT was appropriate for the ninth grade students; therefore each student was considered having a capacity to answer the questions in measuring, although a student's ability to answer the questions successfully depended upon the student's previous knowledge, skills and experience (Germann and Aram, 1996).

The responses of the students in both the experimental and control groups selecting the desired content choice and reason (combination) were evaluated for both pre-Ecological Concepts Test (pre-ECT) and post-Ecological Concepts Test (post-ECT). Students' responses for each item in the ECT were analyzed according to the students' levels of understanding of ecological concepts. Students' responses for the reasoning of the multiple-choice and the open-ended questions might contain one or more than one group of ideas linked together. As a guide, acceptable scientific explanations were written for each question by the researchers and the experts. Extended lists of ideas in response to each question were set as much as possible in mutually exclusive categories. Students' explanations for each item in the ECT were classified into six according to levels of understanding (Simpson and Marek, 1988; Westbrook and Marek, 1991; Keng, 1997; Çetin, 1998). They were:

Sound understanding (SU): A student' response to a question includes scientifically acceptable explanations. Partial understanding (PU): A student' response is partly correct, but do not include a full range of the scientifically acceptable explanations about the questions. Partial understanding which includes misunderstanding (PUM): A student' response is partly correct, but do not include a full range of the scientifically acceptable explanations about the question and have some misunderstanding statements/ideas. Misunderstanding (MU): A student' response do not include any scientifically acceptable explanations, it implies that that student has some misinterpretations, misjudgments, or misconceptions about the question. No understanding (NU): A student cannot make proper explanation(s) from the scientific point of view (non-sense or irrelevant responses that cannot be coded meaningfully) or rewrite the item asked in the test. No Response (NR): A student leaves empty the space given in the item or writes 'I don't know'.

Thus, a coding scheme was developed and the students' ideas for each question in the ECT were coded. A scoring scheme for the ECT developed according to the students' levels of understanding of ecological concepts can be seen in Table 1. As seen in Table 1, both each multiple-choice item with reasoning part and each open-ended item were scored between 0 and 3. Students' ECT scores ranged from 0 to 51. For example, if a student responded to a multiple-choice part correctly with a sound understanding explanation, then the score "3" was given to the student for that item. If a student made a correct choice for the multiple-choice part, but provided no explanation for that item, the score "1" was coded. If a student gave full explanation with sound understanding for an open-ended question, the score "3" was used.

While the pre-ECT was administered to all students (total 88 students) in four classes at the beginning of the treatment, the post-ECT was administered to 82 students in four classes at the end of the treatment. All students were told the ECT was not an achievement test, but not to copy one another's work during the completion of the ECT approximately in one hour. Before performing statistical analyses for the ECT, missing data analysis was performed on the ECT. The reliability coefficient of this test was computed by Cronbach alpha estimates of internal consistency, found to be .69.

Students' misunderstandings related to each key concept area of the ECT were identified by the pre- and post-ECTs (Table 2).

Attitude Scale towards Biology: It was developed by the researchers to determine students' attitudes toward biology. It has 15 items with a 5-point Likert type scale: strongly agree, agree, neutral, disagree and strongly disagree. It was scored from 5 to 1 and total possible ASB scores could range from 15-75. It was administered as pre-Attitude Scale towards Biology (pre-ASB) and post-Attitudes Scale towards Biology (post-ASB) to all subjects for

Table 1. A scoring scheme for the ecology concept test.

Coded scores for multiple-choice questions with reasoning Part		**evels of understanding**
Correct	**Incorrect**	
3	0	SU
2	0	PU
1	0	PUM
1	0	MU
0	0	NU
0	0	NR
Coded scores for open-ended questions		Levels of understanding
3		SU
2		PU
1		PUM
0		MU
0		NU
0		NRNR

ECT: Ecology Concepts Test; SU: Sound Understanding; PU: Partial Understanding; PUIM: Partial Understanding including Misunderstanding; MU: Misunderstanding; NU: No Understanding; NR: No Response.

Table 2. Students' misunderstandings of ecological concepts

Key concept area of ECT	Misunderstanding
Biotic and Abiotic Factors	*Related to living things and non-living things (light and water; heat and producer; producer and decomposer):* • Light is living things because it shines. On the other hand, water is living things because we drink it. • While heat is non-living things, producer is living things. • While light is non-living things, water is living things. Because living things exist with water, non-living things is made with light. • Producer and decomposer are human being and human being is living organism/Human being is producer/consumer/decomposer/there is a person or a living organism that produces or decomposes. • Producers are living organisms because they are the reproduction of somebody. • Producers are green plants. Decomposers mix dead plants and animals into soil by decaying them. *Related to produce own food (Water snake; fly; Pine tree; Sparrow):* • Water Snake: Because Water snakes live in for example a stream of an ecosystem and is able to produce certainly its own food in the water/Water snake eats the organisms in the sea. • Fly: Because flies take their food from the environment. • Pine tree: Because it finds own food, as ready/the pine tree cannot walk, it gets food ready. • When Pine tree consumes food, the tree cannot grow. • Pine tree takes its (ready) food from the soil/since the tree is found on the soil, it lives there and takes its food from it/it produces its food from the soil/Pine tree feeds with the minerals in the soil. The others take food as ready from the outside. • Production: Pine tree makes cone in the ecosystem/the seeds that fall from the cone of the pine tree enters underground and form new pine trees by mixing with the soil. • Because Pine tree is depended to the soil, it takes its own food from the soil/since pine tree is a producer, it takes its food from the soil. • Sparrow: Because sparrow interacts with the people/it is an autotrophy organism/since sparrow is a flying bird, it produces its own food. Sparrow eats grasshopper, worm, fly, bee, etc.
Food Chain	*Related to energy pyramid in an ecosystem (producer; consumer):* • The tertiary consumers, animals take food produced by producers. • The primary and secondary consumers take food from producers. • Secondary consumers feed on the tertiary consumers. • Tertiary consumers form the first chain. • Tertiary consumers have the lowest energy in the consumers since energy should be taken from the soil and water. 10% of it is taken.

Table 2. Contd.

Biological Organization	*Related to symbiotic relationship (parasitism; mutualism):* • Organisms help each other in parasitism/they cause damage to each other. • These animals attack another animal and eat it in order to survive. For example, they live as parasites e.g. flycatcher. • Mutualism: They live with the leftovers of other organisms.
Cycles of Materials	*Related to matter cycle (oxygen, carbon, phosphorus and nitrogen cycles):* • Oxygen is source of photosynthesis because we release carbon dioxide and take oxygen while photosynthesis was made. • Human beings take oxygen and give out hydrogen with respiration. • While living organisms make oxygen cycle, they release hydrogen and they breathe clean air. • Plants do not use carbon dioxide in atmosphere in carbon cycle. • Phosphorus pass to the water, then it evaporates and goes to the clouds and comes back to the water. • Phosphorus cycle continues by fishes in sea. • Phosphorus cycle starts with animals in land first. • Related to leguminous plants do not take role in nitrogen cycle because take role in carbon cycle/as nitrogen is taken by respiration/as nitrogen cycle is mineral substance. However, leguminous plants are food. • Plants cannot take nitrogen gas directly from atmosphere in nitrogen cycle since the nitrogen gas is slowly absorbed by the nitrogen cycle from atmosphere. • Blue-green algae emerge free nitrogen of atmosphere and they play role in nitrogen cycle.
Environmental Pollution	*Related to reasons of fish death in spring, lake, or sea:* • Because of the bad weather conditions. • Because of the strong water current of spring, lake, or sea and landslide. *Related to reasons of the color of water and bad smell:* • Because water looks like turbid since lakes are muddy/water is seen as the bottom of the lake. • Because turbid sand flows into water. • Because of the reflection of shadow of the trees near the lakes. • Because there are animals living in the streams or swamp under lakes. They made turbid in lakes and then bad smell spreads. • Because of erosion. • Because of fossil fuel. • Because of algae occurred by feces of frogs. • Because decomposers decrease. *Related to papers, plastic bottles, tin cans, garbage of fruits and vegetable in environment:* • They both mix with and stay on the top of the soil/they remain in the soil/they mix with the soil/they fly somewhere. • It takes centuries for the soil to decompose these leftovers. • They are embedded in the soil after the rain and some natural happenings and they are destroyed after staying there for centuries/they are destroyed and wiped out in the soil. • They are destroyed by warm and cold and rain in the course of time and wiped out. • They become soil by decaying. • The nature decays some of them. On the other hand some stay for centuries. • The garbage that we throw in the nature stand there as they are/they harm the nature/they stand in the nature without disappearing. • If they are not collected, they mix with the soil 3-4 years later. • Disappear. • All of these leftovers mix with the soil and the organisms underground eat them. • Some of them destroy itself in the nature, whereas some stay in the nature. • They are decayed and mixed with the soil by decomposers. • Some disappear by themselves. On the other hand, plastic bottles, metal drink cans do not disappear/cannot be destroyed, they stay as garbage and pollute environment since they stay in the nature for a long time.

ECT: Ecology Concepts Test.

completion in approximately 10-15 min. The reliability coefficient of this test, computed by Cronbach alpha estimates of internal consistency, was found to be .91.

Attitude Scale towards Environment: After revision of a few items of the ASE developed by Özkan (2001), the ASE was used to determine students' attitudes toward environment. The ASE has 22 items with a 5-point Likert type scale: strongly agree, agree, neutral, disagree and strongly disagree. The ASE was scored from 5 to 1 and total possible ASE scores could range from 22-110, with higher

Table 3. Research design of the study.

Group	Before treatment	Treatment	After treatment
Experimental Group	ECT, ASB, ASE	CCTI	ECT, ASB, ASE
Control Group	ECT, ASB, ASE	TI	ECT, ASB, ASE

ECT: Ecology Concepts Test; ASB: Attitude Scale towards Biology; ASE: Attitude Scale towards Environment; CCTI: Conceptual Change Text Based Instruction; TI: Traditional instruction.

scores showing positive attitudes toward environment and lower scores showing negative attitudes toward environment. It was administered as pre-Attitude Scale towards Environment (pre-ASE) and post-Attitude Scale towards Environment (post-ASE) to all subjects for completion in approximately 10-15 min. The reliability coefficient of this test, computed by Cronbach alpha estimates of internal consistency, was found to be .83.

Data related to the TEC, ASB, and ASE were analyzed by descriptive statistics, independent t-test analysis and Multivariate Analysis (MANOVA) to respond to the research questions.

Classroom Observations: Non-systematic classroom observation technique was used in the control and experimental groups to control teacher effect and to verify the treatment: determination of the interactions between the teacher and students in four classes; determination of the teaching and learning environments of the conceptual change text based instruction in the experimental group and the traditional instruction in the control group during the treatment. The descriptive analyses of the data of the classroom observations were performed based on one of the researchers' notes taken.

Interviews: In order to get some more evidences for the treatment, interviews were conducted with two teachers and the students in the experimental group after the treatment. Semi-structured interview technique was used with the teachers to get teachers' opinions about students' common misconceptions of ecological concepts and the effectiveness of the conceptual change text based instruction. Follow-up questions naturally emerged to clarify unstructured thought-provoking questions during the interview sessions. Each interview session with the teachers took nearly one hour, notes were taken and one of the interviews was audiotaped. A group interviewing technique was used with the students in the experimental group in two classes. Group interviews were interactive in some spontaneous manner and had an unstructured form with no preset questions. It was conducted with the students by posing appropriate questions to keep the focus. Focus was to obtain students' opinion about the effectiveness of the conceptual change text based instruction. Each interview session with the students took nearly 45 min and notes were taken.

Interview tapes and interview notes were useful for analyzing the data of both interviews. In order to analyze the data of both interviews, two interview questions were determined: 1. What are the reasons behind the students' misconceptions considering the items in the Test of Ecological Concepts? 2. What are the opinions of the teachers about the instruction used in the experimental group? Interview analyses were performed to get the responses of teachers and the students based on these questions descriptively.

Treatment

In this study, the high school was chosen according to convenience sampling. This study used a quasi-experimental design since there was no possibility of assigning the students to classes randomly. This study was conducted with two teachers and a total of 82 students from four biology classes in a high school in the Northwestern Turkey. Each teacher had one control class and one experimental class. Two of the classes were assigned as control group and experimental group randomly. The research design of the current study is presented in Table 3.

As seen in Table 3, traditional instruction was given to the control group and conceptual change text based instruction was given to the experimental group. The ECT, ASB and ASE were administered to all subjects as pre- and post-tests, in order to examine the effects of the treatment on students' understanding levels of ecology, students' attitudes toward biology and environment.

Treatment was over a five-week period with two 45-min course sessions per week. 'Unit Ecology' and related instructional objecttives were taught in both groups. Before the treatment, teachers and the students in the experimental group were informed about the CCTI and application of CCTI in class, usage of conceptual change texts and worksheets in small group discussions. Ecology courses in the control and the experimental groups were observed by non-systematic classroom observation technique in order to control the teacher effect and to get more data for the study.

At the beginning of the treatment all students in four classes were given pre-ECT, pre- ASB and pre-ASE as pre-tests. It was observed that two of the teachers applied traditional instruction in their control classes similarly. The CG took ecology courses by the traditional instruction based on direct lecturing; questioning, making discussions, giving everyday life examples and using a biology textbook in the classroom. Teacher in control group used blackboard to write some ecological concepts and phenomena and draw some pictures about ecology. While teacher mainly followed the sequence of the textbook, explained the facts to students, some students took notes. She sometimes directed some questions to students and started whole class discussion. Teacher also gave some daily life examples about the ecological topics.

It was observed that two of the teachers applied CCTI in their experimental classes in similar way. Students in the EG were divided into four or five groups according to their average mean of biology two middle exams. Moreover, their class teachers decided the sitting plan of the students in the biology laboratory before the treatment. The experimental group took ecology courses by CCTI including conceptual change texts, worksheets, demonstrations and discussions in small group in biology laboratory.

The conceptual change texts were designed: living organisms and their environment, nutrient cycles and environmental pollution. While developing conceptual change texts, four conditions, intelligibility, plausibility, fruitfulness and dissatisfaction, were taken into consideration to occur conceptual change (Posner et al., 1982). Each conceptual change text started with a question first and it continued with some misconceptions about the current ecological concepts. Thus, it was expected that students were dissatisfied with their existing conceptions by giving some misconceptions on specific ecological concepts. Later, in the conceptual change text directed students to start a small group discussion session and a whole class session via worksheets. Worksheets were not involved in conceptual change texts. They were distributed separately to the students. Worksheets designed as supporting instructional materials to the conceptual change texts included also some teacher demonstrations. Finally, each conceptual change text included general scientific explanations abou t the topic and both the statements of misconceptions and their scientific explanations.

For instance, in the Conceptual Change Text 1: Living Organisms and Environment, Question 2: What are other living and non-living factors affecting living organisms?" were asked to students. Later, it was stated that "When the students were asked to answer what were the factors of living and non-living of environment, some students thought light is a living factor, water is living factor; both producers and decomposers can be human beings; the factors of producer and decomposer are living because they are plants and animals. Then, it was stressed that all students' ideas were wrong. It was passed to Part Discussion: Let us see Worksheet 1: Our living and non-living environments before making some explanations on this topic and now let us investigate the wrong points in these students' ideas given above.

The CCTI started by distribution of the first conceptual change text to the students in the EG before 2-3 days of the ecology course. The students were asked for reading the texts at home. It was very crucial because students could see what the common misconceptions were and to think whether they had any misconception or not and to see the correct scientific explanations about the ecological concepts. Thus, it was assumed that students could be more active in the small group discussions. In the first ecology course in the experimental group, the teacher read the first question and the misconceptions about the topic from the first conceptual change text to the students. Then, worksheets were administered to each student in small groups. The students were asked to respond to the questions in the worksheets individually first and then they were asked to discuss the questions in small groups to revise their responses in order to make consensus. Finally, the teacher started a whole class discussion.

Before filling the worksheets, sometimes teacher made demonstrations with specific phenomenon such as; showing some posters, some dead plant and animals, some models, slide projector and so on. In that case, worksheet included some questions related to the demonstrations. While students responded to the questions in the worksheets, they used mainly the conceptual change texts and rarely their biology textbooks. Discussions could provide interaction among students; and teacher and students. Discussions were the important part of the conceptual change text based instruction. They were designed as the teacher-guided discussions. For example, while the conceptual change text of food chain and food web was taught, students were asked to discuss food web topic with some questions written in the worksheet given. Teacher made a demonstration about fungi under the microscope. Afterwards, the teacher showed and explained an energy pyramid model and also she showed some pictures and explained the relationship between food chain and energy pyramid to students by slide projector. Later, the teacher initiated a small group discussion on the questions in the worksheet and students work together. Then, the teacher was asked to answer each question from one of the students in each small group.

In conclusion, after following the sequence in the conceptual change text, students were expected to respond to the same question, which had been asked at the beginning in the conceptual change text comparing with their previous answers. Students were introduced with misconceptions by contrasting their preconceptions relating specific phenomenon through questions in small group discussion environment. During the whole class discussion sessions, sometimes teachers explained the abstract concepts or made corrections about some common mistakes. It was expected that the CCTI would activate students' misconceptions by presenting examples and questions, present descriptive evidence in text about these misconceptions and provide a scientifically correct explanation of the situation. Thus, the students would accept the new concepts instead of the old ones.

After completion of the instruction of ecology unit in the control and the experimental groups, the post-ECT, post-ASB and post-ASE were administered to both groups.

FINDINGS

Results of the ecology concepts test, attitude scale toward biology and environment

The ECT was administered to the students in the experimental and control groups before the treatment. Independent t-test analysis results revealed that there was no statistically significant mean difference between the two groups ($t= -.58$, $df=80$, $p>.05$). Thus, the students in both groups were assumed as equivalent with respect to their understanding of ecological concepts before the treatment. The ECT, ASB and ASE were administered to all of the students as pre- and post-tests. Descriptive statistics for the pre- and post-tests of the experimental and the control groups before and after the treatment were performed. The results of descriptive statistics are presented in Table 4.

Students' ECT mean scores ranged from 0 to 51. The mean scores of the experimental group increased as 10.25 (37.04 for pre-ECT and 47.29 for the post-ECT) and the mean scores of the control group increased as 5.67 (37.73 for pre-ECT and 43.40 for the post-ECT). The students in the experimental group achieved higher ecology success than the students in the control group. There was a slight increase in the mean scores of both the ASB and the ASE of the students in the experimental and control groups.

After the treatment, the effects of the treatment on the collective dependent variables of the post-ECT, post-ASB and post-ASE were determined by Multivariate Analysis (MANOVA) and Analysis of Variances (ANOVA). All values in the MANOVA below were given according to Wilks' Lambda. The results of the MANOVA showed that there was a significant mean difference between the experimental and control groups with respect to collective dependent variables of the post-ECT, post-ASB and post-ASE ($\lambda=.867$, $p=.011$). In order to test the effect of the treatment on each dependent variable, ANOVA was performed. According to the results of the ANOVA, the conceptual change text based instruction was more effective on students' understanding of ecological concepts than the traditional instruction ($F(1,80)=7.696$, $p=.007$). An inspection of the mean scores indicated that experimental group students performed better on the ECT. There is no significant difference in the means of the post-ASB between the experimental and control groups ($F(1,80)=.324$, $p=.571$). The effect of conceptual change based instruction was not better than the traditional instruction on attitudes toward biology. The effect of conceptual change approach was also not better than the traditional instruction on attitudes toward environment ($F(1,80)=.643$, $p=.425$).

Students' levels of understanding of ecological concepts

To determine students' levels of understanding of

Table 4. Descriptive statistics for pre- and post-tests of the experimental and control groups.

Group	Test	Mean	Standard deviation
	pre-ECT	37.04	4.66
	post-ECT	47.29	5.80
Experimental	pre-ASB	56.54	10.35
Group	post-ASB	57.21	10.00
	pre-ASE	89.66	10.26
	post-ASE	90.42	10.90
	pre-ECT	37.73	5.98
	post-ECT	43.40	7.22
Control	pre-ASB	58.40	10.52
Group	post-ASB	58.50	10.31
	pre-ASE	85.58	10.19
	post-ASE	88.51	10.60

ECT: Ecology Concepts Test; ASB: Attitude Scale towards Biology; ASE: Attitude Scale towards Environments.

Table 5. Percentages of the students' levels of understanding of ecological concepts

Levels of understanding	pre-ECT for EG	post-ECT for EG	pre-ECT for CG	post-ECT for CG
SU	17	24	20	26
PU	21	27	20	26
PUIM	2	2	3	2
MU	16	9	19	15
NU	10	16	9	15
NR	34	22	29	16
Total	100	100	100	100

ECT: Ecology Concepts Test; SU: Sound Understanding; PU: Partial Understanding; PUIM: Partial Understanding including Misunderstanding; MU: Misunderstanding; NU: No Understanding; NR: No Response.

ecological concepts, the students' responses were closely examined on each of the 17 questions in the Test of Ecological Concepts Test as pre- and post-test. Students' levels of understanding of ecology were examined under six headings: SU, PU, PUIM, MU, NU and NR. Tables were established for each item according to before and after the treatment for each level of understanding across key concept areas. Striking differences were indicated on several items between two groups, in favor of the experimental group. Here, one table related to some students' misunderstandings of ecological concepts was presented because of the page limitation of this paper (Table 2). Overall percentages of students' responses to all questions from 1 to 17 calculated according to total percentages of the key concept areas of ecology across students' levels of understanding of ecological concepts before and after the treatment are represented in Table 5.

There was an increase in the levels of students' sound understandings in the experimental after the treatment was higher than the control group according to Table 5. For instance, the questions related to key concept area of environmental pollution as the experimental group students' sound understandings increased after the treatment. Question 13 explained briefly the reasons of the color and bad smell of rivers and lakes. For this question, an acceptable explanation might include this main idea: Algae accumulation can cause turbidity. Increasing number of bacteria and their process of decomposition can be a reason for bad smell. The students' partial understandings increased in the experimental and control groups after the treatment, in favor of the experimental group, especially for Item 11. This item was about whether there is a balance in population of some African countries or not. In this item, students were asked to explain their ideas about the question. An acceptable explanation of this question might be: No, people are dying because of famine in Africa and some people are not able to reproduce. The students' partial understandings which include misunderstandings in the control group were lower than the students in the experimental group after the treatment. For example, one such item was related to the biotic and abiotic factors. In this item, students were asked to find the correct statement (D: Producer and decomposer) and explain briefly the reason for the choice. An acceptable explanation of the question might include the following main idea: Producers and decomposers demonstrate the characteristics of living things such as; developing, feeding, producing, and dying; however climate, light, water and heat cannot demonstrate such characteristics.

The students' misunderstandings decreased in the experimental and control groups after the treatment, in favor of the experimental group, especially for the items related to key concept area of biotic and abiotic factors. For example, one such item was related to insectivorous plants. In this item, students were asked to find the correct item about plants called insectivorous plants. An acceptable explanation of the question might include the following main idea: Insectivorous plants are producers because they make photosynthesis. They are consumer and get what is absent; for example nitrogen from the outside. A slight decrease was also found in the experimental group students' level of misunderstanding of the key concept area of environmental pollution, an increase was found in the control group students' level of misunderstanding of the key concept area of environmental pollution after the treatment. While a slight decrease was found in the control group students' level of misunderstanding of the key concept area of food chain, there was no change in the experimental group students' level of misunderstanding of the key concept area of food chain after the treatment.

Final outstanding point of the study that while there was an increase in the levels of students' no understandings in the experimental and the control groups after the treatment, there was a decrease in the levels of students' no response in both groups after the treatment.

Results of classroom observations and interviews

The results of the classroom observations and the interviews supported each other in some aspects. Based on the observation results, it could be assumed that both the teachers conducted the ecology courses according to the ecology content determined by Ministry of National Education by following a textbook, using direct lecturing, questioning and discussions and giving everyday life examples in the control group. Both of two teachers used the CCTI in the experimental classes. They used conceptual change texts. They used worksheets after performed some demonstrations like showing posters, plants and dead animals in small groups in the experimental group. The teachers guided and monitored small group discussions. The students seemed to enjoy participating in these activities and showed interest in the teaching materials employed in the classrooms.

Similarly, the results of the interviews with two teachers and the students described their opinions about the new teaching method and what kinds of problems in the treatment occurred. Selected examples of excerpts from interviews with them are as follows:

Ideas about teaching ecology with the CCTI were:

It was a difficult and different method for me. Students were not accustomed to this instruction and it made me tired. The students were not willing to read the texts [conceptual change texts]. Misconceptions given in the texts might not be useful. It would be better to give the facts in the texts in order to teach the topics (Teacher 1)

… It is hard to apply this method because students focus on the university entrance examination and want to get higher grades rather than learn ecology. Students are not used to take such methods so; there are some difficulties in applying such methods. If all the biology topics were taught using this method, it would be easier to follow the courses for the students. In this method, the class size should be kept small for the group work and class management (Teacher 2)

Controversial to teachers' opinions about the new method, many of the students in the experimental group stressed that this method was interesting. They felt free to talk and discuss the ecology topics with their classmates during the small group discussions; expressing what they thought as a group was not something they experienced before. Seeing an energy pyramid model and other demonstration materials in their classrooms made them think about the ecological concepts. Several students expressed that they wished the other classes also had used this method.

Ideas about likes and dislikes at most related to the CCTI were:

I liked worksheets at most. I could apply them into small group work … but preparing materials is time consuming. We do not have diagrams and posters in our school; however I can ask students to prepare diagrams and posters. (Teacher 1)

It is not good to give some misconceptions of ecology to students at the beginning of the text. Attention span of the students is generally 20 min … Students may learn misconceptions as if they are correct and they could miss the following parts. In addition, the answers of the questions should not be given in the provided texts … However, it is nice to give some texts to students to get them ready for the classes and then it may arouse their interest towards ecology topics. (Teacher 2)

Parallel to Teacher 1 some students in the experimental group stated that they liked activities in worksheets and group work at most. On the other hand, they stressed that the number of activities in the worksheets was too much and they were getting bored. Most of the students mentioned that they liked to respond to the questions in the worksheets during the whole class discussion. Otherwise, only some certain students responded to teachers' questions asked in other biology courses during the direct instruction. Few students also stressed that they did not like this method at all and preferred the lecture method.

Ideas about main problems occurred during the CCTI were:

Ecology topics were at the end of the semester. Therefore, students took all examinations before and they knew whether they passed or failed from the biology course. The EG was unwilling to participate in the new instruction and students came to the class without reading the texts … The instruction is time consuming. The instruction time should be three hours per week and one of these hours should be allocated for either small group work or laboratory experiments (Teacher 1).

Time was insufficient. The ecology topics were taught at the end of the semester. The teachers and the students encountered this method for the first time and texts were too long. Texts could have fewer explanations and they should attract students' attention more. Students were not ready for group work and discussion environment and students were coming to class unprepared (Teacher 2).

The majority of the students liked the demonstration materials and activities in the worksheets. However, it was hard to focus on the long conceptual change texts and the long activities in the worksheets. Most of the students complained about too much noise during the activities and they had difficulty to concentrate on the topic because of that noise. In short, both the teachers and students stressed same problems about the treatment: noise and too long conceptual change texts.

DISCUSSION AND CONCLUSION

The main purpose of the present study was to investigate the contribution of a conceptual change text based instruction accompanied by demonstrations in small groups on ninth grade students' understanding of the ecological concepts, and attitudes toward biology and environment. The findings of this study supported the claim that conceptual change approach is one of the most effective strategies improving students' understanding in science. The results revealed that there were statistically significant differences of understanding of ecology and remediation of misconceptions of ecological concepts between the CCTI and the traditionally based instruction, in favor of the students in the experimental group. While students' levels of understanding in the experimental and the control groups showed that the students' sound understanding and partial understanding increased in both groups after the treatment, in favor of the experimental group, the students' misunderstandings decreased in both groups after the treatment, in favor of the experimental group.

The greater success of CCTI on students' understanding of ecological concepts in the experimental group than the control group had could be explained as follows: The study results supported that it is not easy to remove misconceptions by traditional instruction and the conceptual change approach is one of the most effective strategies improving students' understanding in science instruction (Sungur et al., 2001). During the treatment, the control group received the instruction based on direct lecturing; questioning, giving everyday life examples and using a biology textbook in the classroom. However, the CCTIs were designed to remediate misconceptions of ecological concepts commonly held by students. In order to decrease or remove the misconceptions, some activities were designed for supporting the conceptual change texts. Conceptual change texts emphasized students' misconceptions of ecology and the students were dissatisfied with their existing conceptions or prior knowledge. This methodology encouraged the students to reconstruct their ideas. The conceptual change texts and the worksheets included some examples of current ecological phenomena and daily life experiences, thus students might grasp some ecological concepts concrete and meaningful in school context. It was expected that the students would accept the new conceptions instead of the old ones as much as possible.

The CCTI was implemented in an instructional technology enriched setting supported with demonstration tools and visual aids and then the experimental group received the instruction using conceptual change texts accompanied by worksheets, demonstrations, posters and slide projector during the small group discussions in biology laboratory. The students were willing to take part in these activities.

Despite there is no methodology that can be used for all topics in science; a well-designed conceptual change approach based instruction in science can represent an alternative instruction approach to encourage students to modify misconceptions in science. Based on the results of the post-ECT in this study, the CCTI explicitly dealt with the students' ecology misconceptions, while the traditional instruction did not. Hence, the CCTI is a powerful methodology for science classes. This result supports the findings of other studies reporting the conceptual change text based instruction increased the students' science achievement (Alparslan et al., 2003; Chambers and Andre, 1997; Çakır et al., 2002; Eryılmaz, 2002; Köse et al., 2006; Mirjamaija, 2001; Sungur, 2000; Sungur and Tekkaya, 2003; Sungur et al., 2001; Yeşilyurt, 2002). For instance, Sungur et al. (2001) showed that the conceptual change texts accompanied by concept mapping instruction produced a positive effect on tenth grade students' understanding of the human circulatory system. Yeşilyurt (2002) enlightens us on similar results; the conceptual change text based instruction overcome students' misconceptions on fluid force at seventh grade level showed better scientific conceptions and elimination of misconceptions than the traditional methods based instruction. Çakır et al. (2002) stressed that it caused significantly better acquisitions of scientific conceptions related to acid and base concepts than the traditional instruction. The study of Alparslan et al. (2003) stated that although the conceptual change instruction which explicitly dealt with students' misconceptions produced significantly greater achievement in the understanding of response concepts. Köse et al. (2006) reported similar conclusion; conceptual change texts based instruction was significantly effective in overcoming prospective science teachers' misconceptions of photosynthesis and respiration in plants.

In contrast, the results of this study showed that there were no statistically significant differences in the students' attitudes toward biology and attitudes toward environment between the experimental and the control groups. Attitudes do not change as easily. Attitudes occur as a result of experience of and observation of a person. Society also may affect attitudes (Cherry, 2014). Therefore, future studies can be designed in longer time to increase students' attitudes toward biology and environment.

These results of the present study are similar to that of the study results of Özkan (2001). She illuminated that the students who were taught using the conceptual change texts based instruction had significantly higher scores of ecology achievement than those students who were instructed by traditional method, while there were no significant differences in students' attitudes toward environment between the experimental and control groups. Graham (2003) demonstrated that the student-centered instruction with conceptual support had a significant effect on the students' misconceptions and achievement, but it was not effective on the students' attitudes toward science. However, there were some studies showing conceptual change based instruction was effective in improving students' attitudes toward science. For example, Greenfield (1996) indicated that students in grades 3-12 in the USA showed the most positive attitudes toward science and the most positive perceptions of their own science ability and achievement.

Rogers and Ford (1997) examined the factors of class, age and number of previous biology courses affecting students' attitude toward biology and they reported these factors did not show a significant correlation on students' attitude toward science. Morrell and Lederman (1998) presented some important findings about students' attitude toward school and science as follows: The relationship between students' attitudes toward school and science was weak; while students' attitudes toward school were positive, students' attitudes toward science were poor; the relationships among students' attitudes toward school and science and the factors of size of sample, gender and grades were not strong. Females showed slightly more positive attitudes toward school than males, but there were no significant gender differences regarding science attitudes. Although students' attitudes toward school did not significantly decrease between 5th and l0th grades, students' attitudes toward science showed decreasing in older students.

Prokop et al. (2007) also highlighted that Slovakian students had a positive attitude toward biology lessons. Gender was another parameter for attitude and girls had more interest in biology. Though biology lessons were most popular lesson among younger students, the degree of interest decreased as the students get older. Therefore, age was found the major factor that impacts students' attitude toward biology. Similarly, Gentry et al. (2002) reported that the elementary school students were more interested in classroom activities than the middle school students. The girls were more interested in classroom activities and they enjoyed more than the boys.

In sum up, the results of the studies stated that students' interests declined by age are concurrent with the results of the current study indicating ninth graders' attitudes toward biology were not significant in the experimental and the control groups.

Another point of this study, while these results showed that students' no response decreased in both groups after the treatment in this study, students' no-understanding increased in both groups after the treatment. The reasons behind the conceptual difficulties, misconceptions, non-understanding of ecological concepts in this study could be explained by the data of the interviews with teachers. The reasons might be either the lack of students' knowledge about the ecological concepts related to the questions in ECT. Teachers mentioned that many students only desired to graduate from high school, do not have an intention to continue to school life and those factors caused low attitudes toward science courses for the students. Those results provided a proof for the results of the study. Sample size of the present study and treatment period might also cause those kinds of results. Future research can replicate a study with a longer time period, since longer time might affect the students' attitudes toward biology and students' attitudes toward environment positively (Sinclair, 1994). Another reason behind these results of the study might be the treatment was performed in the end of the semester. Thus, at that time students felt exhausted and they might not perform well. Sander et al. (2006) recommended that for a better understanding of ecosystem, imbalance and the dynamics of biodiversity, the dimensions of both space and time should be incorporated in curricular design.

Although ecological concepts take part in an important role in biology teaching, students might not internalize main ecological concepts even after biology instruction. The major reason might be that preconceptions which could influence learning are not sufficiently taken into account in the development of curricula (Sander et al., 2006). Stern and Roseman (2004) implied that students have difficulties regarding food, matter and energy transformations, matter conservation in living systems and plant and animal nutrition and middle-school textbooks do not take these difficulties into account. "The majority of schools are still relying on textbooks as the primary source of the classroom curriculum and textbooks strongly influence students' learning through their influence on teachers. While science educators have different views on whether curriculum materials are needed at all and on the role they should play … Curriculum materials can and should play an important role in improving teaching and learning" (Stern and Roseman, 2004, p.19).

This study would present an example of incorporating the CCTI to ecology unit for teachers, curriculum designers, science educators and other researchers. They are faced with the challenge of changing students' alternative ideas to scientifically accurate understandings. They could consider the students' existing conceptions or misconceptions in science in order to select and organize students' intended learning outcomes in science. Using conceptual change texts would make students to realize students' common misconceptions on ecology and the remediation of these misconceptions (Adeniyi, 1985; BouJaoude, 1992; Griffiths and Grant, 1985; O-Saki and Samiroden, 1990).

In this study, convenience sampling was used, and the sample was chosen from the accessible population in the Northwestern Turkey. Thus, there is a limitation about generalization of the findings of the study. The results can only be generalized to the accessible population and to similar populations in Turkey.

Furthermore, some conceptual change strategies such as concept map, fortune lines, word association, analogy, and drawing-writing, poster drawing, journal writing can be used in order to determine the students' ideas on a particular topic (Bahar, 2002; Bahar et al., 2008; Ersoy and Türkkan, 2010; Işık and Çetin, 2014; Özsoy, 2012; Taşkın and Şahin, 2008; White and Gunstone, 1998; Yürük et al., 2011) can be used in order to determine the misconceptions and remediate them. Moreover, computer simulations can be useful to promote conceptual change in science education (Smetana and Randy, 2012; Trundle and Randy, 2010).

It is hoped that the results of the study will guide the future studies about the implementation of the CCTI in the other science areas like chemistry and physics at different grade levels since the conceptual change texts including worksheets used in this current study were clear. The CCTI can be also combined with other teaching methods such as traditional methods, field study, hands-on activities and etc. according to the appropriateness of the science topics straightforwardly.

Conflict of Interests

The author has not declared any conflict of interest.

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