



A QUALITATIVE INVESTIGATION OF STUDENTS' UNDERSTANDING ABOUT ECOSYSTEM AND ITS COMPONENTS

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SYNOPSIS

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Conceptual
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Students' misconceptions are the main obstacles for realizing ecological concepts, and getting a better understanding. In this perspective, in this investigation, common conceptions of students in regard to ecological phenomena especially about ecosystem concept and food web were demonstrated. The sample of the study was ninth-grade students (n= 165) and six biology teachers teaching in these students' schools. Results of the study revealed that participating students had difficulty in constructing ecosystem and food web concepts which are at the heart of ecological concepts.

INTRODUCTION

Ecology has long been recognized as one of the most important and difficult to learn concepts of the biology curriculum (Ozkan et al., 2004). In biology education, ecological subjects play an important role in dealing with nature in a responsible way. Despite its importance, students have been reported to perform poorly in ecology (Ugulu et al., 2008). Empirical research has shown that, even after instruction, students display difficulty in understanding essential ecological concepts such as 'food chain and web,' 'cycle of matter', and 'ecological niche' (Pfundt & Duit, 2002). According to research on conceptual change, difficulties in understanding scientific concepts are not caused by insufficient knowledge. They arise from the fact that everyday conceptions of students differ from scientific ones (Sander et al., 2006).

From this point of view, one of the obstacles in teaching ecology is the fact that there are many uncertainties as to how certain facts, concepts and terms should be understood. This situation is even mirrored in schoolbooks where the same terms are used in different ways (Sander et al., 2006). Another difficulty faced in the process of ecology instruction is teacher-centered teaching. The learner-centered

environments tend to engage students in knowledge construction, while teacher-centered environments promote information absorption (Gravoso et al., 2008). In fact, many studies show that teacher-centered approach often promotes misconceptions and inert knowledge (Bruer, 1994; Schank et al., 1999).

Over the past few decades, research on teaching and learning of ecology has revealed that the students possess several ideas that are at variance with scientifically accepted knowledge even though ecology forms a predominant aspect of most biology curriculum (Aubusson, 2002; Eilam, 2002; Griffiths & Grant, 1985; Hogan, 2000; Manzanal et al., 1999; Munson, 1994; Shepardson 2005; Strommen, 1995). SHEPARDSON (2005) investigated students' statements while describing ecology, how they interpret the world, and what does the world meant to them. Students were required to draw ecological pictures and then describe ecology using these pictures. Then, they were shown some pictures and asked to explain the pictures. Students' drawings and interpretations were examined to form analysis categories (Yorek et al., 2008).

SHEPARDSON (2005) indicated that students constructed the concept of ecology through a limited ecological point of view. For students, ecology is a field or habitat where animals live or a place that helps animals to live. Upper grade students state nutrition, water, and habitat requirements in their explanations. However, majority of the students did not mention about energy flow, matter cycle, and nutritional relationships or they did not have a through understanding of the subject. It is found that relationships between biotic and abiotic components and their interdependences could not be explained. Ecology is a rural area that can only be formed naturally. According to students, ecology can not be formed by humans or by artificial means. In addition, humans were perceived not as part of nature but as separate from nature. SHEPARDSON (2005) suggests that student explanations carry anthropo-morphic characteristics.

STROMMEN (1995) investigated students' conceptual understanding of forest. Students defined forest in terms of animals such as lion, tiger, and bear and the place where these animals live or in addition to animal-nutrition relationship, from a one-dimensional viewpoint they mentioned about hunter-prey relationship. Nutritional relationships were not assessed in terms of energy flow within ecosystem.

In Turkey, students learn ecological concepts at fourth, seventh, and ninth grades in general science classes. Ecological concepts are given gradually to teach those concepts, and students are expected to apply them to their daily lives (Cetin, 2003). However, students' misconceptions are the main obstacles for realizing ecological concepts, and getting a better understanding. Ecological topics are difficult to understand for students because they contain complex and interrelated concepts. Ecosystem is a central concept in ecology and the content of all

ecosystems involves three functional processes: photosynthesis, cycling of matter, and flow of energy (Cokadar & Yilmaz, 2010).

In this perspective, common conceptions of students in regard to ecological phenomena especially about ecosystem concept and food web were demonstrated. These conceptions were proven to be essential for understanding the ecological concepts and, moreover, for successful instruction and meaningful learning of ecology.

METHOD

The study employed qualitative research methods (Bogdan & Biklen, 2007; Shepardson, 2005; Yıldırım & Simsek, 1999). The National Curriculum in Turkey was analyzed to determine students' conceptual understanding level and according to this analysis 'Conceptual Understanding of The Living Things and Classification' (CULC) test was developed. In addition, semi-structured interviews were carried out with teachers and students to gather information about course structure and students' conceptual understanding. The CULC test is shown in Table 1.

Table 1: Nutritional relationships among hawk, rat, grasshopper, and grass.

Categories	Gender		Schools					
			1	2	3	4	5	6
Hawk eats rat, rat eats grasshopper, grasshopper eats grass	M	Pretest	42.9	100	77.8	57.1	100	100
		Posttest	64.3	100	66.7	85.7	100	100
	F	Pretest	69.2	82.4	95.0	56.3	100	79.2
		Posttest	100	88.2	90.0	62.5	100	82.6
Other	M	Pretest	35.7	-	11.1	42.9	-	-
		Posttest	21.4	-	33.3	14.3	-	-
	F	Pretest	30.8	17.6	5.0	37.5	-	20.8
		Posttest	-	11.8	10.0	31.3	-	17.4
Blank	M	Pretest	21.4	-	11.1	-	-	-
		Posttest	-	-	-	-	-	-
	F	Pretest	7.7	-	-	6.3	-	-
		Posttest	-	-	-	6.3	-	-

DESIGN OF THE CONCEPTUAL UNDERSTANDING TEST AND VALIDITY AND RELIABILITY

The content of the test was limited to the content of two units included in the high school biology curriculum in Turkey, 'Biodiversity and Classification' and 'Ecology: Earth Environment and the Living Things'. Two in-service biology teachers

and two university faculty members, one is expert in ecology and the other in biology education, together discussed and evaluated the test in terms of content validity. Final version of the test was developed in light of expert views.

It is said that in qualitative studies related to conceptual understanding, preset categories may not be used for the purpose of analyses and categories specific to any research may be determined for this purpose (Martinez et al., 2001; Shepardson, 2005; Thomas, 2002). In this study, using the responses of 50 students drawn randomly among from students, analysis categories were determined. Using analysis rubric constructed from these categories, student responses were coded. An expert in biology education was asked to code the responses of 50 students using the same rubric. Comparisons of coding revealed that there was 80% agreement in the coding. Differences were worked out together. Responses which were not included in any category were shown as 'not related' in a separate group.

THE SAMPLE

The sample of the study was ninth-grade students (n= 165) selected via cluster sampling from the mentioned population and six biology teachers teaching in these students' schools. The same textbook (Ministry of Education Press) was used in the selected schools. Schools accepted students from different parts of the province and students varied in terms of socioeconomic status.

RESULTS

It is thought that for a meaningful construction of ecological concepts, ecosystem and the relationships among elements of ecosystem should be comprehended.

In this context, the first question sought to understand students' construction of possible nutritional relationships among the living things and the level of understanding of cross relationships. The second question investigates forest ecosystem, and the concept of ecosystem. The purpose of the third question is to reveal the level of decomposers in the general structure.

Analyses of the responses to the first question revealed that students did not have a through understanding of nutritional relationships. Students displayed a nutritional relationship among animals such as grasshopper eats grass, rat eats grasshopper, and hawk eats rat. They rarely mentioned the possibility that a rat could eat grass or a hawk could eat a grasshopper. In addition, it is seen that despite the fact that it is not known whether a rat eats grasshopper, students established a linear cause-effect relationship among the living things with the thought that 'strong eats weak' (Table 1).

Table 2: Forest ecosystem and its elements.

Living things in forest			Schools						
			1	2	3	4	5	6	
Plants	M	%	Pretest	7.1	-	-	14.3	-	11.1
		%	Posttest	-	-	-	-	-	-
	F	%	Pretest	15.4	-	-	-	-	4.2
		%	Posttest	7.7	5.9	-	6.3	-	-
Animals	M	%	Pretest	50.0	10.0	33.3	42.9	10.0	44.4
		%	Posttest	28.6	-	33.3	14.3	30.0	44.4
	F	%	Pretest	15.4	17.6	5.0	43.8	6.3	8.3
		%	Posttest	7.7	11.8	-	12.5	6.3	13.0
Animals and plants	M	%	Pretest	58.6	60.0	33.3	14.3	70.0	44.4
		%	Posttest	21.4	80.0	-	28.6	60.0	33.3
	F	%	Pretest	46.3	76.5	55.0	25.0	68.8	62.5
		%	Posttest	38.5	58.8	55.0	37.5	43.8	52.2
Living things other than humans	M	%	Pretest	-	10.0	11.1	-	-	-
		%	Posttest	-	10.0	-	-	-	-
	F	%	Pretest	-	-	10.0	12.5	-	-
		%	Posttest	-	5.9	-	6.3	-	13.0
Living things in forest	M	%	Pretest	14.3	20.0	-	-	10.0	-
		%	Posttest	-	-	22.2	28.6	10.0	22.2
	F	%	Pretest	-	5.9	15.0	-	18.8	8.3
		%	Posttest	23.1	11.8	15.0	25.0	31.3	13.0
All living things	M	%	Pretest	-	-	22.2	28.6	10.0	-
		%	Posttest	35.7	10.0	44.4	28.6	-	-
	F	%	Pretest	23.1	-	15.0	18.8	6.3	16.7
		%	Posttest	15.4	5.9	20.0	25.0	18.8	8.7
Blank	M	%	Pretest	-	-	-	-	-	-
		%	Posttest	14.3	-	-	28.6	-	-
	F	%	Pretest	-	-	-	12.5	-	-
		%	Posttest	7.7	-	10.0	12.5	-	-

The analyses of the second question revealed that students focused on the word ‘forest’ rather than the concept of ecosystem (Table 2). They mentioned primarily about animals and also about plants as elements of ecosystem. The fact that they did not mention any other element indicates that the focus was on the dominant elements in nature and they did not have an understanding of the possible relationships. In addition, particularly boys focused on animals when they asked about the living things in forest. An excerpt from student interviews is shown below.

Student-I: Forest ecosystem is an ecosystem that is formed by the living things in the forest. That can be living things in the cavities in trees.

Student-II: I think forest ecosystem is formed by the living things that can live in forest. There are animals that can live in a forest in a forest ecosystem.

Student-III: It means to protect the variety and number of the living things in forest. There may be animals such as wolf, grasshopper, snake, worms, etc. in forest.

Student-IV: There are carnivore and herbivore animals in forest.

Some students explained the third question as interpreting what they see with statements such as mixing with soil and disappearance of an apple after it has fallen to the ground (Table 3). It is thought that 'soil' is seen as the main elements that destroy everything, a mechanism that does not display the truth completely. Students may have used such an explanation because of the fact that decomposers can not be seen with naked eye.

Table 3: Decomposers.

			Schools						
			1	2	3	4	5	6	
Disappears in soil	M	%	Pretest	21.4	40.0	44.4	57.1	30.0	33.3
		%	Posttest	14.3	30.0	55.6	-	-	22.2
	F	%	Pretest	30.8	64.7	25.	87.5	37.5	66.7
		%	Posttest	46.2	47.1	40.0	31.3	12.5	39.1
Eaten by insects	M	%	Pretest	14.3	-	-	14.3	-	-
		%	Posttest	14.3	-	-	28.6	-	-
	F	%	Pretest	-	5.9	-	-	-	-
		%	Posttest	-	-	-	-	-	-
Decomposer bacteria decomposes	M	%	Pretest	57.1	40.0	33.3	-	60.0	66.7
		%	Posttest	35.7	70.0	44.4	71.4	90.0	66.7
	F	%	Pretest	46.2	17.6	50.0	6.3	50.0	25.0
		%	Posttest	38.4	52.9	50.0	50.0	87.5	60.9
Blank	M	%	Pretest	7.1	22.2	22.2	28.6	10.0	-
		%	Posttest	35.7	-	-	-	10.0	11.1
	F	%	Pretest	23.1	11.8	15.0	6.3	12.5	8.3
		%	Posttest	15.4	-	10.0	18.8	-	4.3

When Table 3 is analyzed it is seen that the answers in the form of apple disappears as a result of saprophyte activities increases especially after the post-test. It is recognized that students who stated that soil destroyed the living things in the pre-test, changed their answers in the post-test as apple disappears not because of soil itself but because of activities of organisms in the soil.

DISCUSSION

STROMMEN (1995) found that students defined forest using forest animals like lion, tiger, and bear and the place where these animals live. In addition to animal-nutrition relationship students had one dimensional viewpoint of prey-hunter. The results revealed in STROMMEN (1995) are similar to our findings that nutritional relationships did not explored in terms of energy flow in ecosystem. In addition, it was found that students established relationships among some animals without knowing whether there is a prey-hunter relationship among them. Moreover, students could not grasp the possibility of cross nutritional relationships among animals (Shepardson, 2005).

Finally, it was found that students could not construct truly the microscopic living things that can not be seen with naked eye in ecosystem and the importance of these living things for ecosystem. As a result, while students were trying to explain some subjects they produced mechanisms that did not exist because they did not take into account these living things (or may be they did not know about these living things). For instance, a student who does not know the concept of decomposer may form an idea such that soil takes in dead plants and animals and destroys them. BRAUND (1991, 1998) and TUNNICLIFFE and REISS (2000) reported that while describing living things students mostly focus on their appearance and depend on their observations in their explanations. Similarly, in the present study, since the activities of decomposers in soil can not be seen and observed with naked eye, students depend on what they see, 'soil' in their explanations.

HAGE and RAUCKIENÉ (2004) suggest that ecology education has been regarded as different from other educational types and it has gone through considerable change over the last 30 years not only on the basis of its goals but also on the basis of principles and terms. They mention that today's ecological problems can not be overcome with current anthropocentric view. We need a new concept, a new viewpoint and understanding for increasing ecological awareness in order to balance the relationship between humans and nature.

REFERENCES:

- AUBUSSON, P. 2002: ecology of science education. - *International Journal of Science Education*, 24: 27-46.
- BOGDAN, R.C. & BIKLEN, S.K. 2007: Qualitative research for education: An introduction to theory and methods. - *Pearson/Allyn and Bacon*, Boston.
- BRAUND, M. 1991: Children's ideas in classifying animals. - *Journal of Biological Education*, 25: 103-110.

- BRAUND, M. 1998: Trends in children's concepts of vertebrate and invertebrate. - *Journal of Biological Education*, 32: 112-118.
- BRUER, J.T. 1994: Schools for thought: a science of learning in the classroom. - The MIT Press, Cambridge, 336pp.
- CETIN, G. 2003: The Effect of Conceptual Change Instruction On Understanding of Ecology Concepts. - Ph D Thesis, The Middle East Technical University, Ankara.
- COKADAR, H. & YILMAZ, G.C. 2010: Teaching Ecosystems and Matter Cycles with Creative Drama Activities. - *Journal of Science Education and Technology*, 19: 80-89.
- HAGE, R. & RAUCKIENE, A. 2004: Ecocentric worldview paradigm: The reconstruction of consciousness. - *Journal of Baltic Science Education*, 2: 50-58.
- EILAM, B. 2002: Strata of comprehending ecology: Looking through the prism of feeding relations. - *Science Education*, 86: 645-671.
- GRAVOSO, R.S., PASA, A.E., LABRA, J.B. & MORI, T. 2008: Design and use of instructional materials for student-centered learning: a case in learning ecological concepts. - *Asia-Pacific Educational Research*, 17: 109-120.
- 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*, 22: 421-436.
- HOGAN, K. 2000: Assessing students' system reasoning in ecology. - *Journal of Biological Education*, 35: 22-28.
- MANZANAL, F.R., BARREIRO, L.M.R. & JIMMENEZ, M.C. 1999: Relationship between ecology fieldwork and student attitudes toward environmental problems. - *Journal of Research in Science Teaching*, 36: 431-443.
- MARTINEZ, N.M., SOLANO, I. & GOMEZ, E.J. 2001: Characteristics of the methodology used to describe students' conceptions. - *International Journal of Science Education*, 23: 663-690.
- MUNSON, B.H. 1994: Ecological misconception. - *Journal of Environmental Education*, 25: 30-35.
- OZKAN, O., TEKKAYA, C. & GEBAN, O. 2004: Facilitating Conceptual Change in Students' Understanding of Ecological Concepts. - *Journal of Science Education and Technology*, 13: 95-105.
- PFUNDT, H. & DUIT, R. 2002. Bibliography: Students' alternative frameworks and science education. - Kiel, Germany, Leibniz-Institute for Science Education. <http://www.eric.ed.gov/PDFS/ED342643.pdf>
- SANDER, E., JELEMENSKA, P. & KATTMANN, U. 2006: Towards a better understanding of ecology. - *Journal of Biological Education*, 40: 119-123.
- SCHANK, R.C., BERMAN, T.R. & MACPHERSON, K.A. 1999: Learning by doing. In: Reigeluth, C. M. (Eds), *Instructional-design theories and models: a new paradigm of instructional theory*. - Erlbaum, Mahwah, pp. 161-181.
- SHEPARDSON, D.P. 2005: Student Ideas: What Is An Environment? - *Journal of Environmental Education*, 36: 49-58.

- STROMMEN, E. 1995: Lions and tigers and bears, oh my! Children's conceptions on forests and their inhabitants. - *Journal of Research in Science Teaching*, 32: 683-689.
- THOMAS, G. 2002: Theory's spell-on qualitative inquiry and educational research. - *British Educational Research Journal*, 28: 419-434.
- TUNNICLIFFE, S.D. & REISS, M.J. 2000: Building a model: How do children see plants? - *Journal of Biological Education*, 34: 172-177.
- UGULU, I., AYDIN, H., YOREK, N. & DOGAN, Y. 2008: The Impact of Endemism Concept on Environmental Attitudes of Secondary School Students. - *Natura Montenegrina*, Podgorica, 7: 165-173.
- YILDIRIM, A. & SIMSEK, H. 1999: Sosyal bilimlerde Nitel Arastirma Yontemleri - Seckin Yayincilik, Ankara.
- YOREK, N., AYDIN, H., UGULU, I. & DOGAN, Y. 2008: An Investigation on Students' Perceptions of Biodiversity. - *Natura Montenegrina*, Podgorica, 7: 165-173.

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