

Student Science Teachers' Ideas about the Degradation of Ecosystems

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Abstract

The aim of this research is to investigate student science teachers' opinions about the causes of degradation of ecosystems and the effects of such degradations on the environment. This research focuses on the following questions: What kind of descriptions do student science teachers ascribe to the reasons of degradation in ecosystems? What are the effects of ecosystem degradations on the environment? What are the misconceptions in relation to degradations in ecosystems? A total of 130 participating students, who were studying to become science teachers at Faculty of Education of Necmettin Erbakan University in Turkey, participated in this study. To reveal the participating students' opinions about the reasons for degradations in ecosystems and their effects on the environment, they were asked to answer two open questions: (1) What are the reasons for degradations in ecosystems? (2) What are the effects of degradations in ecosystems on the environment? The participants were asked to answer these two questions. Data obtained from the questions were analyzed and the frequencies of the answers were classified in different categories. Moreover, these included some misconceptions such as 'the greenhouse effect can lead to skin cancer' and 'ozone layer depletion leads to global warming'. The findings are compared with related literature and suggestions are presented.

Keywords: student's science teachers, opinions, degradation of ecosystems, misconceptions

1. Introduction

Human life and natural life are built on several balances. The relationship built by the human being with the environment is one of the greatest balances. Breaking the links of the chain which constitute the natural balance occurs as a result of external effects which might occur in these natural systems and will affect the whole chain and adversely affect the balance. Living things and non-living elements in the environment are in a close relationship. One cannot be taken into consideration without the other. Any part of nature and its organisms which affects another in an exchange of living and non-living substances is called an ecosystem. Life entails energy flow and substance cycles in ecosystems. An ecosystem, which is an open system, has a continuous energy and food intake and outtake. The organisms' relationships with each other and their surroundings are continuous within the framework of ecological rules. Today, environmental problems have increased due to developments in technology and industry. Environmental problems are one of the problems experienced by people, and while some environmental problems, i.e. degradations in ecosystems, occur naturally, others occur due to the effects of human beings. Human beings affect living and non-living elements in ecosystems in which they live and cause degradation of ecosystems. While human beings live together with natural species in ecosystems, the balance of nature is degraded and many environmental problems occur as a result of developments in technology over time and irresponsible use of natural resources.

In order to overcome these problems, recent studies have particularly focused on the human factor (Barr, 2007; Ewans et al., 2007). Being the most important factor in the emergence of environmental problems, the human being has to be unavoidably involved in the centre of the solution of these problems (Bozkurt, 2001; Urey, Sahin, & Sahin, 2011). And therefore, individuals should be aware of their responsibilities in eliminating environmental problems. This can only be possible through an effective environmental education (Campell, Waliczek, & Zajicek, 1999; Urey, Çolak, & Okur, 2009).

Studies have usually focused on the challenges encountered by students in understanding ecology and environment related concepts. Despite efforts to apply alternative teaching strategies for a better understanding of ecology and environment related conceptual knowledge, such challenges in teaching and learning about

ecology and the environment still remain a problem for students. There have been numerous studies on the understandings and misconceptions of students about ecology and the environment (Soyibo, 1995; Dove, 1996; Boyes & Stanisstreet, 1999; Khalid, 1999, 2001; Andersson & Wallin, 2000; Bahar & Aydın, 2002; Papadimitriou, 2004; Darçın, Bozkurt, Hamalosmanoğlu, & Köse, 2006; Selvi, 2007; Selvi & Yıldız, 2009; Dikmenli, 2010a; Dikmenli, 2010b). These research studies assert that misconceptions started as a vacuum formed by a lack of knowledge and continued with the effect of different factors. If this vacuum cannot be properly filled or if the knowledge filled in cannot be structured, students start to fill in these spaces as a result of their random experiences. And thus misconceptions are formed in the minds of students and it becomes difficult to replace these concepts with the correct ones. The nature and predominance of today's students' views, including their misconceptions, are important because today's young people, who are tomorrow's scientists, will be affected by these problems and will need to provide solutions to the environmental problems which will arise from our current actions (Boyes & Stanisstreet, 1997). Children are the masters of the future (Boyes & Stanisstreet, 1998), so the students of today are the key factor in solving future environmental problems. Having correct knowledge about environmental issues will provide solutions for environmental problems.

Developments in industry and technology and the depletion of natural resources have brought environmental problems to the forefront. Some elements of nature must be replaced as they are used in order to leave nature relatively undisturbed. These elements, having an ecological significance in nature, are given and taken between living beings and their environment. These elements complete their circulation by following certain cycles by means of solar energy (Lin & Hu, 2003). Based on the expression 'As greenhouse effect increases, there will be more deserts in the world', Boyes and Stanisstreet (1999) asserted that one negative result of the 'greenhouse effect' was the idea of global warming in the great majority of the students. Furthermore, students of all age groups state that global warming will cause changes in climate. Accordingly, some of the students thought that global warming will lead to an increase in the desert areas on the Earth.

Recent research studies have revealed that there are a great number of misconceptions and comprehension difficulties in relation to ecology and ecosystems among students. It is also show that learners have problems in explaining ecology and changes in ecosystems (Bahar & Aydın, 2002; Khalid, 2003; Selvi, 2007). Nonetheless, there has not been sufficient research on the reasons for ecosystem degradation. Researchers, teachers and student teachers should have knowledge about the reasons for degradations in the ecosystem and their results. Particularly, teachers and student teachers should set out the necessary conditions to achieve the understanding of students. In this regard, degradations in ecosystems and the effects of such degradations on the environment are of importance.

Purpose:

The aim of this research was to investigate student science teachers' opinions about the reasons of degradation in ecosystems. Additionally, the misconceptions about the effect of degradations in ecosystems on the environment were researched. This study focuses on the following questions:

- 1) What kind of descriptions do student science teachers ascribe to the causes of degradation in ecosystems?
- 2) What do student science teachers think about the effects of degradations in ecosystems on the environment?
- 3) What categories can be derived from these descriptions in terms of common features?
- 4) What are the misconceptions about the reasons and results of degradations in ecosystems?

2. Methodology

2.1 Participants

A total of 130 participating students, who were studying to become primary science teachers at Faculty of Education of Necmettin Erbakan University in Turkey, participated in this research. The average age of the students was 22.5 years (range 21–25). The majority of the students were female (107 of 130). The study was conducted in April 2015.

2.2 Data Collection

In order to establish the opinions of the student science teachers regarding the reasons for ecosystem degradations and their effects on the environment, they were asked to answer two open questions: (1) In your opinion, what causes degradation of ecosystems? Explain. (2) What are the effects of the degradations in ecosystems on the environment? Explain. Open-ended questions are an effective technique which is frequently used in science education research (Eisen & Stavy, 1988). Open-ended questions was used in order to obtain in depth the opinions of the students in relation to the subject. The open questions given above are the basic data

sources for this study. Data obtained from the questions were analyzed and the frequencies of the responses were classified in different categories. The participants were given approximately 20 minutes to write down the responses.

2.3 Data Analysis

At the beginning 130 participating students were asked to answer the questions (1) In your opinion, what causes degradation of ecosystems? (2) What are the effects of the degradations in the ecosystem on the environment? However, it was found that 126 participating students answered these questions. Four students gave no answers to the written questions. Therefore, data analysis was conducted in four phases on 126 papers. First, the written answers were read in detail to establish the general level, and it was seen that there was a very wide spectrum of descriptions for the reasons for ecosystem degradations and their effects on the environment. Second, the 'content analysis technique' (Yildirim & Simsek, 2005) was used to separate each description into its components and analyzed for similarities or common factors with other descriptions. Based on the written responses of the participants, the main categories for the reasons of the degradations in the ecosystem and their effects on the environment were established. Third, each description was placed in an appropriate category. Lastly, the descriptions made by each participating student for both questions were categorized. Some of the participants made multiple descriptions. For question 1, as a result of the analysis of the written responses, a total of 455 valid definitions were identified. For question 2, as a result of the analysis of the written responses, a total of 270 valid definitions were identified. Each of them was further examined independently by the researcher and two experts in science education.

3. Results and Discussion

Regarding the questions: (1) What causes degradation of ecosystems? Explain. (2) What are the effects of the degradations in the ecosystem on the environment? Explain, the answers given by the participating students were classified in two main categories for question 1 and six main categories for question 2. The participants' descriptions about the reasons for the degradations in the ecosystem varied. The distribution of these descriptions according to categories is shown in Table 1. The answers of some of the students fell into multiple categories.

3.1 Reasons for Ecosystem Degradation

The categories for the reasons for degradations in ecosystems are shown in Table 1. As seen in Table 1, degradation due to human activity is the dominant category. A great majority of the students thought that the reason for degradation in ecosystems is human being based. Human beings affect the living and nonliving beings around them in the ecosystems where they live and cause ecosystem degradation; and the balance of the ecosystem was degraded along with developments in technology and industry and the irresponsible use of natural resources over time while living together with the natural living things in the ecosystems, and many environmental problems have emerged. Rapid population growth, irresponsible industrialization, unregulated urbanization, irresponsible use of natural resources, nuclear weapons and explosions, floods caused by dam waters, destruction of forests and avalanche etc. are the human being based factors which have negative effects on the natural balance and result in environmental degradation. According to student teachers, air pollution, water pollution, soil pollution and nuclear pollution are the pollutions which emerge as a result of the degradation of ecosystems. Human being based degradations are categorized as follows.

Category1: Degradation due to human activity

- a) **Unregulated industrialization (lack of filters in factory chimneys, wastes polluting water, air and soil):** Unregulated industrialization giving rise to environmental pollution such as emissions from factory chimneys and a lack of filters in factory chimneys was the dominant category (46%). For example: 'Unregulated industrialization such as lack of filters in factory chimneys, emitting toxic gases directly into the atmosphere and wastes such as those emerging during factory production have disrupted the nature of the ecosystem and led to environmental problems' (Student 78).
- b) **Destruction of forests:** Destruction of forests was the reason for ecosystem degradation according to the participants represented in this category (40.5%). For example: 'Forests are damaged as a result of neglect and forest fires caused by human beings. Human beings also destroy our forests in order to create living space for themselves and supply their timber needs' (Student 43).
- c) **Irresponsible hunting:** Irresponsible hunting was the reason for ecosystem degradation according to the participants represented in this category (39.7%). For example: 'I'm against all kinds of hunting. Untimely and out-of-season hunting disrupts the balance of the ecosystem. Hunting is carried out according to irregular rules. Irresponsible people entrap animals or hunt them in their breeding period. The authorized

bodies should take strict action' (Student 101).

- d) **Nuclear waste:** Nuclear waste was the reason for ecosystem degradation according to the participants represented in this category (34.1%). For example: 'Wastes which emerge as a result of nuclear explosions and even accidents result in negative effects on human beings and other living things. The Chernobyl accident still leads to the birth of disabled children in our country. Nuclear wastes also increase cancer risks' (Student 30).
- e) **Use of unnecessary agricultural pesticides:** The use of unnecessary agricultural pesticides was the reason for ecosystem degradation according to the participants represented in this category (33.3%). For example: 'Pesticides kill all insects whether harmful or useful. When an insect species is killed, the other species which feed on them are also adversely affected. Particularly the use of agricultural pesticides to obtain more products before the season disrupts the ecosystem' (Student 42).
- f) **Use of excessive chemical fertilizers in agriculture:** The use of excessive chemical fertilizers in agriculture was the reason for ecosystem degradation according to the participants represented in this category (30.2%). For example: 'Farmers constantly fertilize the soil to obtain increased production. These fertilizers are accumulated in the soil and cause pollution. The recycling of dead plant and animal residues can be used instead of chemical fertilizers' (Student 8).
- g) **Overpopulation:** Overpopulation was the reason for ecosystem degradation according to the participants represent in this category (27.8%). For example: 'Human beings destroy green areas for shelter along with overpopulation in ecosystems. Green areas have been destroyed in order to build concrete buildings in big cities. Domestic wastes and factory wastes are also greater in quantity in places with a high population' (Student 89).
- h) **Vehicle exhaust gases:** The toxic gases emitted from the exhausts of vehicles were the reason for ecosystem degradation according to the participants represented in this category (22.2%). For example: 'There are a lot of vehicles in places with lots of people and the gases streaming from the exhausts affect the whole ecosystem. Gases turn into acid rain from the atmosphere. The ozone layer is depleted and there is global warming and the greenhouse effect' (Student 56).
- i) **Use of chemical weapons:** The use of chemical weapons was the reason for the ecosystem degradation according to the participants represented in this category (19.8%). For example: 'The use of chemical weapons is a crime against humanity. It destroys nature and the environment. All living things are damaged' (Student 49).
- j) **Unregulated urbanization:** Unregulated urbanization was the reason for ecosystem degradation according to the participants represented in this category (15.9%).
- k) **Use of low grade fossil fuels:** The use of low-grade fossil fuels was the reason for ecosystem degradation according to the participants represented in this category (15%).
- l) **Use of chemicals and sprays:** The use of chemicals and sprays was the reason for ecosystem degradation according to the participants represented in this category (11.9%).
- m) **Avalanche:** Avalanche resulting from human activities was the reason for ecosystem degradation according to the participants represented in this category (3.2%).
- n) **Economic reasons:** Economic reasons were the reason for ecosystem degradation according to the participants represented in this category (2.4%). For example: 'There is an increase in unemployment in the economically undeveloped societies. In parallel to this, there is an increase in environmental destruction. Human beings use the environment irresponsibly' (Student 23). (Table 1).

Category 2: Degradation of natural origin

A few students supposed that reasons of natural origin cause degradation in ecosystems. 6.3% of the students cited earthquakes, for example: 'Earthquakes lead to very adverse destruction in the ecosystem. Green areas disappear in places where earthquakes occur. The Düzce earthquake, which occurred in 1999 in our country, resulted in the disappearance of many living things. Its effects still continue... Many people and other species disappeared' (Student 109). It was found that 5.6% cited floods, 3.2% cited hurricanes, 2.4% cited volcanoes, and 1.6% cited typhoons as causing degradations in ecosystems.

Table 1. Student science teachers' conceptions on the causes of ecosystem degradation

Categories	Subcategories	N (126)	%
1 Degradation due to human activity	Unregulated industrialization (lack of filters in factory chimneys, factory wastes polluting water and soil)	58	46.0
	Forest destruction	51	40.5
	Irresponsible hunting	50	39.7
	Use of nuclear wastes and substances causing radiation	43	34.1
	Use of unnecessary agricultural pesticides	42	33.3
	Use of excessive chemical fertilizers in agriculture	38	30.2
	Overpopulation	35	27.8
	Vehicle exhaust gases	28	22.2
	Use of chemical weapons	25	19.8
	Irregular urbanization	20	15.9
	Use of low grade fossil fuels	19	15.0
	Excessive use of chemical perfumes and other sprays	15	11.9
	Avalanche	4	3.2
	Economic reasons	3	2.4
2 Degradation of natural origin	Earthquakes	8	6.3
	Floods	7	5.6
	Hurricanes	4	3.2
	Volcanoes	3	2.4
	Typhoons	2	1.6

3.2 Results of Degradations in the Ecosystem

Six different categories appeared upon the analysis of the open-ended questions in relation to what the degradations in ecosystems caused. The opinions of the participants in relation to what the degradations in the ecosystems caused varied. The distribution of these descriptions according to categories is shown in Table 2. It should be noted that the responses of many participants fell into more than one category.

Table 2. Student science teachers' conceptions about the effects of ecosystem degradation on the environment

Categories	N (126)	%
1 Decrease in biological diversity	88	69.8
2 Changes in world geography and climate	75	59.5
3 Soil erosion	45	35.7
4 Decrease in and drying up of water sources	37	29.4
5 Energy shortages in the ecosystem	13	10.3
6 Lack of available nutrition	12	9.5

Category 1: Decrease in biological diversity

The category of decrease in biological diversity was the most dominant category according to the answers given by the students (69.8%). The majority of student science teachers thought that degradations in the ecosystem can adversely affect biological diversity. For example: 'Disruption of the balance in ecosystems can result in a reduction in and extinction of species. Each species has a benefit for the ecological balance. The disappearance

of one species can result in decreases in other species. The number of dying species in the world increases with every passing day' (Student 54).

Category 2: World geography and climate change

The participants represented in the second category considered that degradations in ecosystems will change the climate and geography of the world (59.5%). For example: 'Each environment has structural differences such as a specific climate, temperature, moisture rate, light and salinity. Based on these structural differences, biological species also vary. Bears which live in deserts and bears which live at the Poles have different characteristics. Results include global warming, greenhouse effect, ozone layer thinning. Degradations in the ecosystem change climatic and geographic characteristics. Degradations in an ecosystem change the climate of that region. The degradations in an ecosystem automatically change the climate of that region. And this affects the biological balance' (Student 103).

Category 3: Erosion depletes the soils

The participants represented in the third category believed that ecosystem degradation will lead to erosion and soils will disappear (35.7%). For example: 'With degradation in ecosystems, primarily plants are damaged. Plants hold the soil with their roots. The soils where crops grow also shelter animals. Erosion occurs as the soil is carried to the seas with the force of the water and wind. Vegetation cover prevents the abrasion of the soil against precipitation. And soil is not removed due to the holding of the vegetation cover. Soil is constantly carried by wind erosion in the Karapinar region' (Student 49).

Category 4: Water sources diminish and dry up

The participants represented in the fourth category thought that water sources will gradually diminish and dry as a result of degradations in the ecosystem environments (29.4%). For example: 'When a forest ecosystem is degraded for several reasons such as human beings creating living spaces for themselves, that region can no longer receive regular rain. Accordingly, streams and lakes cannot be fed. Underground waters diminish. Irresponsible agricultural activities can also lead to water shortage. Thus, the water sources in those environments will start to dry up. So, the environmental balance changes and biological richness is diminished' (Student 61).

Category 5: Energy shortages in the ecosystem

The participants represented in the fifth category considered that ecosystem degradation can lead to energy shortages (10.3%). For example: 'There is a food chain between the living things in the ecosystem. No living thing can live without energy. As the ecosystem environment starts to be degraded by several effects, the biological balance of that environment is also degraded. Accordingly, the number of living things reduces and starts to disappear. And the reduction in the number of some living things can make it difficult for that environment to be fed and result in energy shortages' (Student 76).

Category 6: Lack of available nutrition

The participants represented in the sixth category believed some species will reduce and disappear in degraded ecosystems (9.5%). For example: 'The species which are fed by disappearing species have difficulty in finding food. Biological diversity has to reduce depending on the amount of available nutrition' (Student 33).

It was also determined from their answers to the open-ended questions that student teachers had some misconceptions. These results were similar to those of other research studies in terms of some dimensions. Student teachers experienced misconceptions about the reasons for important environmental problems such as global warming, the greenhouse effect, ozone layer thinning and acid rain. This result is similar to that of Groves and Pugh (1999). Student teachers were mistaken in not only expressing the thinning in the ozone layer as depletion but also stating that the greenhouse effect occurs following depletion. For example: 'The greenhouse effect occurs along with an increase in air pollution, water pollution and soil pollution and the ozone layer is depleted and many species disappear' (Student 24). Similar results were found by Urey et al. (2011). These mistakes seem to start in the elementary school and continue through to university level (Papadimitriou, 2004).

Additionally, student science teachers also hold a misconception in stating that chemical pesticides which are used in agricultural control result in ozone layer thinning, and that sulphur oxides and greenhouse gases result in both the ozone layer thinning and acid rain. Sulphur oxides can lead to acid rain but they cannot directly result in ozone layer thinning. Greenhouse gases are not involved in the generation of acid rain. Student science teachers demonstrate their mental ambiguity by their general expressions that pollutants (nuclear pollutants, chemical waste substances) lead to the greenhouse effect, global warming, ozone layer thinning as well as acid rain

(Papadimitriou, 2004; Selvi, 2007; Urey et al., 2011). Some student teachers, on the other hand, assert that degradations in the ecosystem lead to global warming and global warming leads to several cancers including skin cancer. This misconception is similar to that in Khalid's study (2001). Students also have a misconception that 'ozone depletion may cause global warming'. This mistake is similar to that in Khalid (2001). Additionally, some student teachers asserted that fertilizers and hormones used in agriculture led to the greenhouse effect; this mistake is similar to findings in other studies (Bahar & Aydın, 2002; Arsal, 2010). This study also determined student teachers who supposed that nutrition would reduce the greenhouse effect. This result was similar to a study by Arsal (2010).

Student teachers have a misunderstanding in relation to today's environmental problems. Student teachers regard health problems such as infertility, skin cancer along with earthquakes, volcanic explosions, floods and desertification as the result of the greenhouse effect. Some studies found similar results and it was seen that student teachers regarded environmental problems as the causes for each other and listed the indirect effects caused by these problems as the direct effects (Boyes & Stanisstreet, 1999; Darçın et al., 2006; Selvi, 2007; Selvi & Yıldız, 2009). Student teachers seem to conveniently confuse these concepts and this leads to misunderstanding. It was even seen that some student teachers used rather general expressions in order to avoid that mental conflict.

4. Conclusion and Implications

This study was done to determine the opinions of student science teachers about the reasons for ecosystem degradations and their effects on the environment. Based on the results of the research, while the participants regarded human factors as the main reason for ecosystem degradations, a few of them emphasized ecosystem degradations of natural origin. Student teachers consider that human-based factors such as industrial pollution, forest destruction, irresponsible hunting, agricultural pesticides, fertilizers, nuclear waste, urbanization, use of poor quality fossil fuels etc. cause degradation of the ecosystem (Table 1). Student science teachers are also knowledgeable about what degradation in ecosystems will bring about. They think that biological diversity will diminish, world geography and climate will change, and there will be soil erosion, water shortage, energy shortages and nutrition deficiencies as a result of the degradations in ecosystems. Based on these results, student science teachers gave a general statement about the reasons for ecosystem degradations and the effects of these degradations on the environment.

However, student teachers were found to have some misconceptions about ecosystem degradation. The findings obtained in this study in relation to misconceptions are similar to those reported in other research studies. It was also found that there were similar misconceptions at elementary school level in some studies conducted with student teachers studying in different departments. This result makes us think that student teachers have graduated with some misconceptions in this regard. At this point, it is important for both teachers and student teachers to be equipped with clear, scientific knowledge free from misconceptions.

It is known that scientific knowledge, free from such misconceptions, can only be obtained by using effective teaching methods and techniques. To achieve this, teachers should use graphical-visual tools such as concept maps, meaning analysis tables, conceptual change texts, analogies, conceptual caricatures, concept networks, mental maps and fishbone diagrams in their lessons. Furthermore, several social activities can be organized in relation to environmental education such as in-class-out-of-class trips, observations and mini-meetings in which students are active, documentaries/animated films can be screened, and banners, posters and caricatures can be used.

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