Developing and Implementing an Instructional Technology Aided Conceptual Change Approach in Teaching Ecology Concepts at Ninth Grade

Gülcan ÇETİN, Middle East Technical University, gulcan@hotmial.com
Hamide ERTEPINAR, Middle East Technical University
Ömer GEBAN, Middle East Technical University

Abstract
The purpose of this study was to investigate the effectiveness of using conceptual change texts accompanied with small group work on ninth grade students' learning of ecology. The developed texts were constructed to remediation of students' misconceptions with accommodated new ones about ecology. Conceptual change texts were implemented in an instructional technology enriched setting supported with demonstration tools and visual aids. Activities were conducted in small groups working with worksheets, demonstration, posters and slide projector during the instruction. While the experimental groups took instructional technology aided conceptual change approach within groups, the control groups were taught with traditional method over a four weeks period. An Ecology Concepts Test was constructed to identify students' misconceptions and to indicate how successful the course had been in improving students' learning about ecology. All students were administered Ecology Concepts Test as pre-test and post-test. The experimental and the control groups were observed using non-participant approach as much as possible. According to pre-test analysis results, there was no significant mean difference between experimental and control groups. After treatment, the results of post-test indicated that experimental groups caused a significantly better acquisition of scientific conceptions related to ecology concepts than the traditional instruction.
Key Words: Misconception, conceptual change approach, conceptual change texts, ecology, and teaching.

INTRODUCTION

There are many studies specifically investigate students' understanding of several biological concepts such as inheritance, human biology, human body, homeostasis, natural selection, human circulatory system, plants as living things, amino acids and translation, respiration, and nutrient cycling in ecosystems (Okeke & wood-Robinson, 1980; Adeniyi, 1985; Stavy, 1988; Hellden, 1992b; Hogan & Fisherkeller, 1996; Bahar et al., 1999).
Ecology is considered as main topic in biology instruction. The concepts of food chain/food web and decomposition can also be considered as two central concepts (Griffiths & Grant, 1985; Webb and Bolt, 1990; Hellden, 1992a; Gallegos, et al, 1994; Khatete, 1995; Leach, 1995, Çetin, 1998). Khatete (1995) studied the concept of decomposition with Kenyan children in everyday contexts. He examined children's ideas about decomposition, food spoilage, and the scientific basis of food preservation. Furthermore, Adeyini (1985) studied on common misconceptions held by junior secondary school students: ecosystem, habitat, population, biotic community, producer, consumer, food chain, trophic level, energy flow, pyramid or number/energy, and the carbon cycle. He reported that students possessed several alternative conceptions about food chain, energy flow, and pyramid of energy, and the carbon cycle. He observed the teacher in the classroom and took notes about them and also lessons were audio taped. He developed an interview protocol to assess students' knowledge about ecology. He concluded that although some of these misconceptions might have existed before instruction, a few of them appeared after instruction. He also stated that students' prior misconceptions tended to block understanding of new concepts and generalizations.
In the present studies, researchers also deal with conceptual change text oriented instruction. To design an instruction involving conceptual change text helps to students to understand science concepts (Sungur, 2001). Özkan (2001) studied on remediation of seventh grade students' misconceptions related to ecological concepts and on students' environmental attitudes through conceptual change approach. She constructed two-tier multiple-choice test and it was conducted as pre- and post-ecology achievement test to the control group and experimental group. The misconceptions identified through an ecology concept test related to the concepts of environment, ecosystem, decomposer, population, and energy resources in ecosystems, food chain, and food web. Her study indicated that experimental group achieved significantly better than the control group. Furthermore, there was no significant difference was found between the experimental group and the control group relating attitudes towards the environment.

METHOD

Purpose of the study was to investigate the influence of conceptual change texts oriented instruction within small group work accompanied with demonstration over the traditional instruction on ninth grade students' understanding of ecology unit in the biology course.

Sample

The subjects of this study included 79 ninth grade students in a high school; four ninth grade classes taught by two biology teachers were selected. Each two teachers had two classes, one experimental group and one control

group. According to convenience sampling, the two teaching methods were assigned to one class of each teacher. The experimental groups were taught with conceptual change text oriented instruction within group work accompanied with demonstration while the control groups was taught with the traditional instruction.

Measuring Tools

In this study, two measuring tools were used: an Ecology Concepts Test and non-participant classroom observation. The Ecology Concepts Test was developed by the researchers. The test was to identify the misconceptions and the understanding level of students about ecology before and after treatment. During the development of the Ecology Concept Test, ninth grade biology curriculum prepared by the Ministry of Education was examined regarding objectives and ecology concepts of ecology unit firstly. This study covered those ecology concepts: non-living and living factors of environment; producer, consumer and decomposer relationship in matter and energy flow; symbiotic relationships; food chain and food web; cycle of matter; population; community; ecosystem; environmental population; environmental conservation and erosion.

According to the objectives and the concepts in the curriculum mentioned above, test items were developed. While writing the test items, the Ecology Concept Test on 8th grade developed by Çetin (1998) was utilized. Test format and question type was similar. In this study, some new test items were written as well. Moreover, other sources were searched to write the items such as secondary science textbooks, ninth grade biology textbooks, university ecology textbooks, University Entrance Exam questions, related literature, and instruments developed by other researchers. The test covered 18 items. The first pilot test was conducted to 80 tenth grade students in a high school.

After the revision of first pilot test, some items were removed and some items were written again and there were 25 questions in the test. It was piloted secondly to 165 ninth grade students in eight high schools in the center of Balıkesir. After the revision of the test, it had 17 questions. Test included all ecology concepts. The ECT was administered to all subjects of the study as pre-test and post-test.

This test contained two parts. Part one included ten multiple-choice items. Each question has one correct answer and three distracters. Each multiple-choice item required students to select correct answer, also to write reason(s) of that correct answer. The second part composed of seven open-ended questions.

Reasons part of selected correct answer enabled to the researcher to identify students' understanding level of ecology concepts asked. Open-ended items give an opportunity to the students to express ideas on ecology topics more openly.

Total achievement score of each student was calculated according to the students' multiple-choice item score and reasoning part score of multiple-choice item and also essay type item scores together. In multiple-choice items, correct answer took 1 grade and wrong answer took 0 grade. For reasoning part score of multiple-choice item grade was between 0-3. Students got 3 if their responses include complete understanding statement(s). Students got 2 if their responses involve partial understanding statement(s). If students tick the correct answer without any explanation in reasoning part or students tick the correct answer and give some partial understanding statements(s) including some misconceptions, they got 1 grade. If students tick the correct choice but give wrong explanations (misconceptions), they got 1 grade. Essay type items were also graded between 0-3 grades as similar as reasoning part.

Throughout the treatment process the instructions in the experimental and the control groups were observed and taken notes as much as possible. The main purpose of the observation was to determine how the conceptual change texts oriented instruction and traditional instruction in four groups presented. During the lesson teaching and learning environment was observed with a naturalistic approach.

Procedure

The main aim of this study was to investigate the influence of conceptual change texts oriented instruction within small group work accompanied with demonstration on ninth grade students' understanding of ecology unit in the biology course. Treatment took over a four weeks in a high school in a center of a province of West of Turkey. Each classroom instruction was two 45-minute sessions per week. At the beginning of the treatment, a total of 86 students from four biology classes by two teachers were included to the study. As the classes formed before and teaching was continuing, there was no possibility of making a selection of students and make a class randomly. According to availability of each two classes, they were assigned as control groups and the others as the experimental groups. Each two teacher had one control group and one experimental group. While the control groups were taught by traditional methods, the experimental groups were taught by conceptual change text oriented instruction within group work accompanied with demonstration.

In the control groups, teaching styles of the two teachers were observed quite similar. Each control group took the traditional instruction that involved lessons using lecture, asking questions methods to teach ecology concepts. Both teachers and students used only ninth grade biology textbook approved by the Ministry of Education during the class. Teachers taught ecology according to the sequence of topics in the textbook. Teachers explained the topic, asked questions to different student or the student who was eager to answer the question. Sometimes teachers wrote some concept name or draw a schema or diagram on the board. Sometimes they also said that 'Open your note books and took note …' to students. And students took note.

In the experimental groups, teacher and students used conceptual change texts. Students were also allowed to use same textbooks approved by Ministry of Education with the control groups used during the class. Through the treatment the experimental groups were administered three conceptual change texts: living organisms and their environment; cycles of matter; and environment pollution. Before treatment of conceptual change approach, teachers were given information what the conceptual change text was and how the conceptual change text instruction within group work accompanied with demonstration can apply. At the beginning of the treatment, all students in four classes was administered the Ecology Concepts Test. Teachers were delivered conceptual change texts before application. After students completed the Pre-Ecology Concepts Test, students were handled first conceptual change text. They were informed about nature of the conceptual change texts and the small group discussions: what was expected from them during the courses, how they could use the conceptual change texts and how they use the worksheets for discussing the ecology topics. The expectation for using the conceptual change texts in the classroom was to eliminate the students' common misconceptions about ecology and improve students' understanding of ecology. Students were told to read the text before 2-3 days ago from the ecology course and bring them to the ecology course. To read texts before the class was crucial because they could think what was the common misconceptions and whether they had or not and see the examples and the correct scientific explanations about ecology. Also, students used texts and studied ecology topics at the course time. Worksheets were given out to the students at the discussion time. Students were expected to discuss the topics in small groups at the classroom hour. Thus, discussion results should have been written the worksheets given. Discussions could provide interaction between student-student and teacher-student. Students could also learn from each other and from the teacher. Discussions were teacher-guided discussion. They were the important part of students' conceptual change text based instruction. The conceptual change study was designed that it was conducted in small groups. For example, when the food chain and food web text was taught, students discussed food web topic with some questions written in the worksheet given. Teacher made a demonstration about decomposer such as fungus under the microscope and students made a discussion about fungus. The teacher showed and explained a food pyramid model and students made a discussion about it. Later, some pictures were showed and explained relating food chains to students by slide projector. In other lesson: cycles of matter, the poster of carbon, water, oxygen, carbon dioxide, phosphorus, nitrogen cycles were showed and explain by the teacher. Later teacher told students make discussions on questions in the worksheet. Firstly, students tried to answer all questions in the first activity altogether. Then, the teacher required one student of each group to give answer for the question. During this time, sometimes teacher explained more the topic or corrected some mistakes. Sometimes the teacher wrote the results of the question on the board.

Conceptual change texts prepared by the researchers offered a set of guidelines to help students gain experience in grasping the ecology concepts. These guidelines provided special learning environments, for example it was expected that identification of common misconceptions to the students would dissatisfy students with their existing conceptions. Students may have been different conceptions about the specific situation or the concept. Later, conceptual change texts would provide to activate students' misconceptions by presenting examples and questions, present descriptive evidence in text that the topical misconceptions were incorrect, and provide a scientifically correct explanation of the situation. Thus, it was expected that the students would accept the new concepts instead of the old ones. Questions in the worksheets and information in texts were discussed within small group work. Giving some misconceptions on specific ecology concept, students were dissatisfied by their own preconceptions with specific phenomenon through questions in discussion environment. The teachers for whole class supplied the texts for each ecology course and discussion environment with demonstrations.

After treatment, the post-Ecology Concepts Test was administered to all subjects when the instruction of ecology unit was completed for all groups. At the end of the treatment 79 students took test as pre- and post-test and all of them attended the treatment.

RESULTS AND DISCUSSION

The aim of the study was to examine the effectiveness of using conceptual change texts accompanied with small group work on ninth grade students' learning of ecology. Teaching processes were observed in most of the ecology courses in the experimental and the control groups. Those observations demonstrated that teachers applied conventional lectures and teachers applied conceptual change approach successfully. The Ecology Concepts Test was also conducted to all subjects of the study as pre- and post-test. Independent-samples t-test was used to test the hypothesis at a significance level of 0.05. Analysis of pre- and post-test scores, the results of pre-test showed that there was no significant mean difference among experimental and control groups in terms of understanding ecology ($t=1.84$, $p>0.05$). The results of post-test indicated that there was a significant difference among groups with respect to understanding in ecology concepts in the favor of the experimental groups ($t=2.14$, $p<0.05$). In other words, the results of the pre-test pointed out that the experimental and the control groups were equal in respect to their prior knowledge about ecology concepts. Homogenity of subjects in the groups was crucial point to start a treatment. However, after treatment, the results of the post-test showed that the conceptual change texts oriented instruction within small group work accompanied with demonstration caused a

significantly better acquasition of scientific conceptions than the traditional instruction. The main difference between the two methods was that the conceptual change oriented instruction explicitly dealt with students' misconceptions relating ecology while the traditional method did not.

Grater success of students in experimental groups could be explained as follows: Students in the experimental groups were involved in activities during the instruction that helped them revise their prior knowledge and struggle with them. For example, students' misconceptions about ecology were emphasized in the conceptual change texts prepared. In order to deal with these misconceptions, students were made dissatisfied with their own existing conceptions and new conception, which let them find out solutions and better explanations to problems were introduced. In this way, students were allowed to think about their prior knowledge and reflect this. Actually, the important part of using conceptual change texts was intensive social interaction between student-student and teacher-student provided by the teacher-guided discussions. These discussions made with the guidance of the teacher who helped students to share their ideas, and ponder on them deeply. Discussion of the ecology concepts in the texts could facilitate students' understanding as well as represents their conceptual restructuring. As a result, students became persuaded that scientifically acceptable new conception was more meaningful.

A well-designed conceptual change approach to science and instruction represents an alternative approach designed to encourage students to alter misconceptions. It can be said that using conceptual change texts was a powerful instructional methodology according to the results of post-test. Therefore, this methodology could be used in other studies. In this conceptual change approach for the science and biology classrooms, the teacher could be aware of students' prior knowledge and misconceptions about the science and biology topics. The conceptual change texts provide students to realize common misconceptions and their correction on misconceptions. However, the teacher and students should be informed about importance and usage of conceptual change texts in science and biology classes. Then, the teacher could plan their instructional activities accordingly.

Student' misconceptions and alternative ideas can be taken into consideration by curriculum developers. Then, the remediation techniques of them should be designed. If these techniques can be combined with small group work with demonstration, they would be very powerful methodology for science classrooms.

REFERENCES

Adeniyi, E.O. (1985), "Misconceptions of selected ecological concepts held by some Nigerian students", *Journal of Biological Education,* Vol. 19, No.4, pp.311-316.

Bahar, M., Johstone, and Hansell, M.H. (1999), "Revisiting learning difficulties in biology", *Journal of Biological Education,* Vol.33, No.2, pp.84-86.

Çetin, G. (1998), *A Comparison of Some English and Turkish Students' Understanding of Selected Ecological Concepts,* Unpublished Master Thesis, Leeds University, Leeds.

Gallegos, D. et al. (1994), "Preconceptions and relations used by children in the construction of food chains", *Journal of Research in Science Teaching*, Vol.31, No.3, pp259-272.

Griffiths, A.K. & Grant, B.A.C. (1985), "High school students' understanding of food webs: Identification of a learning hierarchy and related misconceptions", *Journal of Research in Science Teaching,* Vol.Vol.22, No.5, s.421-436.

Hellden, G. (1992a), Pupils' understanding of ecological process: Report No.2, The LISMA group learning in science and mathematics, Kristianstad University Collage, Sweden.

Hellden, G. (1992b), Pupils' understanding of ecological process. Summary in English of the thesis: report no.3, The LISMA group learning in science and mathematics, Kristianstad University Collage, Sweden.

Hogan, K. Fisherkeller, J. (1996), "Representing students' thinking about nutrient cycling in ecosystems: biodimential coding of a complex topic", *Journal of Research in Science Teaching,* Vol.33, No.9, s.941-970.

Khatete, D.W. (1995), *Children's understanding of decomposition and its importance in nature among some Kenyan Children,* Unpublished Doctoral Thesis, Leeds University, Leeds.

Leach, J. (1995), *Progression in Understanding of Some Ecological Concepts, Children Aged 5 to 16,* Doctoral Thesis, Leeds University, Leeds.

Okeke, E.A.C. & Wood-Robinson, C. (1980), "A study of Nigerian Pupils' understanding of selected biological concepts", *Journal of Biological Education,* Vol.14, No.4, s.329-338.

Özkan, Ö. (2001), *Remediation of seventh grade students' misconceptions related to ecological concepts through conceptual change approach,* Unpublished Master Thesis, The Middle East Technical University, Ankara.

Stavy, R. (1991), "Using analogy to overcome misconceptions about conservation of matter", *Journal of Research in Science Teaching,* Vol.28, No.4, pp.305-313.

Sungur, S. (2000), *The contribution of conceptual change texts accompanied with concept mapping to students' understanding of circulatory system,* Unpublished Master Thesis, The Middle East Technical University, Ankara.

Webb, P. & Boltt, G. (1990), "The food chain to food web: a natural progression?", *Journal of Biological Education,* Vol.24, No.3, s.187-197.

