INVESTIGATING PRE-SERVICE SCIENCE TEACHERS' CONSTRUCTION AND UNDERSTANDING OF ENVIRONMENTAL KNOWLEDGE THROUGH FIELD BASED COLLABORATIVE INQUIRY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN THE DEPARTMENT OF
ELEMENTARY SCIENCE AND MATHEMATICS EDUCATION

FEBRUARY 2010

Approval of the Graduate School of Social Sciences

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ABSTRACT

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February 2010, 139 pages

Based on the importance of implementing effective environmental education has been asserted to a sustainable solution to the environmental problems, this study aimed to (1) investigate the pre-service science teachers' processes of construction of explanations regarding environmental problems, and (2) provide an environment for researchers to understand the dispositions of participants in terms of how using environmental explanations for answering the questions.

The research has been realized within the context of an elective course titled "Laboratory applications in environmental education" in the Department of Elementary Education throughout 2008-2009 Spring semesters. The 21 pre-service science teachers attended the course and participated the environmental learning activities including five different environmental problems; biological diversity, surface waters, drinking water, waste water and air pollution with in a small group. Field trip activities, group discussions and whole class discussions were conducted through the course.

Data were collected through audio and video recorders from one small group and through pre, post-tests. Analyses of data revealed that pre-service science teachers could not aware of the complex and multidisciplinary nature of environmental knowledge, so they mostly interpreted environmental problems through the everyday knowledge that they derived from everyday experiences. Through peer collaboration in fields and student-facilitator collaboration in discussions weeks, the pre-service science teachers have a chance to analyze different perspectives and ideologies about the causes and solutions of environmental problems. The pre-tests and post-test results revealed that in the field-based collaborative inquiry activities the participants' nature of explanations shifted from descriptive to formal and scientific explanations.

Keywords: Environmental Education, Environmental Knowledge Construction, Field-Based Collaborative Inquiry, Teacher Education

ÖZ

FEN BİLGİSİ ÖĞRETMEN ADAYLARININ ALAN GEZİLERİ VE İŞBİRLİKÇİ SORGULAMA ORTAMINDA ÇEVRE BİLGİSİNİ YAPILANDIRMA VE KAVRAMALARINI ARAŞTIRMA

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Etkili çevre eğitimi uygulamalarının çevre problemlerinin çözümü için sürdürülebilir bir yol olduğunun önemine dayanarak, bu çalışmada (1) fen bilgisi öğretmen adaylarının çevresel problemler üzerine yaptıkları çevre açıklaması yapılandırma süreçlerinin incelenmesi ve (2) katılımcıların çevre ile ilgili kavramlar hakkında sorulan soruları cevaplamak için çevresel açıklamaları nasıl kullandığı incelenmesi amaçlanmıştır.

Araştırma "Çevre Eğitiminde Laboratuvar Uygulamaları" dersi kapsamında, İköğretim Eğitimi Bölümünde, 2008-2009 bahar döneminde gerçekleştirilmiştir. 21 fen bilgisi öğretmen adayı derse devam etmiş ve bu çalışma için beş farklı çevresel problemle ilişkili olarak hazırlanan beş farklı öğrenme aktivitelesine katılmıştır. Ders boyunce alan gezileri, grup tartışmaları ve sınıf tartışmaları yapılmıştır.

Veri bir grubun işbirlikçi tartışma süreci ses ve görüntü kaydına alınarak ve ön-test ve son-test uygulanarak elde edilmiştir. Analizler sonucu fen bilgisi öğretmen adaylarının çevre bilgisinin karmaşık ve multidisipliner yapısının farkında olmadıkları ve çevre problemlerini yorumlarken çoğunlukla gündelik deneyimlerden doğan günlük bilgilerin kullanıldığı saptanmıştır. Alan gezileri sırasında yapılan akran işbirliği ve tartışma haftalarında yapılan öğrenci-öğretmen işbirliği ile fen bilgisi öğretmen adayları çere problemlerine, nedenlerine ve sonuçlarına yönelik faklı bakış açıları ve fikirlerle karşılaşma şansı elde ederek çevre problemlerine daha formal ve bilimsel açıklamalar getirmişlerdir. Ön-test ve son-test sonuçlarıda bu durumu desteklemiştir.

Anahtar Kelimeler: Çevre Eğitimi, Çevre Bilgisi Yapılandırma, Alan Gezileri ve İşbirlikçi Sorgulama, Öğretmen Eğitimi

To all my family

Vedat, Emine and Mehmet CİHANGİR

ACKNOWLEDGMENTS

The completion of my degree of master and this thesis represents the work, encouragement, and support of many people to whom I am very thankful.

First, I would like to thank to my supervisor Özgül YILMAZ-TÜZÜN and co-supervisor Gaye TEKSÖZ for their knowledgeable recommendations, valuable advice, and assistance throughout my thesis process. Thank you sincerely.

I would like to thank my mother and father for their endless love, patience and support throughout all my life. I would also thank to my brother, Mehmet, since he was with me every time throughout the process. Having such a family is worth everything for me, I love you very much. Thank you for everything.

I would like to thank my fiancée, Eren, for his invaluable love, patience and support throughout the process. I love you very much. I could not have completed this thesis without his heartfelt and optimistic supports. Thank you for everything.

I would also like to thank my close friends for their moral support, encouragement, and patience throughout the process. I love you very much. Thank you for everything.

I would also thank the members of my committee for their willingness to serve on the committee and their valuable feedback.

Lastly, I thank TÜBİTAK for their scholarship during my master studies.

Thank you all very much indeed.

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CHAPTER I

INTRODUCTION

From the late nineties environmental problems such as population growth, ozone depletion, global warming, loss of biodiversity and water shortage have increased in a great amount (Kaiser & Fuhrer, 2003), developed into global issues (Manzanal, Barreiro, & Jimenez, 1998), and resulted in irreversible threats for living things (UNESCO-UNEP, 1978). According to United Nation the World Commission on Environment and Development (WCED) (1987), many environmental problems are mainly caused and accelerated as a result of human activities. Owing to the fact that human activities resulted in having environmental problems, rather than only using legislations to prevent these activities in short run, developing environmentally friendly and sustainable behaviour (is defined as intended to act toward contribution to the solutions of environmental problems (Cook & Berrenberg, 1981)) of human is seen as an important solution to environmental problems in long term. It has long been argued that this goal could be achieved by implementing effective environmental education (EE) (United Nations Educational, Scientific, and Cultural Organization–United Nations Environmental Programme, UNESCO-UNEP, 1978).

In the line with these efforts the world's first Intergovernmental Conference on EE was conducted in Tbilisi, Georgia at 1977 by UNESCO in cooperation with the United Nations Environment Programme (UNEP). In this conference the necessity of EE and the goals for effective EE were clearly declared for the first time. The important goal of the effective EE was accepted as improving individuals' and communities' understanding about the holistic and complex nature of environment, which include interactions among biological, physical, social, economic, and cultural aspects of environmental problems. It is also stated that in order to achieve on this goal people needs to acquire necessary knowledge, values, attitudes, and skills essential for active participation in environmental problem solving processes (UNESCO-UNEP, 1978). This means that the target of EE is to raise environmentally literate individuals. Environmentally literate individual is defined as citizen who has environmental knowledge, and eager to work toward maintaining a dynamic equilibrium between the quality of the environment and human life (Hungerford, Peyton, & Wilke, 1980). Due to the similarities in their definitions the term environmental literacy has been used as synonymous with environmental behaviour so it was also accepted that the factors affecting environmental literacy can also affect environmental behaviour (Sia, Hungerford, & Tomera, 1985).

Due to the complex nature of environmental problems, implementation of an effective EE program is necessary. Effectiveness of EE programs can be evaluated in terms of their success in developing environmentally friendly human behaviour. Evaluation on the other hand, requires analyzing the factors promoting environmental behaviour. Within this context Hines and his colleagues (1987) define a model for *Responsible Environmental Behavior (REB)* that used to identify predictors of environmental behaviour, knowledge of environmental issues in a relationship with personality factors and action skills. Therefore, according to the authors of REB model, knowledge is a strong predictor of environmental behaviour. In light of Hines model, Hungerford and Volk (1990) proposed another model for REB, according to the *Environmental Behavior Model;* there are three categories of variables: entry-level variables, ownership variables, empowerment variables as predictors of REB. In their model Hungerford and Volk (1990) also specified major and minor determinants for each variable category and generally all major and minor variables include knowledge of environmental issues as a prerequisite to REB. The model proposes that knowledge of ecology and in-depth knowledge about environmental issues refers to the conceptual framework necessary for sound decision making about environmental issues and understanding the effects of environmental problems on humanity and ecology. Most recently Dillon and Gayford (2007) also found that environmental behaviour strongly correlated with environmental knowledge treated as knowledge of ecology. Although the assumptions underlined in a rich variety of educational model proposes that existence of environmental knowledge is one of the important predictors of environmental behaviour, some other research findings revealed that environmental knowledge of an individual has a weak relationship with his environmental behaviour (Maloney & Ward, 1973; Muller & Taylor, 1991). The poor correlation might be due to the reason that most of the researchers and teachers seem environmental knowledge as same as ecological concepts and determining environmental knowledge assessments by items determining ecological concepts and interaction.

At this point it is necessary to take readers' attention to nature of environmental knowledge. Long before having environmental sciences as a discipline, scientists in the discipline of ecology provided their expertise to environmental researchers. Thus, environmental researchers use the ecological knowledge provided by ecologists to understand environmental issues (Allaby, 2000). At the point environmental researchers understood that environmental problems have diverse dimensions and understanding of these issues only accomplished by evaluating their all dimensions, researcher has also recognized that environmental knowledge is more inclusive than ecology which is a scientific discipline only explaining existing relationships among members of living communities and between those communities and their abiotic environment. For effective EE in other words meaningful comprehension of environmental knowledge and conversion it in the form of action, individuals need to comprehend ecological knowledge for making ecologically sound decisions with respect to environmental issues; develop conceptual awareness for understanding how human activities may influence the relationship between quality of life and the quality of environment; grasp necessary knowledge and skills for investigating environmental issues and evaluating the alternative solutions for environmental issues (Hungerford, Peyton & Wilke, 1980). In other words, environmental knowledge includes knowledge generated from different disciplines such as biological, physical, and chemical surroundings of living organisms and overlapping of these disciplines such as palaeontology. Moreover, all this knowledge has meaning in environmental sciences when it is combined with changes brought to natural environment as a result of human activities (Allaby, 2000). Due to complex and interdisciplinary nature of environmental knowledge, just assessing students' ecological knowledge may not be enough for us to understand their knowledge regarding environmental issues. Thus, in this study environmental knowledge was operationalized according to the definition given above and nature of pre-service science teachers' (PSTs) construction of explanations addressing environmental problems caused by human activities was investigated.

The field-based collaborative inquiry was thought to be one of the most appropriate techniques for revealing constructed explanations of learners. From the perspective of constructivist theory learning is an active and continuous process whereby the learner takes information from the environment and constructs personal interpretations and meaning based on prior knowledge and experience (Roth, 1990). Furthermore, learners actively construct knowledge by reflecting upon their physical and mental actions (Piaget, 1970) through social interactions with members of the community (Vygotsky, 1986). Social interactions both direct and mediate knowledge construction through the communication of expressions, actions, and use of written and oral language (Vygotsky, 1986). Learning thus involves a personal construction of meaning and a socially negotiated meaning among learners of community (Cobb, 1990). These learning characteristics may also provide an effective learning environment for students to learn environmental concepts. According to Bennett and Heafner (2004), the process of inquiry and active participation is necessary for meaningful EE. Hungerford and Volk (1990), in Environmental Behavior Model, stated the importance of “personal investment of issues and the environment” for making issues personal for learners, necessary for understanding issue and human relations. According to Gray’s (1982) study (as cited in Manzanal, Barreiro & Jimenez, 1998) by active participating in the learning process via field trip learners have firsthand experience about the habitat being studied and comprehend sampling and data collection skills necessary for environmental science. While studying habitat learners simply identify the relation between organisms and the surrounding environment so by this way they get a chance to infer their place and role in the environment and consequently the impact of human society on environment. It is also pointed out in Tbilisi Intergovernmental Conference (1977) that for effective EE active participation of learners in non formal educational settings such as field trips is necessary to some extent. In other study it was also mentioned that the holistic and composite structure of environmental interaction in an open air create environmental questions in learners’ mind and by this way students have chance to criticize what they have learned so meaningful understanding is realized (Manzanal, Barreiro & Jimenez, 1998). Most of environmental researchers agree that meaningful learning is one of the desired outcomes of effective EE (UNESCO, 1977).

In this study, learning environment provided to PSTs to construct explanations regarding environmental problems includes the characteristics of collaborative inquiry and field-based teaching. The combination of collaborative inquiry and field trip is called as field-based collaborative inquiry in this study. It was assumed that PSTs will have opportunity to better conceptualize environmental knowledge in this learning environment and construct more explanations while dealing with an environmental problem. Therefore, inquiry-based instruction and hands-on activities has been used (Chiappetta & Koballa, 2002) in this study, for the purpose of promoting active student involvement in the learning process. But these kinds of non formal learning approaches such as field trips generally fail to account for the social practice of science such as promoting skills necessary for evaluation and defence scientific theories or findings. So it has been accepted that, an effective science education program it is also necessary to enable the students in terms of development of own constructed explanations that enable students to apply their understandings of science to personal decision making and engage in social discussion about issues related to science (Sadler, 2006). By the means of these social discussions, the students have a chance to evaluate evidence, assess alternatives, establish the validity of scientific claims, and address counterevidence (Driver, Newton, & Osborne, 2000). Thus, for this study a total of five learning tasks prepared according to the ideas indicated above were given to the PSTs. During accomplishing these tasks, the PSTs' construction of explanations regarding environmental knowledge was explored. Each learning task was concentrated on a different environmental problem such as biological diversity, surface waters, waste water, drinking water and human air pollution and includes two weeks; one for field investigation and one for group interpretations. Due to complex nature of environmental knowledge, that kind of learning environment including inquiry and social interaction is necessary, so evaluation process of explanation constructions of participants is complicated. For analyzing explanation construction of environmental knowledge of the PSTs in social science learning environment as in this study, an analytic tool which offering a dynamic and process-oriented account on collaborative science learning and which untangle the interplay between the communicative and cognitive elements of discourse process is necessary. This analytic tool developed by Kaartinen and Kumpulainen (2002) and was used in this study. The analytic tool highlights the mechanisms of construction of explanations in a social science learning environment. The analytic tool used in this study focused on four parallel analytic frames, i.e. discourse moves, logical processes, nature of explanation, and explanation-building. According to the Kaartinen and Kumpulainen (2002), whereas the analysis of the discourse moves and logical processes is aimed at providing insights into the nature of reasoning and explanation-building from the viewpoint of participants in social science learning environment, the analysis of the nature of explanation and cognitive strategies is aimed at unraveling conceptual and procedural elements in reasoning and explanation building.

Benton, Knapp, and Farmer (2007) stated that the process of inquiry and active participation is also necessary for comprehension of EE. So it is possible that there will be a change in conceptual understandings of PSTs. According to view of socio constructivist approach, Chinn and Anderson (2000) proposed that collaborative construction of knowledge may be prerequisite for learning because learners' ideas are externalized and become objects for discussion, negotiation, and modification. Thus, another aim of this study was to investigate predispositions of PSTs' conceptual understanding of environmental concepts during the process.

1.1 Significance of the study

EE authorities point out that EE should start in primary school years for preventing construction of misconceptions (Summers, Kruger, Childs, & Mant, 2000). In Turkey students learn environmental knowledge through physics, chemistry and biology courses given by science teachers. Hence, science teachers have an important role in educating students as environmentally literate, it is very important to identify these teachers' understanding regarding environmental knowledge. We also accept that teachers who have a poor understanding of environmental concepts possibly transfer this to their students (Khalid, 2003). Thus, the results of this study have potential to make suggestions to teacher education programs to revise current implementation if necessary.

EE programs aimed to prepare environmentally literate individuals who would play an active role for protection of environment by taking informed decisions and environmentally friendly actions (UNESCO – UNEP, 1991). Although the ultimate goal of EE is clearly defined as raising individuals who behave environmentally friendly, it is very complex issue to design an EE program to achieve this goal. Owing to the fact that environmental behaviour is influenced beliefs, attitudes, social structures, and environmental knowledge, it is too hard to make individuals to behave in an environmentally friendly way. By looking at the factors that environmental behaviour is influenced by, it is obviously understood that the schools, are responsible for comprehension of environmental knowledge, has an indirect role about making individuals to behave environmentally friendly. So in the light of the findings of this study, the curriculum developers may have a chance to incorporate behaviour-related instruction in to EE curriculum that has been implemented in Turkey. Thus, this study is important in terms of promoting environmental friendly behaviour by approaching environmental knowledge with its holistic nature which is necessary for informed decisions and environmentally friendly actions for prevention and lessen environmental problems.

For accomplishing EE ultimate aim; raising individual in an environmentally friendly way, there have been significant amount of research in literature for identifying the factors affecting environmental behaviour. Even there is little effort on constructions of explanations about natural sciences, there is not any study scrutinizing constructions of explanations regarding environmental concepts. Revealing construction of explanation in EE area has special importance since by this way educators will be able to understand the nature of environmental knowledge. Thus, there will be a chance to discover the reasons why people who have environmental knowledge do not behave in an environmentally friendly way.

1.2 Specific Purposes of the Study

1.2.1 Purpose 1

To investigate the PSTs' processes of construction of explanation regarding environmental problems.

1.2.2 Purpose 2

To understand the dispositions of participants in terms of how using environmental explanations for answering the questions.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter comprised of the studies and theoretical understanding about EE and collaborative knowledge construction. First part includes the definition and goals of EE, the research studies concerning environmental literacy, environmental knowledge and environmental behavior models. In the second part the related literature about collaborative knowledge construction is presented.

2.1 Environmental Education

From the late nineteen's with the rapid industrial development; all around the world environmental problems such as global warming, the disappearance of ozone layer, exploitation of natural resources, etc has emerged and these problems have threaten the environmental balance. In order to alleviate the outcomes of the environmental problems politicians, environmental activists, environmental organizations, non-governmental organizations, and governments have tried to find solutions to sustain environmental balance. According to United Nation the World Commission on Environment and Development (WCED) (1987), many environmental problems are mainly caused and accelerated as a result of human activities. Owing to the fact that human activities resulted in having environmental problems, rather than only using legislations to prevent these activities in short run, developing environmentally friendly and sustainable behaviour of human is seen as an important solution to environmental problems in long term. Based on the assumption that people who possess environmental awareness are in a better position to maintain a quality environment; EE has been accepted to provide sustainable and global solutions to environmental problems (Hungerford & Volk, 1990). The first Intergovernmental Conference on EE was conducted in Tbilisi, Georgia at 1977. The conference is organized by United Nations Educational, Scientific and Cultural Organization (UNESCO) in cooperation with the United Nations Environment Programme (UNEP). Delegates and representatives from different countries declared the importance of EE for the preservation and improvement of the world's environment. The essentiality and urgency of the EE in this conference was stated with this statement; "EE should be provided for all ages, at all levels and in both formal and nonformal education" (UNESCO, 1978, p.1). According to UNESCO (1978),

> "*Environmental education is a process aimed at developing a world population that is aware of and concerned about the total environment and its associated problems, and which has the knowledge, attitudes, motivations, commitments, and skills to work individually and collectively toward solutions of current problems and the prevention of new ones*" (p. 1).

The goals and objectives of the EE were also stated in a detailed and clear way for the first time in Tbilisi Intergovernmental Conference. The goals for effective EE stated as below.

> *The goals of environmental education are:*
>
> - *to foster clear awareness of, and concern about, economic, social, political, and ecological interdependence in urban and rural areas;*
> - *to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment;*

- *to create new patterns of behavior of individuals, groups, and society as a whole towards the environment* (UNESCO, 1978, p.3).

The widely accepted goals and objectives of the EE stated in Tbilisi Intergovernmental Conference suggest that the acquisition of responsible environmental behavior by a mediating factor of environmental literacy is a desired outcome of EE (Stapp, 1970). In the following years parallel with UNESCO, EE authorities widely accepted that ultimate goal of EE is to enable people to understand the complex nature of environment and make them to adapt their activities by maintaining harmony with the environment (Hungerford, Peyton, & Wilke, 1980; Rubba, & Wiesenmayer, 1985). The detailed information about environmental behavior is given in the next section.

2.1.1 Environmental Behavior and Knowledge

Researchers in the field of EE have consistently stated that the ultimate goal of EE is shaping human behavior in a way to promote environmental welfare (Hungerford & Volk, 1990). Through EE it was aimed to increase individuals' environmental knowledge and, in turn, effecting change and addressing environmental problems (Stapp, 1970; Ramsey & Rickson, 1976). In graduate seminar in the Department of Resource Conservation and Planning of The University of Michigan's School of Natural Resources under the leadership of William Stapp (1970) it was stated that, "EE is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution" (p.54). Later at 1978, in Tbilisi Intergovernmental Conference besides the goal of developing and promoting responsible environmental behavior, it has been also asserted that providing every person with opportunities to acquire the knowledge needed to protect and improve the environment is one of the goals of EE. The goals and the objectives declared at Tbilisi Conference have been reaffirmed by the EE community since 1977. The categories of effective EE objectives declared at Tbilisi Intergovernmental Conference are below.

The categories of environmental education objectives are:

- *Awareness; to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems.*
- *Knowledge; to help social groups and individuals gain a variety of experience in, and acquire a basic understanding of, the environment and its associated problems.*
- *Attitudes; to help social groups and individuals acquire a set of values and feelings of concern for the environment and the motivation for actively participating in environmental improvement and protection.*
- *Skills; to help social groups and individuals acquire the skills for identifying and solving environmental problems.*
- *Participation; to provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems* (UNESCO, 1978, p.3).

By using these objectives, in the context of EE responsible environmental behavior can be defined as "activities that have been suggested as ways people can help solve environmental problems" (Van Liere & Dunlap, 1981, p.662).

Hungerford and Peyton (1980) defined environmental behavior as including; categories of action, levels of action and criteria for analyzing proposed actions. The five categories of action posed by Hungerford and Peyton (1980) can be listed as eco-management, consumerism, persuasion, political actions and legal actions. The categories can be defined as below,

- eco-management: refers to environmental actions in which people work to prevent or resolve environmental issues;

- consumer action: refers to environmental actions in which people use monetary support to prevent or resolve environmental problems;
- persuasion: refers to environmental actions in which people help the others to prevent or resolve environmental problems;
- political action: refers to environmental actions in which people use political ways to prevent or resolve environmental problems;
- legal action: refers to environmental actions in which people use laws and legislations to prevent or resolve environmental problems (Wilke, 1995).

According the objectives declared in Tbilisi Conference and the categories proposed by Hungerford and Peyton (1980), the individuals that behave in an environmentally responsible way can be defined as one who has awareness and sensitivity to the total environment, a basic understanding of the environment, feelings of concern for the environment and active involvement at all levels in working toward resolution of environmental problems.

In order to investigate the place of environmental knowledge in the field of EE and research, the studies in that field should be addressed by making discrimination between empirical and theoretical studies. Through empirical studies, the researchers especially have aimed to determine the predictor variables of responsible environmental behavior. In the light of empirical studies, there have been serious theoretical efforts that tried to propose models for responsible environmental behavior. Besides, responsible environmental behavior models, the empirical studies' findings have also shed light on to the EE programs aiming to foster responsible environmental behavior. In the following part of the chapter, firstly how environmental knowledge has been treated in empirical studies about responsible environmental behavior was explained. Then, the place of environmental knowledge in the theoretically proposed models and the most recent EE program were analyzed.

Empirical studies

Sia, Hungerford and Tomera (1985-86) examined the relative contribution of eight variables in predicting responsible environmental behavior. The variables are knowledge of issues, beliefs concerning issue, individual values, individual attitudes, locus of control, environmental sensitivity, knowledge of and skill in the use of environmental action strategies and ecological concepts. A total of 171 participants from Illinois and Wisconsin attended the study. The participants were selected based on their convenience to the researchers. The participants' behavior were assessed through behavior inventory of environmental action ($r = 0.74$) and participants were administered an instrument ($r = 0.63$) assessing their perceived knowledge of and skills in using environmental action strategies. The researchers conducted multiple regression analysis to determine zero or first order semi partial contributions of the different predictor variables on environmental behavior. The environmental knowledge ($F = 5.16$; $p<0.02$) predictor variable attained statistical significance in explaining environmental behavior. Moreover the researchers examined intercorrelation between environmental behavior and environmental knowledge. Intercorrelation analysis showed that besides environmental sensitivity and skill in using environmental action strategies, environmental knowledge has a significant correlation between environmental behavior ($r = 0.55$). According to the data analysis, seven of the eight variables were found to be statistically significant. Stepwise regression analysis showed that the most important three predictors of responsible environmental behavior were the skills necessary for using environmental action strategies ($r = 0.59$), the level of environmental sensitivity ($r = 0.56$) and the knowledge of environmental action strategies ($r = 0.55$).

Both of the analyses of this research show that environmental knowledge is a strong predictor of environmental behavior which is necessary for a life between quality of life and environment.

Tosunoğlu (1993) conducted a dissertation study aiming to investigate the effects of the variables such as environmental knowledge, sex and parents' educational level on environmental attitudes and responsible environmental behavior in Turkish context. Random samples of 639 university students in Ankara were participated in this study. In order to determine the role of environmental knowledge on environmental attitude and behavior, an environmental knowledge scale, an environmental attitude scale and an environmental behavior scale were developed by the researcher. Path analysis was used to find the relationship between environmental knowledge, sex and parents' educational level variables and the variables of environmental attitude and environmental behavior. One of the results of the study revealed that there was a significant direct relationship from environmental knowledge to environmental attitudes which is also an important predictor of environmental behavior. This study investigated the predictors of responsible environmental behavior in the Turkish context and the results of this study indicated that they get along with the findings of international studies' results.

In another international study, the Lebanon context was examined. Abd-el-Khalick, Boujaoude, and Makki (2003) conducted a study to investigate the relationships between environmental knowledge, attitudes and environmental behavior with secondary school students in Lebanon. A total of 660 grade 10 and grade 11 students were participated in the study. Children's Environmental Attitudes and Knowledge Scale were administered to participants for assessing their environmental knowledge, attitudes, beliefs, affect, and intensions, and commitment to environmental friendly behaviors. The results of the study showed that the students have lacked of environmental knowledge due to the ineffective implementation of environmental concepts in curriculum. The results of the study also revealed that although environmental knowledge affects environmental behavior and attitude, it has an indirect effect on environmental behavior.

Kaiser and Fuhrer (2003) investigated the reasons why knowledge influences on environmental behavior are underestimated. According to the researchers, there have been three reasons of underestimation of the role of environmental knowledge. The first reason of this underestimation was there should be different forms of knowledge working together in a convergent manner in order to affect environmental behavior. According to this study, there have been four types of knowledge (declarative environmental knowledge, procedural knowledge, effectiveness knowledge, social knowledge) that should work together in order to create a change in environmental behavior. The researchers defined declarative environmental knowledge as related with how environmental systems work. Consisted with the results of the study of Maloney and Ward (1973), although declarative environmental knowledge reduces uncertainty that allows people to take action, having the right declarative environmental knowledge does not necessarily mean environmental behavior. Kaiser and Fuhrer (2003) defined procedural knowledge as addressing the issue of how to achieve a particular conservational goal and stated that although procedural knowledge is necessary for environmental behavior, declarative knowledge has more determining effect on environmental behavior. Effectiveness knowledge has been referred to knowledge about the relative conservation effectiveness of different behaviors to reach a certain outcome. According to the researchers, there have been signs to indicate that this type of knowledge is necessary for environmental behavior. The last type of knowledge that should be necessary for environmental behavior is social knowledge. Social knowledge refers to the motives and intentions of others. This knowledge derives from the observations of others' behavior and it can be used for own deficiencies. According to Kaiser and Fuhrer (2003), the environmental behavior promotion is dependent on combination of these four types of knowledge. Declarative and procedural knowledge are needed before effectiveness knowledge is required. And social knowledge is also necessary for individual to behave in an environmentally friendly way. Second reason of the underestimation about the role of environmental knowledge on behavior is statistical procedures used for assessing environmental behavior. It was asserted that statistical procedures such as sets of bivariate correlations, stepwise regression analyses and traditional path models are sensitive to absolute influences rather than mediate ones. Thus, these types of knowledge can easily underestimate the effect of knowledge's distal influence on environmental behavior. Structural equation modeling is recommended to assess the effect of environmental knowledge on environmental behavior for two reasons; measurement errors taken in to account and mediation processes become visible. The third reason of underestimation of the role of environmental knowledge on environmental behavior is that knowledge influence on environmental behavior is disguised by strong psychological factors. In conclusion researchers asserted that the knowledge can help to overcome psychological barriers so knowledge's importance on changing environmental behavior should not be underestimated.

In summary, as stated in various research studies environmental knowledge is one of the important predictors in order to create a change in individuals' environmental behavior in a way to promote the balance between the quality of human life and quality of environment. In other words in order to meet the major goal of EE, it is obligatory to address knowledge and skills necessary for using in environmental action strategies in to EE curriculum. But most of the empirical studies as well as the studies stated above, treated environmental knowledge as similar as ecology achievement. Assuming environmental knowledge as equivalent to ecology knowledge is a deficient approach in the time that science authorities have strongly accepted environmental science as a dependent discipline. The current perspective in EE has accepted environmental knowledge as more inclusive than knowledge of ecology. Palmer (1998) proposed a model asserting that formative influences or significant life experiences (such as education courses, parents, close relatives, television, media, keeping parents, etc.) have a significant influence on environmental knowledge. Palmer's (1998) review also asserted the importance of environmental knowledge gained through living and interacting in communities, socially acquired knowledge, as distinct from formal knowledge gained in classroom. For conversion of environmental knowledge in the form of action, individuals need to comprehend ecological knowledge for making ecologically sound decisions with respect to environmental issues; develop conceptual awareness for understanding how human activities may influence the relationship between quality of life and the quality of environment; grasp necessary knowledge and skills for investigating environmental issues and evaluating the alternative solutions for environmental issues (Hungerford, Peyton, & Wilke, 1980). This study has been an important starting study that treated environmental knowledge constructed through social science learning situation as a synthesis of knowledge generated from different disciplines such as biological, physical, and chemical surroundings of living organisms.

Theoretical studies

Besides different research studies, several responsible environmental behavior models were also proposed by researchers for the last three decades. The first responsible environmental model proposed that there is a linear relationship between environmental knowledge and responsible environmental behavior. This type of thinking has based on the assumption that if human beings become more knowledgeable about environment, they will, in turn become more aware of the environment and its allied problems and, thus, become more tendencies to perform more responsible behaviors. This type of thinking is called as knowledge-attitude-behavior (K-A-B) model (Ramsey & Rickson, 1976). The representation of this model is presented in Figure 2.1.

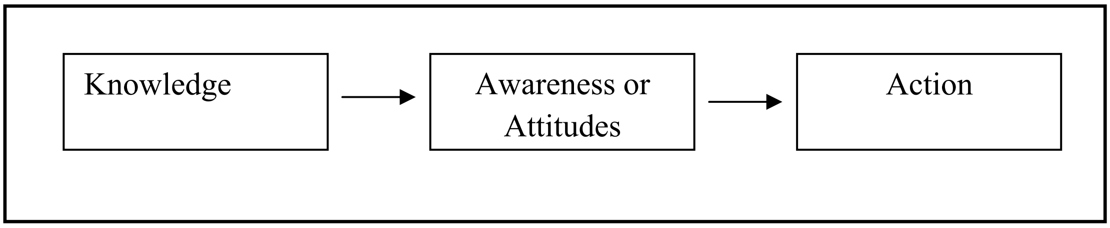

Figure 2.1 Knowledge–Attitude–Behavior (K-A-B) model (adapted from Hungerford & Volk, 1990)

Later research proposed that the relation between knowledge and attitude is more complex than the linear relationship proposed by K-A-B model (Marcinkowski, 1989). Similar with the relationship between knowledge and attitude, it has been proposed that the relationship between attitude and behavior is not also linear and is affected by some other variables (Marcinkowski, 1989). Reviews of the research literature reveal that the implementation of K-A-B model to EE will not be able to achieve on ultimate goal of EE (Marcinkowski, 1989).

Hines, Hungerford, and Tomera (1986-87) proposed another model of responsible environmental behavior through the synthesis earlier research on environment. According to the meta-analysis of the behavior related 128 research studies, Hines et al. (1986-87) made the following inferences;

> *"an individual who expresses an intention to take action will be more likely to engage in the action than will an individual who expresses no such intention… However,… it appears that intention to act is merely an artifact of a number of other variables acting in combination, e.g., cognitive knowledge, cognitive skills, and personality factors"* (p. 6).

According to Hines et al. (1986-87), before an individual can intentionally act, an individual must be aware of the fact that knowledge of the existing environmental problems, knowledge of the actions that should be taken to promote environmental welfare and skill necessary to apply this knowledge to experience. Moreover, it is also proposed in Hines et al. (1986-87) responsible environmental behavior model that an individual's desire to act appears to be affected by personality factors which has been also affected by locus of control, attitudes toward the environment and personal responsibility toward the environment. The representation of this model is presented in Figure 2.2.

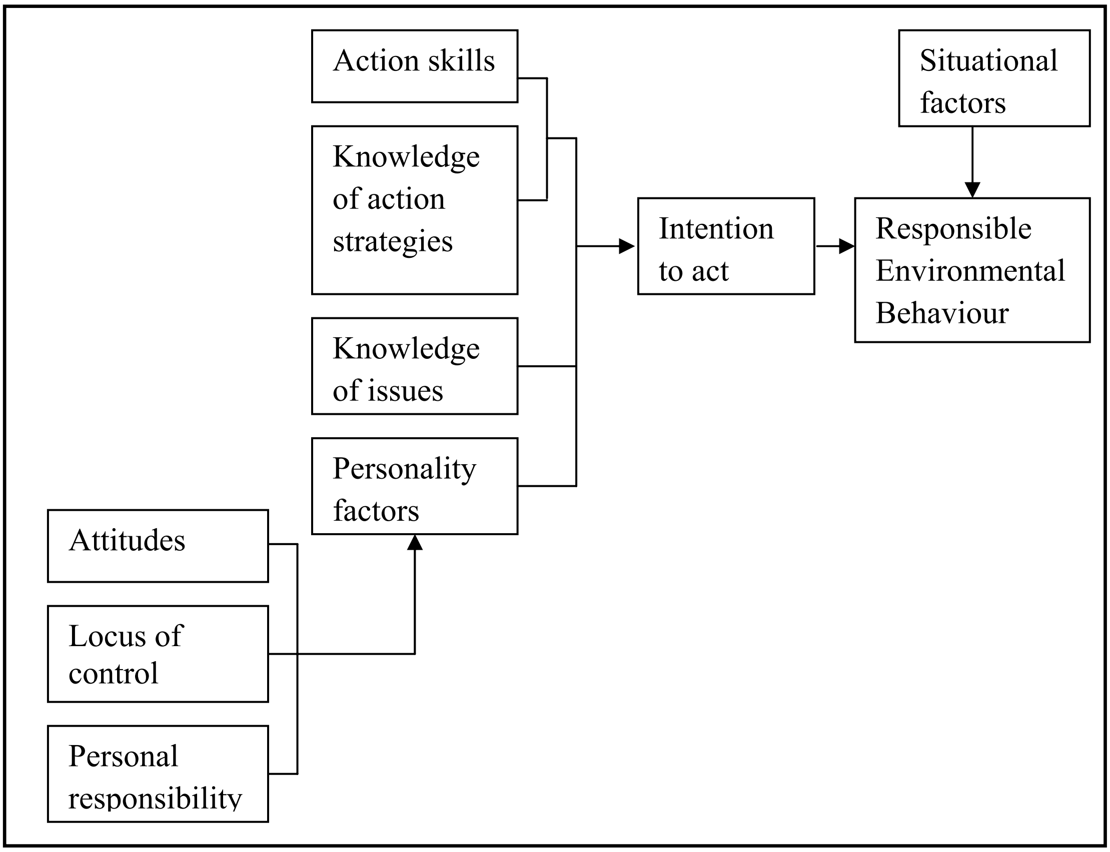

Figure 2.2 The Hines model of responsible environmental behavior (adapted from Hungerford & Volk, 1990)

Hines et al. (1986-1987) model of responsible environmental has been widely accepted by EE researchers and subsequent with this model other researchers have contributed to our understanding of behavior change (Koslowsky, Kluger & Yinon, 1988; Marcinkowski, 1989). These studies parallel with the Hines et al. (1986-87), focused on the predictors of behavior and the effect of instructional strategies on environmental behavior. According to the results of these studies, Hungerford and Volk (1990) proposed another environmental behavior that have asserted that there are three levels of variables which contribute to environmental behavior; entry-level variables, ownership variables, and empowerment variables.

According to Hungerford and Volk (1990), entry level variables are highly correlated with behavior and susceptible to short term environmental instructions. Sensitivity, androgyny, knowledge of ecology, and attitudes towards pollution, technology and economics are asserted as entry level variables. Environmental sensitivity is the most important entry–level variables and "defined as empathetic perspective toward environment" (p. 11). Knowledge of ecology refers to the necessary conceptual understanding for sound decision making processes about environmental problems and stated under minor level variables. Androgyny is another minor level variable and can simply be defined as individuals who do not behave with a traditional sex roles. Attitudes toward pollution, technology, and economics were also stated as entry-level minor variables.

Besides entry level variables, individual should have possessed ownership and empowerment in order to behave in an environmental friendly way. Ownership variables refer to variables that make issues personal for individuals. The most important variables of empowerment variables are in depth knowledge about issues and personal investment in an issue. In-depth knowledge of issue referred as understanding the issue and the human and ecological consequences of the proposed outcomes. Personal investment of issues includes personal identifications of environmental issues.

The empowerment variables include perceived skill in using environmental action strategies, knowledge of environmental action strategies, locus of control, and intention to act as major variables. Perceived skill in environmental action strategies refers whether the learners know how to use ways of using action in a way to resolve environmental problems. Second major empowerment variable is locus of control was explained as the extent to which a person feels he or she can act effectively in a situation. According to Hungerford and Volk (1990), “a person with an internal locus of control feels that he/she can strongly influence the outcome of a situation, …a person with external locus of control feels the outcome of events is largely outside his or her control” (p.12). And it is also asserted that individuals who has internal locus of control have more tendency to behave in an environmentally friendly way than individuals who possess external locus of control.

In general, Hungerford and Volk’s (1990) environmental behavior model proposed that knowledge of ecology and environmental issues are strong variables that take their places under all types of variables. These variables are presented in a flowchart in Figure 2.3.

In conclusion, the environmental behavior models suggested that changing environmental behavior in a way to support environmental welfare is a complex issue. Parallel with empirical studies, these models also treated environmental knowledge as similar as knowledge of ecology. However, the models were stated in later times also tried to include knowledge of environmental issue as an important component of EE and as a predictor of responsible environmental behavior.

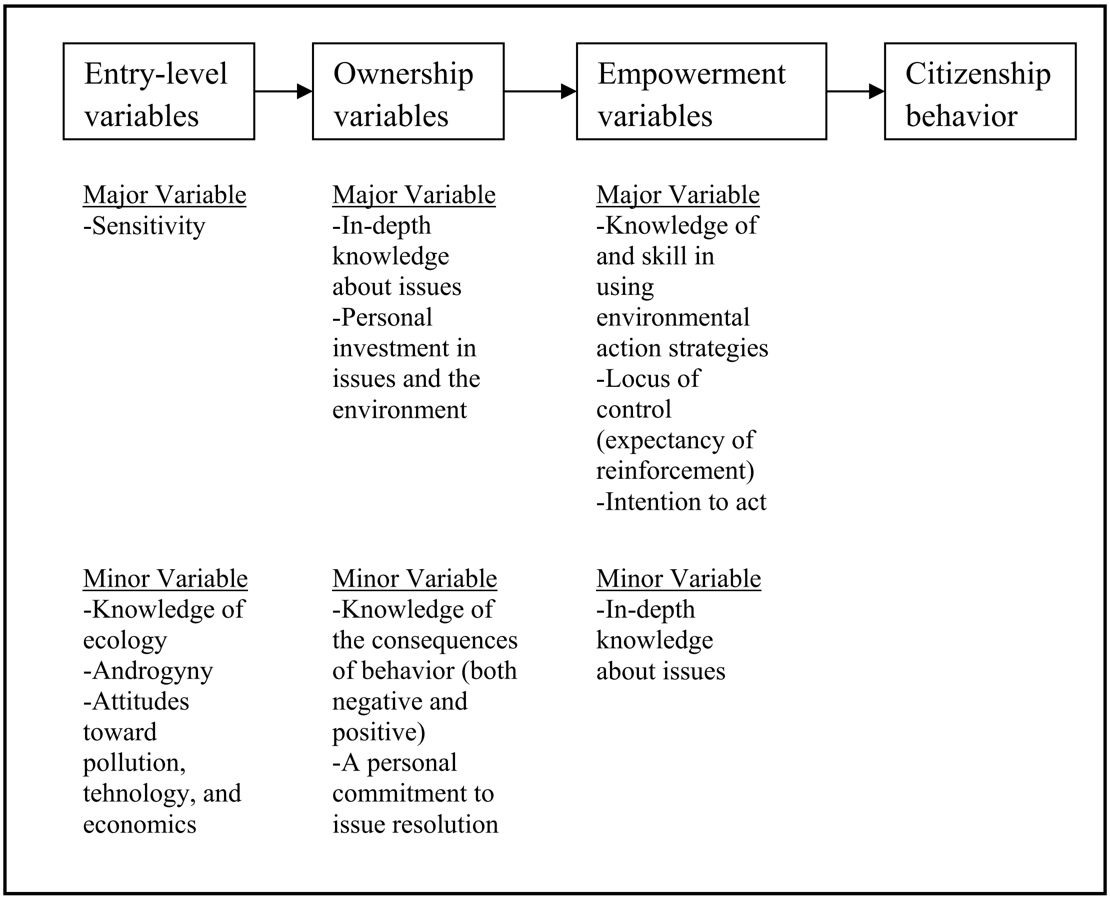

Figure 2.3 Environmental Behavior Model: Major and minor variables involved in environmentally responsible behavior (adapted from Hungerford & Volk, 1990)

2.2 The Socio-Cultural View of Learning and Collaborative Knowledge Construction

From the late nineties, the socio-cultural perspective has started to provide new insights to science education in terms of learning and instruction (Cobb & Bowers, 1999). Actually this learning perspective takes its roots from the writings of Vygotsky (1978) and has lied on the interdependence of social and individual processes in the co-construction of knowledge. According to socio-cultural view, an individual can be able to construct knowledge by participating and interacting in social activities guided by adults or more competent peers (Rogoff, 1990). In light of socio-cultural perspectives, interaction between teacher-student and student-student imply communication, social meaning construction, which is socially shaped (Lemke, 1990; Palinscar 1990). The key assumption of socio-cultural theories is that knowledge construction is happening twice: on an internal plane and on an external, social plane; prior knowledge of an individual that gain through his/her experiences is activated during collaborative discussion and reorganized. The knowledge construction realized in social plane mediated by competent peers and this interaction guides learners in a zone of proximal development in order to apply adequate strategies to solve a problem. According to Vygotsky (1978), zones of proximal development refers to the distance between independent problem solving capability and performance when provided with learning assistance from adults or more capable peers. Socio-cultural view have also asserted that learning is regarded as a participatory process in which learner gradually becomes an active member in a cultural community (Palinscar, 1997) by learning its discourse practices, norms and ways of thinking. This school of thought has also explained knowing as belonging, participating and communicating (Wenger, 1998) and they have seen knowledge as created by each learner. Socio-culturalists have strongly defended their argument that the knowledge of an individual cannot be separated from the historical and cultural background of the learner. Palinscar (1997) also stated from the point of view of the socio-cultural approach, learning and knowledge has not only been influenced by social and cultural factors, they have been actually independent social and cultural phenomena.

The trend for socio-cultural view of thought has gained importance about in the field of education and there have been excessive efforts in this area.

In a line of research, Brown and Palinscar (1989) designed an intervention study in which teachers and students used structured discussions in order to investigate meaning construction. This research indicated that with the means of the discussion (both between teacher-student and student-student) students have a chance to enhance their comprehensive skills; moreover the qualities of teacher-student and student-student interaction were increased. Furthermore, the children who could able to get specific feedback from their teachers were able to extend their contributions to the group discussions by building upon their ideas. Consequently, the children made greater gains than the other children whose teachers were less effective at scaffolding their students.

In another study Daiute and Dalton (1993) investigated that groups of seven and nine years of children were able to use diverse capabilities while they taught their peers how to write stories. The results of the study showed that after intervention, the peer collaborative discussion process, the children could be able to generate new story elements and more mature and complex forms of writing than they had demonstrated alone before the intervention period. Furthermore, the researchers also asserted that since children shared same point of view and life experiences, the peer interaction was more facilitative than teacher and child interactions.

Shepardson (1997) conducted a qualitative study aiming to investigate the nature of small-group interactions in order to mediate of children's science learning and understanding. For the purpose of the study two small groups of 4 first grader and their teachers were randomly selected and observed throughout a unit related with insect life cycles. The unit was lasting about 15 days. Primary data were collected through classroom observations recorded as field notes and videotaped recordings of small-group social interactions. In order to support primary data, informal conversational interviews were also conducted aiming to clarify teachers' and children's interpretation and explanations of spontaneous events that occurred within the small groups. Each child was also interviewed before and after the instructional unit about insect life cycle. Combination of methods of single and cross-case analytic induction was used to analyze data. The results of this study revealed that the teacher's scaffold during discussion processes mediated children's understandings of science in small-group settings. Furthermore the results of this study showed that the children's small group social interaction also mediated their science learning.

Weinberger and Fischer (2006) used computer-supported collaborative learning (CSCL), in order to facilitate knowledge construction of learners and to present a framework to analyze multiple process dimensions of knowledge construction in CSCL, namely (1) the participation dimension, (2) the epistemic dimension, (3) the argument dimension, and (4) the dimension of social modes of co-construction. In order to refine the effects of instructional support on understanding, the researchers evaluate the discourses of participants both in terms of quality and quantity by using a multidimensional approach. The study was conducted with 600 participants. The researchers able to show that computer-supported collaboration have fostered specific dimensions of knowledge construction. Participation dimension could be objectively measured and may thus pose reliable indicators for learning processes in CSCL environments.

Fischer, Bruhn, Grasel, and Mandl (2002) conducted an experimental study aiming to investigate to what extent collaborative knowledge construction can be fostered by providing students with visualization tools. 32 students of Educational Psychology at the University of Munich took part in the study. The students worked in pairs and tried to construct their maps about given issue under two conditions; with content specific and content-unspecific visualization. The participants worked cooperatively on three complex learning tasks in a cooperative learning environment. The participants collaboratively prepared a final product to show their synthesis with their pairs. The discussions and maps were analyzed qualitatively and the results revealed that with content-specific visuals both the processes and the outcomes of the cooperative effort were improved. The study also showed that dyads supported more adequate concepts, risked more conflicts and were more successful in integrating their prior knowledge in to their newly constructed explanations.

Besides stressing the importance of the research studies aiming to investigate social collaboration's mediatory effect on learners' knowledge construction, socio-cultural theories of learning also place great emphasis on analyzing discourse in order to understand learning. Due to fact that this view accepted knowledge is constructed through social interaction and activity (Vygotsky, 1978), the discourse has been realized during the process give important clues about whether individuals' learning is occurred or not (Wenger, 1998).

In the line of these efforts, Hmelo-Silver (2003) conducted a study in order to investigate collaborative interactions and the learning occurs during this process. The researcher used different data analysis techniques; quantitative methods of verbal data analysis and qualitative data analysis in order to able to assess knowledge construction processes of learners. Students' discourses during working on a clinical problem and trying to find solutions to the problem were video recorded. 24 students in six groups participated in this study were fourth-year medical students. Based on knowledge test scores at the beginning of the research one high knowledge group and one low knowledge group were selected as focus groups. The transcriptions of these groups were coded on a turn by turn basis. And the frequencies of the major categories and subcategories were designed to capture thinking processes of participants were calculated. The results of this analysis indicated that high knowledge groups referred to conceptual knowledge more than low knowledge groups. Moreover, high knowledge group work on more task specific than the others and generate more questions in order to clarify the issue. Besides quantitative frequency analysis, there researcher also conducted qualitative analysis in order to address how students constructed explanations. In this part researcher specifically dealt with instances that represent joint understanding of the task, planning and collaborative explanations of students. The result of qualitative analysis revealed that the high knowledge group grasped the big picture of the task quicker than the low knowledge group. And although both groups proposed qualitatively different explanations, the generally engaged in joint construction of the problem space as they constructed interpretations, explanations and plans. The researcher also proposed that collaborative knowledge construction analysis can be made by considering two aspect; content-related analysis and function analysis. Content-related analysis has dealt with to what extent, how frequently, and how adequately learners talk about the specific content of the learning task. Function analysis has referred the way learners cooperatively process the content, hence the functions of utterances during discourse. Thus researcher proposed that since collaborative knowledge construction is a multifaceted phenomenon, in order not to make overly reductionistic interpretations, researchers in this field should use mix methods in order to evaluate all aspects of collaborative knowledge construction processes.

Kumpulainen and Mutanen (1999) introduced a study aiming to highlight the dynamic of peer group interaction and learning with a new analytic tool. Twenty 12-year old students from a Finnish primary classroom participated in the study. The mathematic task was designed according to the innovative pedagogy which stresses the learner's conceptual framework and social activity in the construction of mathematical thinking. In the mathematical task students were expected to construct three dimensional objects with the help of already-constructed two dimensional objects. Each construction process lasted between 5 and 45 minutes and the discourses gathered during the construction process were videotaped. The videotaped data were also supported by researcher field notes. After finishing task, the questionnaire aiming to investigate group collaboration, attitudes toward the task and perceived goals was administered student to get more detailed information. The researcher also conducted stimulated recall-interviews with each student in order to clarify the students’ orientation, working strategies and understanding of the concepts dealt with within the task. The application of the analytic tool is realized with a microanalysis of evolving peer interactions by focusing on three analytic dimensions, namely the functions of verbal interaction, cognitive processing and social processing. The functional analysis concentrates on students’ verbal language, the cognitive and social processing focus on interactive dynamics across the group members; in conclusion researchers asserted that human interaction should be investigated from different dimensions with multiple methods.

In summary, socio-cultural framework, learning is regarded as a participatory process in which the learner gradually becomes an active member in a cultural community with its culture and norms (Kaartinen & Kumpulainen, 2002). Through collaborative knowledge construction, learners engage in discursive processes in which learners able to evaluate evidence, assess alternatives, establish the validity of scientific claims, and address counterevidence, constitute scientific argumentation (Driver, Newton, & Osborne, 2000). Due to the fact that current EE programs stress the importance of formative influences, according to this view for effective EE recognizing the importance of knowledge gained through living and interacting in communities, socially acquired knowledge is crucial. Environmental knowledge has a complex and a multidisciplinary nature that unveils the human and environment relationships by integrating biological, physical and chemical principles. Social communication has an important effect on integration of all principles in to a case related with human-environment relationship since effective internalization and usage of environmental knowledge in environmental cases has been influenced by learners’ social interaction between their peers and teachers (Vygotsky, 1981).

In order to achieve on the desired goals, the EE should be given to learners in the real environment that they can be able to applied theoretical environmental knowledge in to practice. So for that purpose the field trip activities were used in this study. The detailed information about field trip activities and the importance on collaborative construction of environmental knowledge were given in the below sections.

2.3 Studies on Inquiry oriented Field Trip Activities and Environmental Education

In Tbilisi Intergovernmental Declaration (1978), it has been asserted that the goals effective EE, raising environmentally literate individuals and this can be achieved by using multidisciplinary approaches. Moreover, according to Vygotsky (1978), socio-cultural context, the situation that learning occurs in affects learning process and makes them unique. In collaborative inquiry learners are belonged to one group, participating in group work and share their ideas. Science education does not only contain content matter, besides content matter knowledge social and humanistic factors should also be involved in science and process of learning science (Mason, 2007). In other words social environment that learning occurs in affects learning and necessary for real and meaningful learning. In other words literature shows that collaborative inquiry methods can be helpful for long lasting and effective EE. In one of the big cities of Turkey, a Doğança and Mugaoğlu (2007) conducted a study with 55 prospective elementary science teachers, prepared a course related with environmental issues and implement them via laboratory applications. The researchers investigated that environmental attitude and knowledge was developed by the effect of laboratory activities as an inquiry oriented process. There are studies in literature that investigate effectiveness of inquiry oriented methods which refers to instructional practices that promote student learning through student-driven and instructor-guided investigation processes (Lee, Greene, Odom, Schechter, & Slatta, 2004). Disinger (1982) suggested that EE in non-traditional settings outside the classroom may be more effective than in classroom EE in terms of changing behaviour. The process of inquiry and active participation is also necessary for meaningful EE (Benton, Knapp, & Farmer, 2007). According to a research conducted by Rice at al. (2006), learners develop meaningful and more long lasting learning with inquiry oriented methods by involving the learning process actively. In one of the study, Gray (as cited in Manzanal, Barreiro, & Jimenez, 1998) investigated that by actively participating in the learning process via field trip learners have firsthand experience about the habitat being studied and comprehend sampling and data collection skills necessary for EE.

Manzanal, Barreiro and Jimenez (1998) conducted a study aiming to investigate fieldwork contribution to environmental concepts. 67 Spanish students' ages ranged from 14 and 16 participated in this study. Two groups one experimental and one control group were selected for the purpose of this study. Along with the fieldwork, the ecology unit related with the components and relationships of freshwater ecology was set in activity. Depending on the assumption that the ability of students to conduct cognitive tasks during a field trip depends on the familiarity of the field trip setting, before starting on the field trip, one class session was given to students in order to explain the characteristics of the work. A pre-test and a post-test were administered to the participants in order to investigate the effect of field activities on understanding of environmental concepts. Evaluation of the pre-test and post-test questions was made by means of categories in which the measurement applied was the ordinal scale. The results of the research work showed that fieldwork helps clarify ecological concepts and environmental interaction in an open air via field trips create environmental questions in learners' mind and this situation will help students to create more positive behavior by directly intervening in the development of more favorable attitudes toward the defense of the ecosystem.

Eagles and Demare (1999) conducted a study with sixth level elementary students in Canada. They give environmental issues with field trip activities for one week and at the end in their analysis they did not find any significant change in students' awareness and attitudes more than before.

Farmer, Knapp and Benton (2007) examined long term effects of EE school field trip activities on fourth grade elementary students. The field trip to Great Smoky Mountains National Park was conducted for the purpose of this study. 30 students in a fourth grade class at a public elementary school in an urban town in eastern Tennessee participated in the study. For exploring students' memory recollections of the field trip experience and the concepts introduced in the field trip activity, in depth interviews with 15 self selected students were conducted in the fall of 2002, a year after the trip. The open ended and unstructured interview began with the statement "could you please tell me what you remember about the field trip that you took to the Smoky Park National Mountain last year?" For the following sections of the interviews, the interviewer only asked follow up questions for summaries clarification of the students' explanations and gave minimal encouragement to the student. Phenomenological data analysis included three steps; (a) investigation of the phenomena (in this case participant recall of an EE field trip to Great Smoky Mountains National Park), (b) identification of general themes/essences of the phenomena, and (c) delineation of essential relationships among the themes. Codes and categories were constructed by three step coding and data check processes. The results of the study revealed that participants developing long-term retention of ecological knowledge by the means of field trip activities. The researcher also asserted that classroom experiences before and after a field trip are indeed a valuable and supportive tool for promoting more knowledge retention.

In conclusion, the environmental learning tasks used in this study were prepared by considering and combining key aspects of collaborative inquiry and field activities, the combination is called in this study as field-based collaborative inquiry. The researcher has two aims of using field-based collaborative inquiry; one is creating the most suitable learning environment to mediate environmental knowledge constructions of the PSTs and investigate this type instruction whether creates a disposition in the PSTs' nature of environmental explanations.

2.4 Environmental Education Studies related with Pre-service teachers

With the increasing importance of EE as being a sustainable solution to environmental problems, the research studies have gave considerable importance on the role of teachers' mediatory effect on learners' environmental behavior. Since the teachers are important source of knowledge and experience for learners, teachers have an important role in educating students as environmentally literate. So it is very important to identify these teachers' understanding regarding environmental knowledge. It has been also accepted that teachers who have a poor understanding of environmental concepts possibly transfer this to their students (Khalid, 2003). According to the research conducted by Organisation for Economic Cooperation and Development (OECD, 1995), for five OECD countries (Australia, Austria, Finland, Germany, and Norway), the weakest point of EE is the teacher training programs. Thus, teacher training programs should be revised in terms of integration of EE. Due to the fact that, teachers gain their knowledge of professions through their undergraduate courses, it is crucial to point out the level of PSTs in terms of environmental concepts and issues. There have been considerable amount of research conducted in order to investigate the PSTs' level of environmental knowledge, environmental attitudes, environmental concerns and environmental behaviours in the field of EE.

McKeown-Ice (2000) conducted a study aimed to assess the status of EE in pre-service teacher education program in the United States. A survey was delivered to 175 institutions via mail. The survey was consisted by three main parts. The first part of the survey aimed to identify general information about institution (number of faculty involved in, EE, interest of faculty, administration, and pre-service students in EE). The other two parts of the survey covered questions related with programmatic requirements, institutionalization of EE, incorporation of EE into the teacher education curriculum, depth of EE in teacher education program, and self-rating of effectiveness. Among all institution 446 of them responded for the survey.

The data obtained from all institutions analyzed by Fox-Pro database. The results indicated that only an half of the teacher training institution can give EE to their pre-service teachers. The results also revealed that the pre-service teacher education is affected by institutions' interest and knowledge to EE. The teacher education institutions also stated that there is too limited time for courses including EE. According to the researcher, the effectiveness of EE in terms of pre-service teacher education is depended on collaboration between environmental educators, teacher education faculties and governmental policies.

In another study, Petegem, Blieck, Imbrecht, and Hout (2005) proposed an article reports on implementing EE in two teacher training colleges; one college has a long history of EE and one has just started with this study. The aim of this integration effort is to enhance the EE awareness and competencies of pre-service teachers. A workbook on EE in pre-service teacher training including methods, activities and tips on EE was delivered to both colleges. The workbook showed ways to colleges, in order to implement EE in to their pre-service education curriculum. The two institutions were monitored by questionnaires, interviews and focus group discussions. Although, one college has had more experience than the other in terms of EE, implementation of environmental learning task in to both colleges' teacher education programs processes proceeded similarly. The teachers in teacher education programs mostly state that lack of knowledge and training is the most important reason of not offering EE to pre-service teachers.

Torkar and Bajd (2006) conducted another study that aimed to investigate trainee teachers' ideas about endangered bird species and the protection of birds. The trainees were majoring in the department of elementary child, science and biology education. 191 pre-service teachers participated in the study. The participants individually responded an open ended question which was "how can we best protect endangered bird species?". The answers to open ended question were analyzed qualitatively by constructing categories. The result of the study revealed that although some of the pre-service teachers had thought that human intervention is necessary for protecting endangered species, the remaining could not propose any answer for protection of endangered species. The results also revealed that the pre-service teachers could propose more answers related with extinction about the familiar species in the context of their culture.

In the Turkish context, Pekel (2005) conducted another study to identify and describe pre-service science teachers' perceptions of ozone layer depletion. 69 pre-service science and biology teachers participated in the study. The participants were administered a questionnaire including 37 items related with ozone layer depletion and some demographic information. The results of the study indicated that the pre-service science teachers gave true answers for 13 of the 30 questions. The pre-service science teacher has some misconception about the concept of ozone layer depletion: they confused ozone layer depletion with the concepts of global warming and environmental pollution; most of the pre-service science teachers also believe that UV radiation is the main reason for ozone layer depletion. The study proposed that pre-service science teachers has lack of understanding about environmental problems specifically ozone layer depletion.

In conclusion, due to the important effect of teachers on learners' understanding and knowledge, the pre-service teacher education has carried importance for effective EE. EE should be integrated in to the teacher training programs in order to increase the PSTs knowledge and skills necessary for giving effective EE.

CHAPTER III

METHOD

The method chapter is comprised of the detailed explanations about design, procedure, participants, data collection, and data analysis of the study.

3.1 Design of the Study

The goal of this study was to investigate the process of construction of explanations regarding environmental problems and to investigate possible changes in the nature of the PSTs' explanations for environmental problems in field based collaborative inquiry learning environment. The research design can be defined as basic or generic qualitative research approach (Merriam, 1998). The aim of the researcher can be stated simply as to reveal the process of participants' construction of explanation for environmental problems rather than focusing on intensive case and building a grounded theory. In this study data were collected through observations based on basic or generic qualitative study and the explanations of the PSTs were analyzed under recurring patterns in the form of categories. According to the key philosophical assumption of a qualitative study, qualitative research is based on the realities constructed by individuals interacting with their social worlds (Merriam, 1998). Therefore, as compatible with this key assumption, the current research investigated to the PSTs' construction of explanations regarding environmental problems from both individual and group perspectives by allowing them to collaboratively interact with their peers in a social science learning environment. The PSTs were engaged with environmental problems observed in real life settings. According to Merriam (1998), qualitative research usually involves fieldwork aiming to observe participants in real settings. Thus, through including environmental problems into the design, the researcher had an opportunity to observe PSTs in the course of natural settings.

3.2 Preparation of Authentic Learning Tasks

The learning tasks of the course were prepared by a committee which included the researcher (one of the instructor of the course), one of the instructors of the course, and two faculty members who had expertise on EE. Of these experts, one was expert both in the field of EE and elementary education and the other one is expert in the field of EE and environmental engineering. Each learning task included an inquiry oriented investigation of an environmental problem. The committee decided to include five environmental problems into the learning tasks. These environmental problems in the learning tasks were biological diversity, surface waters, drinking water, waste water and air pollution. The learning tasks' manuals used for this study are presented in Appendix A.

Environmental problems of the learning task were selected based on importance. The committee tried to select problems which especially possess local importance for the city Ankara where the PSTs live. We believe that having opportunity to investigate problems in real life setting was crucial for constructing environmental explanations in order to make PSTs to take all aspects of environmental knowledge (environmental, social and economical) into consideration. So after small investigation of the Ankara city and its near surrounding, it was seen that the most problematic cases available in the city included selected problems.

Following sources were examined to prepare the content of the each learning task: Previously conducted studies both in the field of EE and social science learning environments from Educational Resources Information Center (ERIC), International Dissertation Abstracts, Ebscohost, Social Science Citation Index (SSCI), Internet (Google Scholar), and master and doctoral thesis in Turkey and other countries were examined. Moreover, the annual environment reports of Ministry of Environment and Forestry of Turkey (MoEF) and the guidelines about quality parameters of surface waters, drinking water and air offered by World Health Organization (WHO) were used for this purpose.

3.3 Procedure of the Study

The research has been realized within the context of an elective course titled "Laboratory applications in environmental education" in the Department of Elementary Education during 2008-2009 Spring semesters.
The study was realized with the following steps:

i. Conducting field trip activities related with specific environmental problems as a group,
ii. Conducting group discussions after each environmental learning task as a group,
iii. Conducting whole class discussions for closing up each environmental learning task.

Implementation of each environmental learning task took two weeks; one for field investigation and one for discussion. Of all learning tasks three of them included in-situ measurements about biodiversity, surface waters and air pollution in real settings in field weeks; the remaining two environmental learning tasks included visiting treatment plants processing drinking and waste waters rather than conducting in-situ measurements in field weeks. The contexts of learning tasks' are presented in Table 3.1.

Table 3.1 The contexts of learning tasks

Learning Task	**Specific Problem**
Biodiversity	PSTs investigated the causes and effects of loss of biodiversity problem in Eymir Lake by making in-situ measurements.
Surface waters	PSTs dealt with the causes and effects of water pollution problem in Eymir Lake by making in-situ measurements.
Drinking water	PSTs observed the processes and criteria of surface waters undergo in order to be drinking water in İvedik Water Treatment Plant, Ankara. And PSTs tried to interpret the effects of human activities on these processes.
Waste water	PSTs observed the processes that waste water undergo before leaving off to the surface waters again in METU waste water treatment plant. And PSTs tried to interpret the effects of human activities on these processes.
Air pollution	PSTs investigated the causes and effects of air pollution in METU campus area by making in-situ measurements.

In the fields included in-situ investigations, the PSTs formulated hypothesis considering human effect on the quality of environment as groups, made in-situ measurements and collected data for testing their hypothesis. During discussion weeks conducted in classroom a week after the field investigations the PSTs again worked as a group to interpret collected data by considering all aspects of environmental knowledge associated with environmental problems with the guidance of instructors. For the other learning tasks as visiting treatment plants, the PSTs had an opportunity to examine the processes related to water treatment and waste water treatment. The each environmental learning task was completed as presented in Figure 3.1.

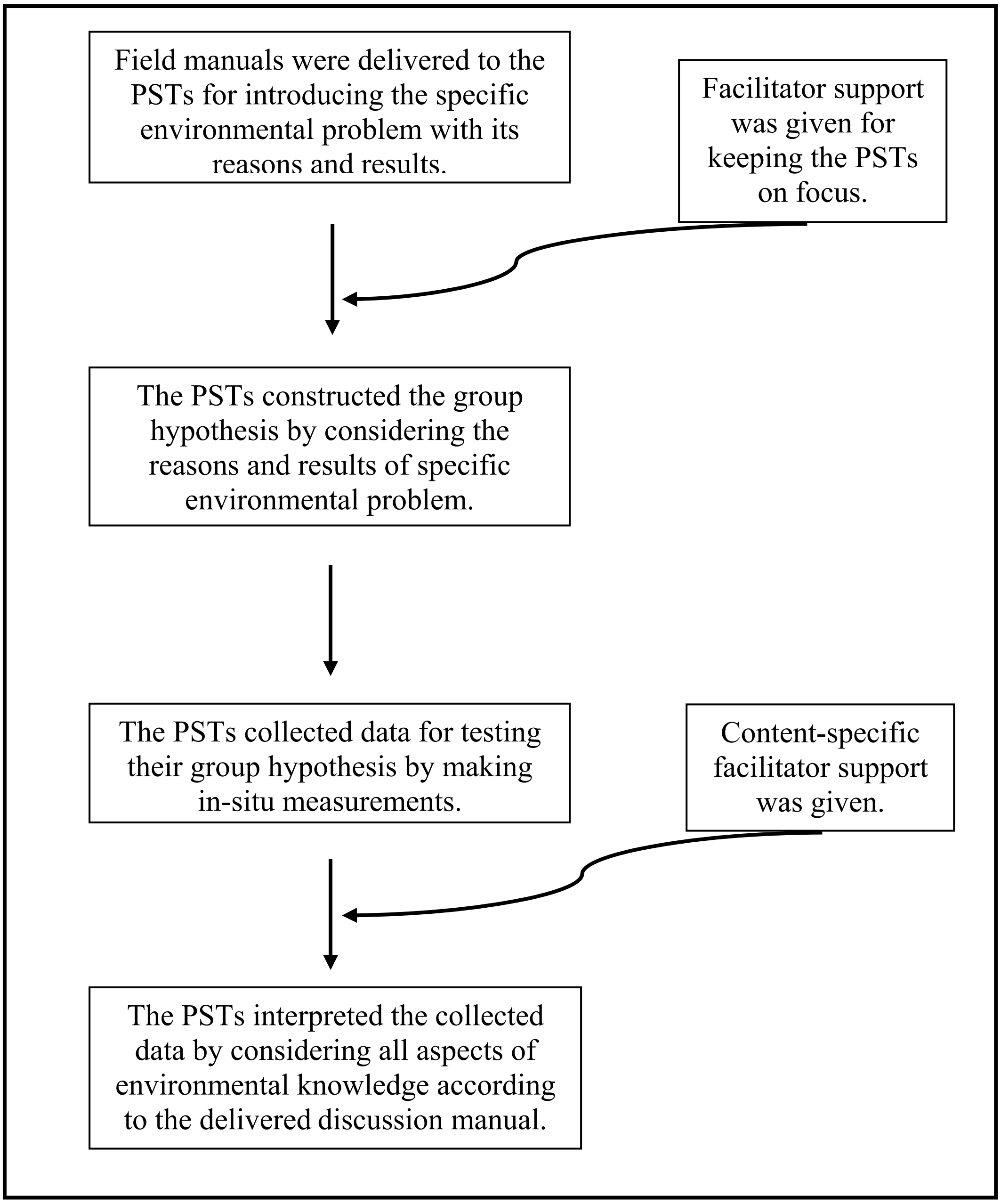

Figure 3.1 The process followed for each environmental learning task

In each authentic environmental learning task, the PSTs worked in self-selected small groups. Due to the reason that the PSTs constructed explanations through learning tasks prepared with field-based collaborative inquiry strategy, addressing group size is important in terms of how many learners can collaboratively construct knowledge. In order to allow all group members to construct explanations in socio-cognitive processes, learning groups should be small enough (Cohen, 1994). Therefore, typical small groups consist of three to five participants (Dillenbourg, 1999). The average size of the mixed-gender groups for this study was five students. There were totally four groups in this course

The PSTs were given three hours for completing each week. They should construct their experimental designs, formulate hypothesis, and collect data in three hours during field activities. They also had same amount of time for discussing to interpret collected data and conclude learning tasks in discussion weeks.

The group discussions realized during the learning tasks reveals that the learning tasks including in-situ measurements, especially biological diversity and surface waters, forced PSTs to interact with their groups' members more than the other tasks. Due to this reason, PSTs had more opportunity to construct explanations regarding environmental problems while negotiating their peers. In the line to achieve researcher's goal, in order to unravel the process of construction of explanations of PSTs, two learning tasks including in-situ investigation are thought to be more beneficial in terms of gathering data. For the concern of uniformity and gathering more data, two authentic learning tasks including in-situ measurements were selected for the purpose of this study.

For understanding what kind of predispositions occurred in PSTs' nature of explanations during the process of field-based collaborative inquiry learning, a pre- and post-test were administered to PSTs. PSTs completed these tests individually before and after the implementation of learning tasks. The pre- and post-tests were consisted of same open-ended question. The open-ended question was related with selected environmental problems. During preparation process of the question, all aspects (environmental, social, economical, etc) of the environmental problems were considered. The questions were constructed in line with recommendations of the same two experts who reviewed environmental learning tasks by researcher. The question was also revised according to experts' suggestions about the relevance of the questions for the aim of the study. The appropriateness of the language structure of question for PSTs was also reviewed by those experts. The revision processes were continued until an agreement was established between the researcher and two experts. The pre-tests and post-tests are presented in Appendix B.

3.4 Participants of the study

Due to the interdisciplinary nature of environmental knowledge, it was assumed that for construction of environmental knowledge (for assessing the outcomes of human actions), basic science knowledge including physics, chemistry, and biology is necessary. So, students who were completed their basic science courses from the department of elementary and secondary education, could registered the course. A total of 19 pre-service science teachers and 2 graduate students who were pursuing their master degrees on elementary science and math education registered for the course. Of all participants registered for this course, five participants were belonged to third grade level, 14 participants were belonged to 4th grade level and both of the undergraduate students were in their third semesters. The average age of the students, 5 males and 14 females, was 23.6 years. Of all participants 11 of them took at least one environmental course during their undergraduate education. Generally all participants asserted that they do not follow a newspaper and a magazine in regular. Among the participants 15 of them stated that they also follow environmental documentaries from television. Demographic information of the PSTs presented in the Table 3.2.

Although the course was offered as an elective course and it can be said that all participants took the course willingly and conducted the activities in an enthusiastic manner, after completion of first learning task, all groups' constructions of explanation were examined in order to found the group who displayed explanation constructions including rich variety of interpretations and explanations. Since researcher specifically dealt with construction of explanation regarding environmental issue, group displayed explanation constructions including rich interpretations and explanations was selected as focus group for this thesis study. The focus group includes five 4^{th} grade PSTs. Thus, it can be said that the researcher made purposive sampling in order to collect information rich data. Purposive sampling is preferred by researchers who want to discover, understand and gain insights by having a desire to gather most information about a specific situation (Patton, 1990). The focus groups had five PSTs who were fourth year students. Although, the focus group was selected after first learning task, each group was treated as a participant through the semester in order not to decrease other students' motivation towards a course. By this way the focus group's participants also did not felt themselves as specially cared; resulting from increased attention and interest towards course.

Table 3.2 Demographic information for participants

	gender		
	male	female	total
demographic variables			
3^{th} grade	3	2	5
4^{th} grade	2	12	14
graduate		2	2
take environmental courses	1	10	11
read newspaper	4	15	19
read magazine	2	5	7
watching environmental documentaries	5	10	15

3.5 Data Collection

The data was collected with the permission of Ethical Committee of Middle East Technical University. In addition according to the rules of the ethical committee every participant signed a consent form confirming that they voluntarily enrolled the study. Moreover, in consent form they were informed about they had an option of excluding themselves from the study whenever they want with any reasons. Informed consent form is presented in Appendix C.

In order to investigate the process of PSTs' construction of explanations regarding environmental problems in social science learning environment, data were collected through audio and video recorders.

And to understand the PSTs' nature of explanations after the process of field-based collaborative inquiry learning environment, data were collected through pre- and post-tests. Below more detailed information was provided for each data collection procedure.

3.5.1 The Process of Construction of Explanations Data

In each field week the participants examined a specific environmental problem with its all aspect in real life settings. Since researcher needed environmental explanations of participants while dealing with a specific issue, the dialogues between participants during small group discussions were recorded by audio-recorder. Since field works were conducted in outdoor conditions, there were some factors (wind, traffic noise, construction noise, etc.) that lowering the quality of voice record. For validation of data in order to prevent that kind of data loss, participants' explanations during small group interactions were also video-recorded. During field investigation process, there could be some situations that participants conducted their investigations apart from other group members. Thus, for validation of data, the researcher also wanted each group's instructors to keep observer notes about all events occurred out of scope of video and audio recorders during field investigations.

In discussion weeks, all groups were interpreted data that they collected in fields. The classroom was big enough that allowed all groups to work simultaneously. The group members sat in a circular seating arrangement. Circular seating was important to foster participants to work collaboratively. Due to the reason that all groups interpreted data in same classroom in discussion weeks, the groups' discussions could interfere with each other and in order not to lose any data both audio and video recorders used together.

3.5.2 The Nature of Explanation Data

To investigate possible predispositions in the nature of students' explanations for environmental problems in field-based collaborative inquiry learning environment, PSTs were administered a pre-test and post-test which they completed individually before and after the implementation of each learning task. All pre-tests were administered at the same time that the semester started. The administration of pre-tests took about 60 minutes. The post-tests were administered after each learning task completed. The administration of each post-test took about 15 minutes.

3.6 Data Analysis

Data analyses were conducted in two different phases. Constructions of explanations of PSTs regarding environmental problems were analyzed through an analytic tool prepared by Kaartinen and Kumpulainen (2002). The natures of students' explanations regarding environmental problems during the process of field-based collaborative inquiry learning were analyzed qualitatively as Kaartinen and Kumpulainen (2002) did in their study.

3.6.1 Construction of Explanations Analysis

The analytic tool developed by Kaartinen and Kumpulainen (2002), aims to investigate explanation construction process in social science learning environment and collaborative inquiry.

The analytic tool includes four parallel analytic frames which are discourse moves, logical processes, nature of explanation and cognitive strategies. Each frame has sub-categories. The analytic frame is presented in Table 3.3 (Kaartinen and Kumpulainen, 2002, p195).

Table 3.3 An analytic tool for analyzing explanations

Discourse moves	Logical processes	Nature of explanation	Cognitive strategies
Initiating	Proposes a cause	Formal explanation	Constructing a question
Continuing	Proposes a result	Causal explanation	Raising a new question
Extending	Advances evidence	Descriptive explanation	Using evidence
Referring back	Suggests a method	Everyday explanation	Applying a principle to a case (modeling)
Agreeing/disagreeing	Evaluates		
Replying	Contradicts		Using everyday knowledge
Commenting			
Concluding			

The analysis of discourse moves highlights the conversational exchanges between students while dealing with a learning task in social science learning environment. Thus, by this analysis researcher could unravel group member's participatory roles during the process of social science learning. Initiating, continuing, extending, referring back, agreeing/disagreeing, replying, commenting and concluding are the moves identified under the category of discourse moves. Initiation moves signal the beginning of the new thematic episodes related with a concept that is dealt with. Continuing moves reflect that students continue to elaborate previously stated reasoning from their own perspectives. Differently from continuing in extending moves, students need to expand explanation constructions from new perspectives under the same theme. Referring back moves focused on referring back to the ideas which has emerged previously during the discussion. Agreeing/disagreeing moves point out students' acceptance or rejections of the idea stated in previous conversational turns. Replying moves can be defined as responses to explicit questions. Commenting moves are statements including personal remarks or evaluations revealed during the process of social science learning. Concluding moves can be defined as statements draw a thematic episode together.

The analysis of logical processes is concerned with the logical relationship between conversational turns and how they give rise to explanation-building in social interaction (Kumpulainen & Kaartinen, 2002, p.196). The analysis of logical processes highlights how students support their claim. The sub-categories highlighted under logical processes category are proposes a cause, proposes a result, advances evidence, suggests a method, evaluates and contradicts. The category of proposes a cause refers to explanations describing causes describing causes as processes or as factors. The explanation, taken into account in proposes a result category, pointed out the results of cause-effect reasoning. The advances evidence category reveals the statements propose evidence can be formal or informal. The category of suggest a method identifies statements that propose the way for investigation process. The category of evaluates shows evaluations of the situations in critical times. The category of contradicts signals the discrepancies among the students' reasoning.

Moreover, in this study there were conversational turns that did not reflect logical processing and consequently they were not coded.

The specific codes stated under the category of nature of explanations are formal explanation, causal explanation, descriptive explanation and everyday explanation. The category of formal explanation highlighted the explanations describing an environmental phenomenon does not contradict scientist's ideas in a formal language. Causal explanation category identifies the explanations including causal relationships (can give causes or results of an environmental problem) in non-formal language. The explanations coded in this category are not necessarily congruent with the experts' ideas. The descriptive explanation category highlighted the explanations characterize the process of origination of environmental problem. The explanations coded in this category not necessarily include causal relationships. The everyday explanation category includes explanations derived from informal context. Since all conversational turn did not include explanations, there were some conversational turns that were not coded under this category.

The sub-categories under the nature of cognitive strategies can be listed as constructing a question, raising a new question, using evidence, applying a principle to a case and using everyday knowledge. The construction of category refers to a situation that a problem is constructed. The category of raising a new question points out the construction of sub-question. The using evidence category unravels the explanations that stand on experimentation and conceptualizing. The category of applying a principle to a case reflects the situation in which scientific knowledge is applied to a specific case. Using everyday knowledge highlights the situations where reasoning is derived from informal, everyday experiences.

For analyzing explanations of constructions of PSTs, the video and audio materials capturing social activity of each group were closely examined. The analysis of the videotapes and audiotapes were supported by the researcher's field notes from field weeks. Verbatim transcriptions were made by researcher for the video and audio recordings of PSTs. Spell check was done to transcribed explanations of PSTs prevent misunderstandings. The transcribed explanations of the PSTs were translated from Turkish to English. The used quotations for this study were given in Appendix D. After transcriptions took their final state, researcher coded explanations qualitatively by using the analytic tool proposed by Kaartinen and Kumpulainen (2002).

The reliability of the coding of the students' explanations has been checked by two independent researchers (a researcher of this study and an expert in the field of science and EE) who have analyzed the data. The inter-rater agreement between the coders was 94 %. The inter-rater agreement was calculated from the data of a biological diversity learning task. Diverse opinions have been negotiated to establish a joint agreement. Owing to the interpretative and complex nature of the analysis this procedure was found most appropriate to the rationale of this study.

3.6.2 Nature of Explanation Analysis

The predispositions in nature of students' explanations for environmental problems during the process of field-based collaborative inquiry learning were analyzed qualitatively as Kaartinen and Kumpulainen (2002) did in their study.

The written explanations of participants in their pre-tests and post-tests were analyzed qualitatively with the help of descriptive categories proposed by Kaartinen and Kumpulainen (2002). The descriptive categories arose from the data they collected for their study about chemistry. The categories proposed by chemistry were discussed in terms of their suitability to environmental knowledge by researcher of this study and an expert. The descriptions of the categories were adapted through the content of the environmental learning task. After harsh revisions of explanations of PSTs in their pre-tests and post-tests, the researcher of this study became sure about there were no extra categories emerged differently from Kaartinen and Kumpulainen (2002, p.198) proposed in their study. The researcher and the expert analyzed the responses of the PSTs according to the description of the categories. The coders had negotiated on a single response until an agreement was reached. Diverse opinions have been negotiated to establish a joint agreement. All responses of the PSTs to the pre-tests and post-tests were coded one by one like this way. The coding scheme is presented in Table 3.4.

Table 3.4 Categories describing the nature of the PSTs' explanations in the pre-test and post-test conditions (adapted from Kaartinen & Kumpulainen, 2002)

The nature of explanation	Definitions
Descriptive	Describes environmental problems as a process. The explanation does not clarify causal relationships
Practical	Explain environmental problems with practical, everyday examples
Explicatory	
• Proposes a result	Approaches environmental problems from the points of view of a result
• Proposes a cause	Explains a reason for environmental problems
• Provides a formal explanation	Examines environmental problems as a holistic phenomenon by taking account of all possible interactions as well as cause and result relationships

3.7 Trustworthiness of the Study

According to Lincoln and Guba (1985), the trustworthiness of a qualitative inquiry aims to support the argument that the inquiry's findings are worth to pay attention. The basic issue in relation to trustworthiness is simple: "How can an inquirer persuade his or her audiences (including self) that the findings if inquiry is worth paying attention to, worth taking account of?"(Lincoln & Guba, 1985, p.290).

In any qualitative research approach, four issues of trustworthiness should be addressed while conducting a qualitative study (Lincoln & Guba, 1985). These issues are credibility, applicability, dependability and confirmability (Sadler, 2004).

3.7.1 Credibility

In qualitative research approach, "credibility is an evaluation of whether or not the research findings represent a "credible" conceptual interpretation of the data drawn from the participants' original data" (Lincoln & Guba, 1985, p.296). To provide credibility the strategy of triangulation was used. This strategy refers to the utilization of multiple investigators and multiple sources of data (Denzin, 1970). In this study data collection triangulation and data analysis triangulation were used. For data collection triangulation, video and audio recordings of PSTs were triangulated with researchers' field notes. For data analysis triangulation, the group discussions' transcripts and the written responses of PSTs to pre-post tests were analyzed by two independent researchers. According to both analyses, at least 94 % inter-rater consistency was determined for the group discussion transcripts.

3.7.2 Applicability

Applicability is the degree to which the findings of the inquiry can apply or transfer to other situations (Merriam, 1998). By some researchers in qualitative research area, the term transferability can be used as synonymous with applicability. To address applicability in this study**,** the PSTs descriptions (major and minor undergraduate area, the environmental courses that take, fathers and mothers' education level, university, gender and country), data collection and analysis procedures were clearly described in the study. Moreover, in order to give other researchers to transfer this study's conclusion to other qualitative studies, some parts data analysis documents are presented in Table 4.1.

3.7.3 Dependability

According to Lincoln and Guba (1985), dependability is an assessment of the consistency of processes of data collection, data analysis, and theory generation. In the present study the consistency of the data analysis process was confirmed inter-rater reliability according to the coding of two independent researchers.

3.7.4 Confirmability

Confirmability is a measure of how well the inquiry's findings are supported by the data collected. (Lincoln & Guba, 1985). For the concern of confirmability, the collected data, data analysis procedure and the process of data interpretation were checked by two experts. Of these experts, one was expert both in the field of EE and elementary education and the other one is expert in the field of EE and environmental engineering.

3.8 Researcher Bias

In qualitative research approach, qualitative researcher is part of the process of inquiry, and all researchers are different. This human factor in qualitative research approach has been said to be the greatest weakness of qualitative method since errors in the manner of interviewing or errors in sampling might be came about by the means of this human factor. These errors can be simply defined as bias. According to Patton (1990), there are four ways in which a researcher might unduly influence the data of a qualitative inquiry. These ways can be listed as the presence of researcher, instrument change, professional incompetence and value imposition. In the present study, it was possible to face with errors resulting from value imposition. Value imposition is a term and can be defined as the qualitative inquiry stay under the influence of the researchers' values or biases (Patton, 1990). Although it has been strongly pointed out that, "Value-free interpretive research is impossible" (Denzin, 1989, p.23), a qualitative researcher may have unconsciously imposed his values, beliefs, or biases onto the participants and may have thus unduly influenced the data (Patton, 1990). In the present study researcher as a bias may expect that the PSTs' understandings about environmental problems would be increased after field–based collaborative inquiry process. Furthermore, assuming that the PSTs have inadequate environmental knowledge may be asserted as another researcher bias.

CHAPTER IV

RESULTS

In this section the findings of the study is presented. The findings are given in two parts. In the first part, the analyses of constructed environmental explanations of the PSTs' are presented. In the second part, the results of the nature of students' explanations for environmental problems in the pre-test and post-test condition are given.

4.1 The Process of PSTs' Construction of Explanations during Environmental Learning Tasks

This analysis highlights the process of explanation construction of the PSTs in focus group while dealing with the authentic environmental learning tasks related with the concepts of biological diversity and surface waters.

The process of PSTs' construction of explanations while dealing with environmental tasks were given in two seperate sections; biodiversity learning task and surface waters learning tasks. Each environmental learning task were given in two sub-sections; one for field week data and one for discussion week data. Owing to the fact that the PSTs were expected to complete several tasks in order to complete whole week's task, the PSTs discourses gather around various different thematic episodes related with sub-cases during each week. For each week, the case-based description of these thematic episodes and the negotiation processes of PSTs during each episode were given first. The PSTs allocated approximately equal time for each episode. In detailed explanations, instead of giving all details for forty-minute continuous period, the distinctive basic features sufficient for giving readers general idea of each episode were emphasized. After case-based descriptions, the detailed information about the level and nature of the PSTs' participation in social explanation-construction process related with whole week's data obtained from analytic tool were given.

4.1.1 Biological Diversity

The data gathered from biological diversity learning task were given in two sections. In the first section the results of field week were given and in the second section the results of discussion week were given.

4.1.1.1 Field Week

In biological diversity field week, the analysis of PSTs' discourse reveals three thematic episodes in the construction of explanations for biological diversity. The conceptual episode themes are:

Episode 1: Selecting areas for assessing the effect of human activities on biological diversity by evaluating the signs of biodiversity loss in Eymir Lake,

Episode 2: Designing a scientific experimentation process for testing constructed hypothesis highlighting the relation between human activity and biological diversity,

Episode 3: Classifying the living things according to their distinctive features.

The activities that the PSTs conducted and the discourses of the PSTs in each of the episode were given in detailed below.

Episode 1: Selecting areas for assessing the effect of human activities on biological diversity by evaluating the signs of biodiversity loss in Eymir Lake

In Episode 1, the PSTs tried to select the most suitable areas for their investigation. The PSTs wanted to select two different areas; one is affected by human activities and one is not affected by human activities. With these two areas the PSTs tried to understand the effects of human activities on biological diversity. Even though the PSTs immediately selected affected area without any critical thoughts, they were confused while selecting untouched area. Melis initiates the discussion by suggesting a method “I think it would be good if we select an area far from the lake and near the road”. In the next turn, Ekin continues by proposing a cause “it will be hard to find an untouched area since everywhere in Eymir Lake are used by human, we can only find a place that have been less affected by human”. Ekin’s causal explanation reveals that finding untouched area is hard and she supports her idea by knowledge she gained through her everyday experiences. Nur continued the discussion by giving an everyday explanation that “we choose two areas that should be far away from Lake, one is near the road one is far from the road”. In her explanation, Nur does not propose any reason for her idea and she only makes explanations by using everyday language. After Nur explanations, other group members agreed on her idea and began to climb higher parts of the Eymir Lake area to find less affected area. While climbing Ekin hesitated for a while in the halfway and continued “it is not logical, we cannot find an area that people come and picnic far from the Lake” by proposing a cause for her explanation. While explaining her views, Ekin also used knowledge derived from her everyday experiences for supporting her view. After Ekin’s moves, Esin made a causal explanation that states her disagreement toward Ekin by proposing cause, “since the lower sides are too close to the Lake ecosystem we should not take an area from there, otherwise we cannot compare species in these two areas (one area they selected was at the higher altitude the other was at the lower altitude). We should select two areas from the same ecosystems”. After Ekin’s statement all group members agreed on her and tried to find an area which is less affected by human activities than the other area by stabilizing type of ecosystem. While selecting the affected area, they assessed the indicators of human activities, i.e., they tried to find out evidences that show them the area was affected by human activities. During the evidence searching process, Ekin continued the discussion, “this area is suitable I think since the length of the grasses are high” by advancing evidence. After Ekin’s explanation, the group members agreed on her and the area selection for unaffected area was decided. Once the two areas were selected this episode was concluded.

Episode 2: Designing a scientific experimentation process for testing constructed hypothesis highlighting the relation between human activity and biological diversity

In episode 2, the PSTs discussed for determining the suitable investigation processes. The episode was initiated by Melis “everybody can count the species around own self” by suggesting an investigation method. After Melis’s suggestion every group members agreed on her idea and accepted counting as a suitable method for their investigation then they began their investigation by counting the species. During this investigation, again Melis initiated another discussion by giving contradicting ideas to her previously stated idea by saying “but in this case we cannot be aware of each others’ counted species and we can count same organism again and again I mean more than one times”. Actually in this case, although she seems to suggest a necessity of a new investigation method, contradicting with previously stated idea is the most important logical process that revealed in this part of the episode. After Melis’s statement, Nur continued the discussion by suggesting a new method “I think we should show every species that we found to each other”. In the next turn, group members agreed on Melis and Nur and they began to investigate and count the species by the way that Nur and Melis proposed.

Episode 3: Classifying the living things according to their distinctive features

In the third episode the PSTs began to classify living things according to their distinctive features after determining the method of investigation process in second episode. The episode was initiated by Melis, “I found a grass like thing (showed her group members), I am counting it, do not write it again”. During this part of the episode, the PSTs negotiated about the name of these living things. The typical excerpt from this part is presented in Table 4.1. In the third episode, as seen from the excerpt the PSTs generally negotiated about the type and the name of the living things and generally they persuaded each other by using the knowledge derived from their everyday experiences.

Table 4.1 An analytic map of the PSTs around the theme of determining a living thing (the transcript has been translated from Turkish to English)

Name	**Transcribed discourse**	**Discourse moves**	**Logical processes**	**Nature of explanation**	**Cognitive strategies**
Melis	Hey, look at this	Initiating			
Ekin	Yes, it is like seaweed	Continuing			
Hale	I saw the greens one of it	Continuing		Everyday explanation	Using everyday knowledge
Esin	Yes, these are dried forms of it	Agree		Everyday explanation	Using everyday knowledge
Ekin	Yes they flourished above the rocks	Extending	Advancing Evidence		Using Evidence
Nur	Ok. We call them land moss	Concluding			

When the level and nature of the PSTs’ participation in social explanation-construction process while dealing with whole week’s task is considered, the analysis conducted by using analytic tool demonstrate demonstrates that each PST had different approaches and strategies while dealing with an environmental problem. The PSTs also have different approaches while dealing with different issues in the same context. Each category analysis of the analytic framework was given in detailed in below sections.

Discourse Moves

Table 4.2 shows the distribution of discourse moves among the PSTs during the biological diversity field activity. The data reveals that the PSTs discourse moves are generally characterized by continuation and agreeing. During social group discussions the PSTs generally contributed to group discussions by agreeing on previously stated ideas rather than elaborating the statements by looking at them from different perspectives. In general the PSTs simply preferred agreeing on the other group members' views rather than discussing on the problematic cases and concluding discussions with clear and persuasive statements. The data also indicated that the PSTs did not prefer to refer back the science knowledge that they have learned previously. Moreover, the data show that the PSTs' patterns of discourse moves did not follow a certain path in that week. In other words, being active in discourse moves may not be an indication of showing the every aspect of the discourse moves. On the contrary for environmental knowledge, it was observed that more silent participants can propose more critical turns that makes other participants listeners. The reason of this situation is that since biological diversity is a familiar concept for the PSTs, they did not need to critically think the scientific reasons behind the cases for proposing any conversational turns. Although, Melis seems a silent participant in comparison with Ekin and Esin, she intervene group discussion during the most crucial points by extending and refer backing. The same situation is also acceptable for Nur, she is also one of the silent participants of the group but she generally proposes statements at crucial points by extending the discussion. The evidences supporting this situation were also emerged in the other weeks' collaborative knowledge constructions data. The discourse moves data also shows that since the PSTs generally preferred to use everyday knowledge, they could not be able to conclude the discussions related with environmental problems with clear and scientific statements.

Table 4.2 Discourse moves (N=244) and their distribution among the group members

Name	Discourse Moves								
	Initiating	Continuing	Extending	Referring back	Agreeing/ Disagreeing	Replying	Commenting	Concluding	Total
Melis	13	13	4	2	6	2	4	0	44
Hale	4	3	3	0	11	0	4	0	25
Esin	9	22	6	1	15	1	10	4	68
Ekin	6	17	12	0	18	2	4	4	63
Nur	7	9	6	0	11	2	7	2	44
Total	39	64	31	3	61	7	29	10	244

Logical Processes

Table 4.3 demonstrates the nature of the PSTs' logical processes in their discussions during biological diversity field activity.

Table 4.3 The nature of logical processes (N=104) in the students' discourse

Name	Logical Processes						
	Proposes a cause	Proposes a result	Advances evidence	Suggests a method	Evaluates	Contradicts	Total
Melis	3	1	7	12	0	1	24
Hale	0	2	2	1	0	1	06
Esin	8	0	7	7	0	1	23
Ekin	10	5	10	5	1	1	32
Nur	4	1	3	8	3	0	19
Total	25	9	29	33	4	4	104

The data demonstrate that the PSTs generally proposed causes, advanced evidence, and suggested a method. Since in this field activity the PSTs tried to determine a process to test their hypothesis, they generally discussed on suitable methods and they suggested different methods of investigation to other group members. So the high frequency of suggesting method is not related with the PSTs' use of environmental knowledge. The data also showed that the PSTs discussions were not evaluative. It actually means that, since PSTs thought that biological diversity is a familiar term and they can easily use their everyday knowledge, they did not need to consider scientific knowledge while making their decisions; in turn they did not criticize the cases that they experienced during the field. In other words, when we look at the logical processes, one can say that advancing evidences, evaluates knowledge, and providing contradicting ideas need effective use of environmental knowledge. According to socio-cultural theory, in social groups knowledge is reorganized, after the idea is proposed to the group and evaluating the acceptability of the idea. The data revealed that since the PSTs could not consider environmental knowledge by considering its all aspects, they could not be aware of any wrong information about the environmental issue so in turn they did not contradict with any proposed idea.

Nature of Explanations

Table 4.4 presents the nature of the PSTs' explanations during group discussions in biological diversity field investigation.

Table 4.4 The nature of explanations (N=95) and their distribution among group members

Name	Nature of explanations				
	Descriptive explanation	Causal explanation	Everyday explanation	Formal explanation	Total
Melis	7	3	5	1	16
Hale	1	2	4	0	7
Esin	8	4	10	0	22
Ekin	8	17	8	0	33
Nur	2	6	8	1	17
Total	26	32	35	2	95

In general PSTs used everyday explanations while expressing their thoughts. Besides everyday explanations the data revealed that the PSTs preferred to give causal explanations in order to defend their opinions. Although giving causal explanations seems one step beyond everyday explanation, the PSTs gave causes based on their everyday experiences rather than based on scientific grounds. Only two PSTs proposed formal explanations during discussions but the frequency of usage of formal explanation was lower than the other types of explanations. Of all 95 explanations only two explanations include formal explanations. The data also indicated that some of the PSTs were not likely to give explanations about biological diversity during group discussions. The inferences that have been drawn from above tables are also supported with the data presented in Table 4.4.

Furthermore, the data revealed that since the concept of biological diversity has been a familiar concept for the PSTs, using everyday knowledge while explaining the related cases with biological diversity did not make the PSTs to feel themselves uncomfortable about not to using their science knowledge. Owing to the fact that they could not refer back the science knowledge that they gained through basic physics, chemistry and biology courses, they could not integrate science knowledge in to environmental cases that they dealt with; in turn, they could not construct environmental knowledge as it should be and they followed a haphazard investigation process.

Cognitive strategies

Table 4.5 illustrates the frequencies of cognitive strategies that the PSTs used during the group discussion in field trip. The data show that the strategies used during the group discussions were not student-specific. Generally all PSTs prefer to use everyday knowledge while trying to conceptualizing environmental knowledge related to biological diversity. Although the PSTs had necessary background scientific knowledge, they could not apply any biological, physical and chemical principle to an existing environmental case. While posing their questions and using evidences they generally preferred to use their everyday knowledge. Rather than thinking the principle lying behind the environmental case, the PSTs preferred to use everyday knowledge while conceptualizing an event. Since the PSTs preferred to accept other groups' member ideas, rather than conceptualizing the environmental concepts deeply, they did not need to question the ideas proposed by other group members and so they did not construct any questions which reflection existence of negotiation of shared meanings. The last part of the data analysis in biological diversity field week also strengthened the inferences that have been proposed in the above sections.

Table 4.5 Cognitive strategies (N=110) and their distribution among the group members

Name	Cognitive strategy					
	Constructing a question	Raising a new question	Using evidence	Applying a principle to a case	Using everyday knowledge	Total
Melis	5	0	3	0	10	18
Hale	0	0	4	0	2	6
Esin	3	4	5	0	17	29
Ekin	4	0	9	1	26	40
Nur	0	0	0	2	15	17
Total	12	4	21	3	70	110

4.1.1.2 Discussion Week

In biological diversity discussion week, the analysis of PSTs' discourse revealed five thematic episodes in the construction of an explanation for biological diversity. The conceptual episode themes are:

Episode 1: human activities that affect selected area,

Episode 2: the effects of human activity on biological diversity in Eymir Lake ecosystem,

Episode 3: hypothesis testability,

Episode 4: rewriting their hypothesis,

Episode 5: the precaution that should be taken for protecting biodiversity in Eymir Lake ecosystem.

The analysis of cased-based episodes revealed that the PSTs in discussion week mainly dealt with the scientific investigation process rather than the conceptual understanding of environmental problems. In discussion week the thematic episodes that the PSTs focused around were generally directed and supported by facilitator's content specific support and open-ended questions. The detailed information and explanations related to each episode were given below.

Episode 1: Human activities that affect selected area

In episode 1, the PSTs tried to find which human activities affect the area that they selected. This episode suggested that at the beginning of discussion week, the PSTs simply accepted the human activities that they determined in field week. The episode is initiated by Ekin "the area (she referred the area that they investigated in field week) was affected by human activities because there were a restroom and a store" by proposing cause. In the next turn Nur continued the discussion again by referring the same area "there was also tear skits" by advancing evidence. After Nur's and Ekin's turns, Hale and Esin continued the discussion by proposing similar causes as Nur and Ekin. While determining the human activities in the selected area, all of the PSTs only used knowledge derived from their everyday experiences. They did not give any scientific principle and scientific evidence while explaining the reasons why they thought that the area was affected by human activities. The PSTs in this episode still accepted proposed ideas in the field work without thinking any scientifically related knowledge. In that episode facilitator did not interfere with the discussion process because she wanted to see how strongly they relied on their everyday knowledge and experiences.

Episode 2: The effects of human activity on biological diversity in Eymir Lake ecosystem

In episode 2, the PSTs evaluated the effect of human activities on biological diversity of Eymir Lake Ecosystem. Ekin initiated the episode by proposing a result "there was no rubbish around the area", according to her, there is no rubbish around the area, since people have regularly cleaned the area. In the following turn, Melis extended the discussion by proposing a result by again using everyday explanation "the plants do not grow". In this episode, the cased-based analysis revealed that the PSTs had difficulties in considering the effects of different human activities, i.e. they could not be aware that a restaurant building and a road have different effects on biological diversity in the Eymir Lake. At this point the facilitator gave direction to the discussion by giving necessary content-specific support including the concepts of habitat degradation, habitat fragmentation and habitat loss to the PSTs for mediating their knowledge construction processes and increasing their conceptualization of environmental knowledge. The content-specific support helped the PSTs to evaluate the effects of different human activities on environment in a more interrogative manner. In light of the provided content-specific knowledge the episode was continued by Esin. She initiated the discussion by proposing a cause "a building and a road have different effects on biological diversity since the road increases the frequency of human existence so the road has more destructive effects on biodiversity than a constructing a building". Her statement showed that she still insists on to use everyday knowledge and refuses to think the scientific principles and concepts while explaining the effects of human activities on biodiversity. Although Esin preferred to use everyday explanations, the other PSTs had great effort to use newly introduced scientific concepts and use formal explanations rather than everyday explanations. The discussions in the second episode also showed that the PSTs had potential to link the scientific principles and knowledge to the environmental problems related to biodiversity in Eymir Lake after the facilitator's support. Otherwise they did not need to look for scientific reasons behind environmental problems. It was concluded that in construction of explanations regarding environmental issues the PSTs are needed to be given direction and necessary encouragement with respect to which type of environmental knowledge they need to use.

Episode 3: hypothesis testability

In episode 3, the facilitator leaded the PSTs to concentrate on the theme around whether their hypothesis is testable or not. With this action facilitator aimed to make the PSTs to discuss on their hypothesis testability by considering the newly introduced scientific concepts that given to them during the previous episode. Melis initiated the episode by proposing a cause “since we selected the areas from the same side of the road, we could not test the effect of habitat fragmentation”. As seen from Melis’s causal explanation, she tried to use the scientific concepts while considering the hypothesis teastability related to the human effects on biodiversity. After Melis’s turn, instead of elaborating Melis’s point of view, Ekin confined only by agreeing her. In this episode, the PSTs began questioning of their process and methods in a more scientific way and started to be aware of the inconsistencies in their investigation process. Due to this reason in this episode the PSTs frequently constructed questions that related to their contradictions and evaluations which showed that there was a negation of meaning, an important prerequisite for knowledge construction. After harsh discussions among the PSTs, in this episode they understood that their hypothesis is too general to test and they could only test the effect of habitat degradation on biological diversity. While deciding this, the PSTs generally used formal explanations including an application of scientific principle in order to support their opinions. For example, Ekin in one of her turn extended the discussion by proposing a cause with formal explanations “we did not test the effect of habitat loss on biological diversity since there is not any area around us facing with the habitat loss problem, except from the road the ecosystem in Eymir Lake generally affected by habitat degradation". In this episode, the PSTs realized that since they did not consider scientific principles behind biological diversity, they could not evaluate the circumstances around Eymir Lake deeply, so they could not be able to conduct logical scientific investigation process in order to test their hypothesis.

Episode 4: rewriting their hypothesis

In Episode 4, after the PSTs determined their hypothesis actually is not testable, they tried to rewrite their hypothesis by considering newly learned environmental concepts and the inconsistencies of their design. Ekin initiated the episode by proposing a result "then, we can say that the biological diversity will increase with the decreasing habitat degradation". In the next turn Melis found her acceptance of Ekin's idea but then she asserted her disagreement by proposing a cause "no, it still not testable since we should include that the more human activity, the more habitat degradation". After Melis's turn, Hale asserted her disagreement by proposing a cause, "but we did not test it". After Hale, Ekin extended the discussion by proposing a satisfactory cause delivered with formal explanation, "biodiversity is our responding variable so we should include it to our hypothesis". These discussions among the PSTs showed that, in this episode there was a sound discussion among the PSTs. Episode 4 was the only episode that all of the PSTs made contribution to the group discussions with an enthusiastic manner. In this episode, since all of the PSTs conceptualized the scientific background lying behind the biological diversity, they took scientific principles and formal explanations in to account while delivering their statements. In this episode, with the content-specific support of facilitator, parallel with their explanations' nature, the PSTs could also use scientific causes and evidences in order to support their views.

Episode 5: the precaution that should be taken for protecting biodiversity in Eymir Lake ecosystem.

The last episode in this discussion week highlighted the PSTs evaluation of the precautions that should be taken for protecting biodiversity in Eymir Lake ecosystem. This episode began after all of the PSTs conceptualized the term biological diversity as a science concept. This episode was started with Esin. Esin initiated the discussion by suggesting a method derived from her everyday knowledge "I think we should fill the lake so people will not prefer to come there". Nur continued the move by again suggesting a method "I think the most important act that we should do is preventing the actions that resulted in habitat loss". In that statement since she knew that habitat loss affects biodiversity more drastically than habitat degradation and fragmentation, it can be said that she applied a principle while considering possible precautions. The data also revealed that in this episode the PSTs did not have any problem while suggesting precautious actions. Although the PSTs used both everyday knowledge and scientific principles in their methods, they generally have tendency to extend previously stated opinion rather than only continuing. This inference revealed that in consistent with the content-specific support of facilitator; the PSTs began to elaborate their conceptions about biological diversity and reflected this in to their discourses and explanations. But since biological diversity is a familiar term for the PSTs, after this support they sometimes still continued to use everyday knowledge by dealing with an environmental case.

When the level and nature the PSTs' participation in social explanation-construction process was considered, the analysis demonstrated that although there was not any difference between the PSTs discourse moves, they used logical processes and cognitive strategies more than they used in the field. This difference could be explained by the facilitator's content specific science support during the discussion.

Discourse moves

Table 4.6 reveals the distribution of discourse moves among the PSTs during the biological diversity discussion activity. The data shows that the discourse among the PSTs is collaborative and as same with field activity characterized by continuing, extending and agreeing. Although the PSTs still had tendencies to continue and agree previously stated idea, the frequency of continuing and agreeing moves is lower than in field week. After facilitator scientific knowledge support the PSTs became aware of the fact that, in order to make decision and discuss on biological diversity using scientific knowledge is necessary and they began to elaborate previously stated idea. The data also reveals that, the extending moves in the discussion week are more than in the field week. The data also revealed that although all PSTs joined the group discussions eagerly, Ekin and Melis were still more active and enthusiastic in terms of making contributions to group discussion than the other group members especially Hale and Esin.

Table 4.6 Discourse moves (N=262) and their distribution among the group members

Name	Discourse Moves								
	Initiating	Continuing	Extending	Referring back	Agreeing/ Disagreeing	Replying	Commenting	Concluding	Total
Melis	0	18	20	1	7	6	5	2	59
Hale	0	14	4	6	4	1	1	0	30
Esin	3	14	9	1	7	0	0	3	37
Ekin	8	22	17	2	10	8	8	3	78
Nur	5	17	14	3	9	4	4	2	58
Total	16	85	64	13	37	19	18	10	262

Logical processes

Table 4.7 demonstrates the nature of the PSTs' logical processes in their discussions during biological diversity discussion activity. The data analysis reveals that the PSTs in group generally proposed cause, result, and methods. With the content-specific support of facilitator, PSTs began to elaborate their conceptions about biological diversity in turn they could internalize the environmental knowledge deeply. Due to this reason, the PSTs could able to consider the causes of biodiversity loss and possible results of this problem. When the logical processes that the PSTs used in field and discussion weeks are compared, it has been seen that PSTs in discussion week proposed more causes and results than in field week. The PSTs generally do not evaluate the ideas proposed by their group members and so they do not contradict with their ideas. Among all PSTs, Melis seems to contribute the discussion by using all logical processes in a balanced way. She is the PST that evaluates the other group members' opinions and contradicts with them. With the content specific support of facilitator, the PSTs used more logical processes compared to the field week while continuing the discussion processes in discussion week. Due to the fact that, with these supports the PSTs could construct knowledge by deeply understanding the concept of biological diversity.

Table 4.7 The nature of logical processes (N=176) in the students' discourse

Name	Logical Processes					
	Proposes a cause	Proposes a result	Advances evidence	Suggests a method	Evaluates	Contradicts	Total
Melis	11	12	0	8	5	4	40
Hale	4	8	2	4	1	1	20
Esin	8	10	2	4	0	1	25
Ekin	17	21	4	8	1	2	53
Nur	9	15	1	12	1	0	38
Total	49	66	9	36	8	8	176

Nature of explanations

Table 4.8 shows the nature of the PSTs' explanations during group discussions in biological diversity classroom discussion. Although the PSTs proposed more formal explanations in discussion week than in field week, since biological diversity is a familiar concept for the PSTs, sometimes during the discussion they still preferred to use everyday explanations while expressing their thoughts. Although the PSTs' everyday explanations still protects its first order, there is an increase in the PSTs' formal explanations. After facilitator science support, the PSTs try to use scientific knowledge in their explanations. They also supported their views with more scientific causes rather than everyday ones. The analysis of nature of explanations revealed that in order to integrate science knowledge in to environmental knowledge, the PSTs should be supported by facilitator. The knowledge gained through field activities can be insufficient without the complimentary classroom activity in order to foster the PSTs' environmental knowledge constructions.

Table 4.8 The nature of explanations (N=164) and their distribution among group members

Name	Nature of explanations				
	Descriptive explanation	Causal explanation	Everyday explanation	Formal explanation	Total
Melis	4	18	11	7	40
Hale	6	2	3	5	16
Esin	6	11	7	2	26
Ekin	5	23	12	11	51
Nur	1	12	8	10	31
Total	22	66	41	35	164

Cognitive strategies

Table 4.9 presents the frequencies of cognitive strategies that the PSTs use during the group discussion in classroom. The data revealed that rather than constructing questions from new perspectives throughout the discourse process, the PSTs posed sub-questions during the discussion week and can apply a scientific principle to a case more in discussion week. Although PSTs still used everyday knowledge while considering the biological diversity, there had been an increasing tendency among the PSTs for applying a scientific principle to an existing case as a result of content-specific support of facilitator. The increase in application of principle to case as a cognitive strategy is due to both related with environmental knowledge and scientific process considerations. Since the PSTs after facilitator support became aware of the fact that they had conducted an ill-structured investigation process in field activity, the PSTs also used principles related their scientific experimentation process besides evaluating the issues related biological diversity.

Table 4.9 Cognitive strategies (N=173) and their distribution among the group members

Name	Cognitive strategy					
	Constructing a question	Raising a new question	Using evidence	Applying a principle to a case	Using everyday knowledge	Total
Melis	0	5	2	18	18	43
Hale	0	3	1	11	6	21
Esin	0	2	2	7	17	28
Ekin	0	4	2	30	17	53
Nur	0	1	0	18	9	28
Total	0	15	7	84	67	173

4.1.2 Surface Waters

The data gathered from surface waters learning task were given in two sections. In the first section the results of field week were given and in the second section the results of discussion week were given.

4.1.2.1 Field Week

In surface waters field week, the analysis of the PSTs' discourse reveals two thematic episodes in the construction of an explanation for surface waters. The thematic episodes are;

Episode 1: determining the factors affecting surface waters' quality parameters in Eymir Lake by examining the circumstances of Eymir Lake Ecosystem and constructing the hypothesis revealing the relationship between determined factors and surface waters' quality parameters,

Episode 2: determining the most appropriate areas to make in-situ measurements in order to test their hypothesis.

The detailed information about the episodes was given below.

Episode 1: determining the factors affecting surface waters' quality parameters in Eymir Lake by examining the circumstances of Eymir Lake Ecosystem and constructing the hypothesis revealing the relationship between determined factors and surface waters' quality parameters

In episode 1, the PSTs tried to determine the factors affecting Eymir Lake surface waters' parameters. As surface waters' quality parameters, in that learning task activity the PSTs dealt with pH, dissolved oxygen (DO) and temperature of the water. A guideline that explains the surface waters quality parameters and the factors affect them was delivered to PSTs before the investigation process. The PSTs were expected from this field activity was to determine which factors may have influence on Eymir Lake surface waters quality by combining the delivered information and

Eymir Lake circumstances. So in this field trip activity in order to decide the factors, the PSTs should examine the restaurants and entertainment places around the Eymir Lake. The episode was initiated by Ekin by suggesting a method, "ok then, let consider sewage discharge for DO. The restaurants absolutely throw their dirtiness to the lake". Ekin's everyday explanation shows that she thought polluted water as a simple concept that is similar with an unclean house. Melis extended the discussion by suggesting method "by this way we can select areas easily, near the restaurant and far from the restaurant". In her turn, Melis was seemed to be concerned about the scientific investigation process and she automatically applied principles in order to test their hypothesis in a right and scientific way. In the next turn Esin asserted her agreement to other PSTs "I also think that sewage discharge is really a good factor to test". After they decided that sewage discharge was a suitable factor for them to observe its effects in Eymir Lake waters' DO value, they began to construct hypothesis revealing the relationship between sewage discharge and DO of water. Esin initiated the process of hypothesis construction "now we should construct a hypothesis". Ekin continued the discussion by asserting a result "the more sewage discharge, the less DO". After Ekin's turn Hale extended the discussion by suggesting a method "I wish I could have a chance to observe microorganisms in the water. In that case, we would make more accurate conclusions by this way". From Hale's statement it is easily seen that she delivered her idea by using ecological principles for gathering more logical scientific investigation processes and so more accurate conclusions with a formal explanation. After they construct their hypotheses in this field activity while planning their scientific investigation processes in order to determine the human effect on Eymir Lake's surface water quality parameters, the PSTs negotiate on experimentation process and constant variables deeply. The PSTs in this field activity were more careful about the design of the experimentation process since they had experienced some problems caused by the inappropriate experimentation design.

Episode 2: determining the most appropriate areas to make in-situ measurements in order to test their hypothesis.

In episode 2, the PSTs concentrated on selecting the areas that they make in-situ measurements in order to test the effect of human activity on surface waters' quality parameters. In this field activity, the PSTs were expected to select two areas; one is affected by human activity and one is not affected by human activity. The PSTs should select two areas in order to determine how surface water quality parameters are changed. Ekin initiated the episode by advancing evidence "there is a bad smell here". In the next turn Melis continued again by advancing evidence with a causal explanation "I think the green like things show that the area is dirty". While giving her explanations she referred to green algae by saying green like things, but she was not aware of the fact that algal bloom is an indicator of water pollution", so we cannot say that they she applied a scientific principle to this case. In the next turns, Hale continues by asserting causal explanation "but we do not know whether the green things are indicator of water pollution". After Hale, Ekin continued the discussion by suggesting method with an explanation derived from her everyday experiences "I think people definitely picnic here and throw their rubbish in to the lake". After Ekin's this statement Nur agreed her by advancing evidence "yes you are right, look there is bottle there so there was human here". In the last two statements, it is easily shown that the PSTs mostly used everyday explanations while determining polluted area. After Ekin and Nur the group agreed on the area and began to make their in-situ measurements.

When the level and nature the PSTs participation in social explanation-construction process is considered, the analysis of data demonstrates that the PSTs' discourse moves decreases from 244 to 159 as compared to biological diversity field trip activity. The PSTs could not talk about surface waters quality parameters since the concept of surface waters is one of the environmental concepts that they did not have any knowledge gained through their everyday explanations. So they could not talk randomly by using their everyday knowledge.

Discourse moves

Table 4.10 shows specifically the distribution of discourse moves among the PSTs. The data reveals that the PSTs could not talk about the concept of surface waters parameters since they did not have everyday knowledge about this concept so they could not initiate random discussions and do comments about this concept. In this field activity the PSTs' discourses again generally based on continuing and agreeing moves. The data also illustrated that the PSTs could not assert clear and scientific outcomes in order to conclude the episodes.

Table 4.10 Discourse moves (N=159) and their distribution among the group members

Name	Discourse Moves								
	Initiating	Continuing	Extending	Referring back	Agreeing/ Disagreeing	Replying	Commenting	Concluding	Total
Melis	0	12	3	1	4	6	0	2	28
Hale	2	13	5	0	4	6	2	1	33
Esin	2	16	3	0	4	3	3	1	32
Ekin	2	14	10	1	7	1	2	0	37
Nur	0	11	5	0	8	2	3	0	29
Total	6	66	26	2	27	18	10	4	159

Logical processes

Table 4.11 demonstrates the nature of the PSTs' logical processes in their discussions during surface waters field activity. The data reveals that the group discourse was generally based on suggesting method. In this field trip activity PSTs concentrated on the scientific investigation process deeply and suggest more methods for keeping other variables stable in order to see the relationship between human effect and surface waters' parameters. So in surface waters field activity the PSTs suggests method more than in biological diversity field week. Since the PSTs dealt with scientific investigation process deeply they asserted more statements including cause-effect relationships. The data also reveals that PSTs did not contradict with other group members' idea and evaluate the cases during they faced in field activity. They have some contradicting ideas with other group members some time, but they resolve them in a short time. In general, the analysis of logical processes revealed that since surface waters concept is not familiar concept for the PSTs, they could not delivered explanations that do not have scientific bases.

Table 4.11 The nature of logical processes (N=89) in the students' discourse

Name	Logical Processes						
	Proposes a cause	Proposes a result	Advances evidence	Suggests a method	Evaluates	Contradicts	Total
Melis	1	3	1	8	1	0	14
Hale	2	2	2	10	0	0	16
Esin	8	3	2	5	1	1	20
Ekin	5	6	5	7	0	2	25
Nur	2	4	1	6	0	1	14
Total	18	18	11	36	2	4	89

Nature of explanation

Table 4.12 reveals the nature of the PSTs' explanations during field activity. In this field activity since the concept of surface waters' quality parameters is unfamiliar to PSTs they could not deliver everyday explanations by using the knowledge derived from their everyday experiences. The data reveals that after biological diversity field activity, in that field, PSTs were more cautious about designing more scientific experimentation process. So they considered the principles lying behind scientific investigation process while shaping their scientific design and they delivered their thoughts and ideas with formal explanations. Even the less frequency of using comments, concluding and evaluative statements supports that the PSTs have problems about scientific knowledge related with the concept of surface waters parameters.

Table 4.12 The nature of explanations (N=63) and their distribution among group members

Name	Nature of explanations				
	Descriptive explanation	Causal explanation	Everyday explanation	Formal explanation	Total
Melis	3	3	5	1	12
Hale	1	3	3	8	15
Esin	0	7	3	0	10
Ekin	2	8	5	3	18
Nur	1	0	4	3	8
Total	7	21	20	15	63

Cognitive strategies

Table 4.13 points out the cognitive strategies that the PSTs used during the surface waters field activity discussion. The data shows that as it is mentioned before since the concept is not familiar for PSTs, there is a significant decrease in using everyday knowledge among PSTs. In this field activity it is seen that, since the PSTs could not delivered their everyday knowledge they were seemed to be silent than the biological diversity week during the discussions. So due to this reason they could not pose questions in a random way.

Table 4.13 Cognitive strategies (N=62) and their distribution among the group members

Name	Cognitive strategy					
	Constructing a question	Raising a new question	Using evidence	Applying a principle to a case	Using everyday knowledge	Total
Melis	0	0	3	1	4	8
Hale	0	2	2	4	2	10
Esin	2	2	2	4	4	14
Ekin	0	1	4	6	8	19
Nur	0	3	2	3	3	11
Total	2	8	13	18	21	62

4.1.2.2 Discussion Week

In surface waters discussion week, the analysis of the PSTs' discourse reveals four thematic episodes in the construction of an explanation for surface waters. The PSTs again were leaded by facilitator as in biological diversity discussion week. The conceptual themes were;

Episode 1: determining the effect of sewage discharge on surface waters' quality parameters; pH, DO, temperature based on experimental work in field,

Episode 2: hypothesis testability,

Episode 3: determining the water quality class of Eymir Lake based on the experimental work, Episode 4: constructing a relation between quality of water and quality of daily life.

Each episode was explained with details below.

Episode 1: determining the effect of sewage discharge on surface waters' quality parameters; pH, DO, temperature based on experimental work in field

In the first episode, based on their experimental work and measurement in the field, the PSTs determine the effect of sewage discharge on quality parameters of Eymir Lake. The episode was initiated by Hale by proposing a cause "we expected pH will be acidic since the discharge from community includes acidic chemicals". In the next turn Esin continued the discussion with her everyday explanation "we said generally the cleaning material make water acidic". Hale asserted her disagreement to them by posing a question "why do we say that cleaning materials are acidic?" The PSTs in this episode generally used causal explanations rather than everyday ones in order to support their views. They used their measurement results while determining how quality parameters have been affected from human activity specifically sewage discharge. Since in this learning task surface waters quality concept is not familiar to PSTs, they could not make everyday explanations during discussion.

Episode 2: hypothesis testability

In the second episode, the PSTs concentrate on their hypothesis testability. In the field activity as I mentioned before, the PSTs put emphasis on the design of experimentation process with a more scientific manner. The PSTs fixed all the other variables stable in order to clarify the relationship between sewage discharge and surface waters' quality parameters. The episode was initiated by Esin. She delivered her thought by proposing a cause "I think it is testable since we construct it by considering everything". Although in her statement she used a causal sentence for supporting her view she did not give any clear cause. In the next turn, Hale extended the discussion by proposing a cause "I think our hypothesis is testable but we could not test it since we could not reach the deeper sides of the lake". After Hale statements, Melis asserted her disagreement with a formal explanation and by explaining a principle why depth was not so important "but we even kept the depth of water constant so the depth of the water did not affect the measurements that we make". In this episode the PSTs generally gave formal explanations and used evidences while discussing on their scientific experimentation process. Since in this episode they could not explain the phenomenon by using their everyday knowledge, they were obliged to use the data and evidences they gathered during the field investigation. And this situation forced the PSTs to consider scientific concepts and principles behind the environmental phenomena and cases.

Episode 3: determining the water quality class of Eymir Lake based on the experimental work

In the third episode PSTs negotiated about the quality class of Eymir Lake water, by comparing their data and the surface waters quality indexes. The episode was initiated by Esin. She suggested a method "I think we should first look at its pH value". And they easily fit their pH value with the value in a class. While considering the data PSTs had a trouble to fit their temperature value to the values given in the surface waters quality index. Esin continued the discussion by proposing a result "our temperature value is 9 and it does not fit anywhere". In the next turn Ekin continued by proposing a sub question "so, it means, is it too bad?" Nur replied Ekin by proposing a cause "I think it may be due to the seasonal changes". After Nur's this statement the problem was resolved and PSTs understood the reason. This situation also enabled the PSTs to see the sampling processes conducted in order to construct these types of environmental indexes. In this episode after the PSTs determined the quality class of Eymir Lake as polluted water, they automatically compared how quality parameters change from clean to polluted water. During this discussion the facilitator came to the scene and gave the key scientific term (eutrophication) to the PSTs. After this support, the PSTs automatically understood that the green like things were photosynthetic green algae and they are indicator of water pollution. From that point the PSTs discussed on why eutrophication resulted in algal bloom and what might be the outcomes that were caused by algal bloom. Ekin initiated the discussion by proposing a cause with formal explanation "since they produce carbon dioxide, CO_2, more than oxygen, O_2, they make the water acidic". Esin continues by proposing a result "and they use O_2 in the water". In this episode the PSTs could not be able to determine effects of algal bloom on water quality parameters. So the discussions were generally supported by facilitator; the facilitator proposed content-specific knowledge for resolving the conflicts in group discussions in order to sustaining the group discussion's continuity. Although the PSTs had learned the concept of eutrophication through their basic biology course, they could not integrate that knowledge while thinking water pollution without the support of facilitator. But after facilitator linked the relationship between the term eutrophication and water pollution, the PSTs began to negotiate the causes and results of the environmental problem deeply and begin to construct explanations.

Episode 4: constructing a relation between quality of water and quality of daily life

In the last episode, the PSTs concentrated on how the quality of water affects their daily lives. In this episode the PSTs again began to use their everyday knowledge since they experienced the consequences of a drought season lasting about two weeks in their city. In this drought season, the drinking water was given from an alternative water source to the city and the water included some chemical with higher proportions which was harmful for human life. That drought season and its effects on human life were speculated by media. Even their statements showed that they have some knowledge about this situation. The episode was initiated by

Ekin by proposing a cause with a causal explanation “the people become cancer if the quality of the water decreases since the chemicals inside the water increases”. In her statement it is easily seen that although she use causal explanation, she derived her cause from her everyday experiences. Melis in the next turn continued the discussion by again proposing a result with an everyday explanation that “while the quality of water decreases, the available water for people usage is decreasing”. This episode revealed that although the PSTs did not know too much about surface waters, since they had experienced such a drought season that was explained above, they could interpret the possible effects of water pollution on humanity.

When the level and nature the PSTs participation in social explanation-construction process is considered, the analysis of data demonstrates that the PSTs could not use everyday knowledge and explanations since the scientific concept is not suitable for discussion by using everyday experiences. The PSTs participated in that study, for the first time dealt with the concept of surface waters through their education. In this discussion week, the data reveals that although PSTs use less everyday explanation, they also can not evaluate the cases and conclude the episodes with clear and scientific statements.

Discourse moves

Table 4.14 demonstrates specifically the distribution of the discourse moves of PSTs while discussing surface waters. The discourses of the PSTs generally were based on continuing, extending and agreeing. After content specific support of facilitator, since the PSTs could internalize the environmental knowledge by integrating necessary scientific principles, the PSTs could elaborate their understandings about the concept of water pollution so they mostly extended previously stated idea. Differently from field week of the surface waters learning task there has been an increase in replying moves and this also indicated that the PSTs pose more questions during the discussion processes of surface waters quality parameters. In this week, the increasing frequency of extending and replying moves indicates that the support of facilitator mediates the PSTs' environmental knowledge constructions.

Table 4.14 Discourse moves (N=289) and their distribution among the group members

Name	Discourse Moves								
	Initiating	Continuing	Extending	Referring back	Agreeing/ Disagreeing	Replying	Commenting	Concluding	Total
Melis	0	16	17	0	4	5	1	2	45
Hale	1	19	4	0	6	7	6	1	44
Esin	7	35	2	0	10	9	2	2	67
Ekin	0	42	20	0	13	13	3	2	93
Nur	0	23	5	1	6	4	1	0	40
Total	8	135	48	1	39	38	13	7	289

Logical processes

Table 4.15 presents the nature of the PSTs' logical processes in their discussions during surface waters discussion activity. The [illegible]veals that the PSTs' explanations' nature is generally based on proposing [illegible] and results. This situation shows that the PSTs concentrated on possible reasons and outcomes of water pollution deeply. It is also seen in the table that the PSTs again could not propose evaluative and contradictory statements in that field activity.

Table 4.15 The nature of logical processes (N=193) in the students' discourse

Name	Logical Processes						
	Proposes a cause	Proposes a result	Advances evidence	Suggests a method	Evaluates	Contradicts	Total
Melis	12	16	3	3	1	1	36
Hale	14	12	0	5	0	2	33
Esin	10	15	2	6	2	2	37
Ekin	27	19	7	4	2	3	62
Nur	9	7	2	3	0	4	25
Total	72	69	14	21	5	12	193

Nature of explanations

Table 4.16 reveals the nature of the PSTs' explanations during classroom discussion activity. In this field activity since the concept of surface waters' quality parameters is unfamiliar to PSTs they could not deliver so much everyday explanations by using the knowledge derived from their everyday experiences. The data reveal that the nature of PSTs' explanations is generally causal. The causal explanations also related with PSTs' logical processes such as proposing cause and result.

Table 4.16 The nature of explanations (N=126) and their distribution among group members

Name	Nature of explanations				
	Descriptive explanation	Causal explanation	Everyday explanation	Formal explanation	Total
Melis	4	14	1	13	32
Hale	2	12	0	2	16
Esin	4	15	3	1	23
Ekin	5	32	3	3	43
Nur	3	8	1	0	12
Total	18	81	8	19	126

Cognitive strategies

Table 4.17 shows the distribution of cognitive strategies that the PSTs used during the surface waters discussion week.

Table 4.17 Cognitive strategies (N=119) and their distribution among the group members

Name	Cognitive strategy					
	Constructing a question	Raising a new question	Using evidence	Applying a principle to a case	Using everyday knowledge	Total
Meltem	0	3	6	16	0	25
Hale	1	4	1	5	1	12
Esin	3	6	5	5	5	24
Ekin	0	14	8	16	9	47
Nur	0	5	2	2	2	11
Total	4	32	22	44	17	119

The data reveals that PSTs can pose sub questions during discussions. This shows that PSTs questioned the cases deeply and they can form questions for deeper understanding. The data also reveals that while assessing the cases PSTs also use evidences. And in this discussion week the PSTs can use scientific principles behind the cases. Since in this week they did not deal with scientific experimentation process they only use principles related with surface waters quality parameters.

4.2 The Nature of the PSTs' Explanations in the Pre-Test and Post-Test Condition

The results of the nature of the PSTs' explanation in the pre-test and post-test conditions regarding biological diversity concept will be given in two sections. In the first section the result of the focus group will be given. And in the second section the results of the whole class data will be given.

4.2.1 Focus group

Table 4.18 highlights the nature of PSTs' explanations before and after the field-based collaborative inquiry learning task regarding biological diversity environmental issue. The data shows that Esin's explanations were practical in nature before and after the inquiry based social learning environment. Even in social science learning environment, her cognitive strategies mostly rested on everyday knowledge and she preferred to use everyday explanations in general. On the other hand, Melis as in group discussions during social science learning environment again expressed formal explanations. During the field-based collaborative inquiry learning environment Ekin, Nur and Hale changes their tendency about nature of explanations. Ekin changes her tendency from giving descriptive explanation to formal one. In group discussions Ekin mostly preferred to use everyday and formal explanations. It interesting that in pre-test condition Hale could not deliver any explanations related with biological diversity. The social learning situation and post-test conditions suggest that Ekin and Nur shifted their perspective in favor of scientific explanations.

Table 4.18 The nature of PSTs' explanations in pre-test and post-test conditions

Student	Explanations for biological diversity in pre-test condition	Explanations for biological diversity in pre-test condition
Melis	Biological diversity is important for healthy ecosystem.	Biological diversity is important. If biological diversity is decreased whole ecosystem will harm from it and may eventually be collapsed.
Definition	**Explicatory (Proposes a result)**	**Explicatory (Formal explanation)**
Hale	No explanation	Biological diversity has an importance for environment. If the biological diversity is decreased by human activities, environment will not be in balance.
Definition		**Explicatory (Proposes a cause)**
Esin	Biological diversity is important for life cycle. All components are important for the life.	The life of the living things link each other, it is important for the survival.
Definition	**Practical explanation**	**Practical explanation**
Ekin	Biological diversity provides the balance of the environment. Disappearance of a species at a place causes a change at the balance and like the dominos everything will change.	Biological diversity is very important for the environment because environment has a balance based on this diversity and as if there is a change, the equilibrium will change so that the balance will break.
Definition	**Descriptive explanation**	**Explicatory (Formal explanation)**
Nur	Having different living things in one area is a very important thing for an environment survives. If one kind of living thing would exist they would consume same thing and produce same things. So there would be no other kind to consume the produced things. And the resources would end up quickly. But biological diversity leads the produced and consumed things be in balanced in the environment.	Biological diversity is important for the environment. Because species interaction leads environment be consistent and alive.
Definition	**Descriptive explanation**	**Explicatory (Proposes a cause)**

4.2.2 Whole class

Table 4.19 presented the analysis of the whole class data. The analysis of the whole class data shows that the students' explanations for biological diversity were mainly descriptive and practical. This situation suggests that the all PSTs generally evaluating the biological diversity on the basis of their knowledge that they gather through their everyday experiences. In pre-test situation, some PSTs also could not deliver a meaningful explanation regarding biological diversity, suggesting they can not apply the principles that they gather through their basic science courses in to the concept of biological diversity.

Table 4.19 The nature of the all PSTs' explanations for dissolving in the pre-test and post-test conditions

The nature of explanation	Pre-test condition	Post-test condition
Descriptive	4	5
Practical	7	6
Explicatory		
• Proposes a result	1	4
• Proposes a cause	2	2
• Provides a formal explanation	2	4
Unrelated or no explanation	5	0
Total	21	21

The post-test results suggest that the field based collaborative inquiry learning situation enable the students the opportunity of elaborating their understandings about biological diversity. Most of the PSTs shifted their tendency in favor of a scientific and cause-effect explanations rather than everyday explanations.

CHAPTER V

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

The method chapter presents the detailed information about the discussions, conclusions drawn from the results of the study and recommendations for further studies.

5.1 Discussion

Discussion section of this chapter was divided into three parts according to the results of the study. The results of the field weeks, discussion weeks and pre-post analysis were given under three main topics. Each main finding of the study was discussed in a detailed way under these three main topics.

5.1.1 Field Weeks

5.1.1.1 Use of Everyday Explanations and Experiences

In this study the PSTs were mainly dealt with two environmental problems (biological diversity and surface waters) during four weeks period. The analysis of the episodes revealed that the PSTs were constructed more explanations in biological diversity learning task than surface waters learning task. One of our earlier predictions about this finding was that the PSTs had more knowledge especially everyday knowledge about biological diversity than surface waters. We thought that since they are more familiar with the species around them such as plants and animals, they might have more flexibility in using these everyday experiences during biodiversity learning task. Later analysis supported that our prediction was true. In biological diversity environmental task, the PSTs proposed more explanations but these explanations mostly include everyday explanations rather than scientific and formal ones. It was interesting to see how comfortable they were while using their everyday experiences in developing their hypothesis and collecting data. Although the PSTs had taken basic science courses and hold necessary formal knowledge background, they found easy to propose environmental explanations including everyday knowledge rather than scientific and formal knowledge. Besides explanations, the frequencies of discourse moves of the PSTs also favor these interpretations; while dealing with an environmental task, the PSTs seldomly referred back to science knowledge that they gained through basic science courses. Although in field activities, the PSTs used evidences and causes as a logical process, the nature of evidences and causes revealed that, they were framed based on their knowledge derived from everyday experiences. The usage of everyday explanations rather than deeply thinking the scientific dimensions of environmental problems and concepts are commonly proposed problems of EE (Arbuthnot, 1977). The situation may be due to the reason that the PSTs didn't perceived environmental knowledge as important as other science disciplines (Crawford, 2000), so they found sufficient to evaluate the environmental problems by only considering their knowledge gained through mass media (Nagel, 2004) and daily life experiences. Furthermore, owing to the fact that learners have experienced the outcomes of environmental problems in their daily life activities and have been familiar with these through mass media, the PSTs may think that environmental knowledge is derived from daily life experiences. Due to these reasons that the knowledge gained through mass media often internalized by learners in a simplistic and misleading way (Adler, 1992) and EE involves more than the current superficial information about environmental hazards provided by the media (Bolscho & Hauenschild, 2006), in field weeks the PSTs could only make haphazard environmental investigations. In Turkish context, the television news and newspapers considerably mention environmental issues such as protection of animals, alternative energy sources and global warming rather than the issues related with environmental pollution. So as expected, the PSTs have had more knowledge about biological diversity problems than surface waters pollution problem. This situation is also supported by the findings of the surface waters learning task. Since the PSTs in this study dealt with the concept of the surface waters for the first time throughout their elementary, secondary and undergraduate education, the related concepts of the surface waters can be said as a new topic for the PSTs. The PSTs in this learning task could propose fewer explanations related with environmental problems.

5.1.1.2 Quick Consensus Building

In field weeks, although the PSTs generally initiated the episodes with clear statements, they could not be able to conclude the episodes about the environmental problems with clear and scientific statements. Moreover, the data gathered from cased based analysis and from analytic tool in field weeks revealed that rather than concluding the cases by extending the previously proposed ideas and explanations, while dealing with an environmental task the PSTs simply preferred to agree on their group's members' ideas in order to continue to investigation. While dealing with environmental issues the PSTs could not integrate and relate basic science knowledge in to environmental problems and elaborate their conceptions so they tended to accept the other group's members' contributions and passed on to another case without making necessary conclusions and comments on previous ideas. This situation was a typical example of *quick consensus building* situation.

According to socio-cultural theory, in collaborative knowledge construction learners need to coordinate themselves in order to reach a common attained goal and learners need to build consensus about the task on which they worked. Quick consensus building is one of the different styles of reaching this consensus. Fischer (2001) described quick consensus building as simply accepting the contributions of learning partners' contributions in order to continue the discourse. So, quick consensus building may indicate coordinating discourse as a current purpose rather than an actual change in understanding and perspective (Roschelle & Teasley, 1995). Thus, quick consensus building should be distinguished from other types of consensuses that indicate construction of knowledge based on scientific grounds. Thus, in the context of this study, owing to the fact that the PSTs in this study can thought that environmental knowledge has been derived from daily life experiences and they could not integrate basic science knowledge in to environmental cases, they quickly accept an idea proposed by other group's members, in turn the PSTs could not construct environmental knowledge during field work. In the case of quick consensus building, since the PSTs rather than constructing environmental explanations, disregarded to elaborate environmental explanation by deeply thinking the scientific reasons of environmental problems (Keefer, Zeitz & Resnick, 2000). Since using everyday explanations seems plausible to the PSTs, after deciding on one issue about environmental problems, the PSTs did not need to think about their agreement whether it was really scientific or not. The situation of being accustomed to learn the same things from the same source of knowledge prevents the learners to search and learn environmental knowledge as it should be. Moreover, since the PSTs participated in this study throughout their elementary and secondary education they generally memorize the requirements of the courses they took (Yilmaz-Tuzun & Topcu, 2008); it is hard for the PSTs to internalize the environmental knowledge with its all aspect in this level. It seems that the lecture based and in-class university courses may also have a promotive effect on this situation.

5.1.2 Discussion Weeks

5.1.2.1 Content Specific Support of Facilitator

PSTs' perceived environmental knowledge was derived from their daily life experiences so they asserted arguments mostly supported by everyday explanations which were found to be connected with using everyday knowledge. Due to this reason in the field, they couldn't integrate science knowledge gained through biology, physics, and chemistry courses to environmental issues and since they didn't have any scientific idea about what they were doing, they couldn't demand right support from facilitator. Thus, lack of conceptualization of environmental knowledge resulted in ill-structured scientific investigations. As explained previously the difference between field weeks and discussion weeks is that, in discussion weeks while the PSTs had tried to interpret the collected data in field week, the facilitator of each group scaffolded the group discussions by giving necessary science concept necessary for evaluation of phenomena related with biological diversity and surface waters. In collaborative learning environments, acquisition of the knowledge with more competent peers creating effective learning situations by enabling learners to express, discover and construct their knowledge structures at a more abstract level (Schwartz, 1985). After facilitator's support in discussion, PSTs became aware of the interdisciplinary nature of environmental knowledge and started to conceptualize environmental issue by considering all aspects of environmental knowledge (environmental, social and economic). The discussions leaded by the facilitator in this study, forced the PSTs to think more deeply and construct explanations according to these deeper thinking process. The micro analysis of conversational turns and case-based analysis also revealed that the PSTs applied more scientific principle to the environmental in the discussion weeks than field weeks. With the help of content specific support from facilitator, the PSTs were aware of the fact that they could not continue the discussion one step forward with their everyday conceptions about environmental issues. From that stage, the PSTs forced themselves for interpretation of science knowledge into the environmental case and they began to construct explanations relied on scientific principles. Although there have been considerable evidence that informal environmental science field trip can be used effectively to advance science learning, in order to solidify some of the ideas that students developed during the field trip, the field trip activities should be followed up by classroom activities (Falk & Dierking, 2000). In the context of EE, field trip activities should be effectively incorporated with classroom activities in order to mediate learners' knowledge construction about environmental issues. As similar with the study of Hmelo-Silver (2003), the conceptualization of environmental issue in collaborative inquiry environment as in this study was realized with facilitator's content specific support since considering aspects of environment (biological, physical, social, economic and cultural) and acquiring necessary knowledge essential for actively participating environmental problem solving processes are necessary for environmental knowledge gain (UNESCO-UNEP, 1978). In this study, with the content specific support of facilitator, the PSTs became aware of the fact that they could not interpret environmental problems and could not conduct scientific experimentation process with the superficial knowledge that they gained through their everyday experiences and media. The content specific support of facilitator in classroom settings mediated the PSTs' construction of environmental knowledge by using scientific principles and cases and also in the form of formal explanations. Although active participant involvement has positively related with the effectiveness of EE, the organized classroom activities should be used to support field activities in order to improve learners' understanding in terms of environmental knowledge (Zelezny, 2001)

5.1.2.2 Peer Collaboration

The mediation of environmental construction of the PSTs in discussion weeks were also supported by the frequencies of the PSTs used logical processes. In both of the discussion weeks with the content support of facilitator, the PSTs proposed explanations including more causes and results compared with the field weeks of the learning tasks. It has been interpreted that the increased understanding of the concepts in discussion weeks, the PSTs could establish more links between the causes and results of a specific environmental phenomenon. The support of facilitator encouraged the PSTs to continue the discussion. Since the PSTs were forced to continue the discussion with the new coming environmental concepts, they proposed more causes and results by using more science concepts. The result obtained from this study revealed that the discourse processes in which each PST asserted their perspectives, interpretations and views, create a ground for collaborative construction of explanations (Teasley & Roschelle, 1993). Due to the reason that the PSTs did not give up to discuss and did not get a quick consensus building, they criticize environmental problems deeply. As opposed to a quick consensus building, in the discussion weeks the PSTs modified their initial positions by correcting themselves according to the basis of their peer and teachers' contributions. The revision and change of the PSTs' environmental explanations are an indication of integration oriented consensus building (Keefer, Zeitz & Resnick, 2000) that shows that the PSTs collaboratively construct environmental explanations by synthesizing their ideas, experience better understanding rather than mere agreement (Berkowitz & Gibbs, 1983). By the means of synthesizing they could able to set cause and effect relationships more than in the field weeks. The collaboration which exposure students with different ideologies and perspectives on the causes and solutions of environmental problems are one of the necessities that proposed in current EE programs (Palmer, 1998). The findings of this study suggested that the diverse perspectives in group discussions seemed to create ideal conditions for collaborative problem solving (Howe, Tolmie, Anderson & MacKenzie, 1992). Since the problem solving skill is one of the stated goals of EE in order to make students to participate in environmental problem solving processes (UNESCO-UNEP, 1978), these type of collaborative inquiry activities should be integrated in to science curriculums in order to foster the effectiveness of EE.

5.1.3 Pre-tests and post-tests

The pre-tests and post-test were administered to the PSTs in order to provide an environment for researchers to understand the disposition of participants in terms of how using environmental knowledge for answering the questions. The result of this study indicated that the science learning-situation, field trip collaborative inquiry environmental learning tasks, supported the PSTs' conceptual elaboration of environmental problems (Kaartinen & Kumpulainen, 2002) and created dispositions in the PSTs' explanations. The PSTs gave more focalized and in depth formal explanations with the learning activities proposed in the study. The analyses of the PSTs' pre-tests and post-tests suggested that enriched non-formal learning environments fostered the reasoning abilities of the PSTS, when combined with inquiry based instruction in the classroom. While in the pre-test condition the PSTs generally proposed explanations that based on descriptive and practical explanation, the post-test condition, they state more formal explanations that include causal relationships. So, informal science learning can facilitate the development of reasoning abilities of the PSTs that are prerequisites to learning and understanding science processes and concepts (Gerber, Cavallo, & Marek, 2001). So, it is suggested that well-designed programs for EE should include non-formal and inquiry oriented activities that includes details of the planning task, methods, style and promotes responsible environmental behavior by taking into consideration of formative influences, that is the all type of real life experiences that may affect the environmental learning process (Palmer, 1998) necessary for better construction of environmental knowledge as a science discipline. A certain form of formative influences that affects to collaborative learning environments amongst children of similar age and adults with similar values, can have a significant and positive impact upon learners' understanding and conceptualizing of issues (Palmer, 1998). This study shows that field-based collaborative inquiry can be used as an effective method for EE and factors such as facilitator support and peer collaboration have a mediatory role on environmental understandings of the PSTs.

5.2 Conclusions

In this study, firstly the environmental knowledge construction processes of the PSTs' were investigated. Secondly, the predispositions of the PSTs' explanations with field-based collaborative science learning environment were investigated.

Results of the study suggest that since in Turkish context the EE has not been integrated in elementary and secondary school curricula with an allocation of adequate place yet, the PSTs has gained this type of knowledge through basic science courses and mass media. Due to this reason, while dealing with an environmental learning task, the PSTs' contributions to group discussions generally in the form of knowledge that has been derived from their everyday experiences and has been interpreted from the media. This situation results in that the PSTs could not be able to discuss on environmental concept by considering its all aspects by their own knowledge. They could not continue the discussion in an interrogative way; they could not integrate the science knowledge in to environmental cases, so they did not need to refer back this type of knowledge while dealing with an environmental problem. Furthermore, since the PSTs did not know the exact processes behind the environmental problems, they could not realize the unscientific aspects of the proposed ideas so they were not confused by a conflict situation.

The results of this study also suggested that facilitator has an important role in mediating environmental knowledge constructions of the PSTs during field based collaborative inquiry environmental learning tasks. According to data of this study in discussion weeks with the content-specific science support of facilitator, the PSTs began to think environmental knowledge while dealing with an environmental task. The data show that in especially in the second discussion weeks the PSTs applied more scientific principles to the environmental case under investigation. Besides knowledge, in discussion weeks the PSTs also constructed explanations that lied on the scientific principles and posed questions that showed their dissatisfaction about the proposed ideas during group discussions. The PSTs in discussion weeks, also tried to conclude the episodes by organizing their discussion in a logical way. In conclusion, the result of the study suggested that without facilitators' content specific knowledge support, the PSTs could not construct environmental knowledge in the field activities. The results of this study revealed that since promoting problem solving and evaluation skills of learners in the context of EE is important; the facilitator should have skills to organize and lead the activities conducted in social science learning environments and necessary background knowledge about environmental concepts rather than not just giving environmental knowledge in an organized way. The current study also showed that the facilitator had important roles about following the PSTs in completing field tasks on time, keeping the PSTs on focus and supporting the PSTs investigation processes in field tasks. The study also revealed that the facilitator has had an important role in discussion weeks; the facilitator should monitor the social collaboration in small groups' discussions and make necessary support in order to mediate environmental knowledge construction and understanding of the PSTs. Thus, it can be said that by the means of this kind of learning activities including in-class and out-of-class activities, the learners can understand the scientific counterparts of environmental cases. And by this way the learners become able to discuss environmental knowledge with its scientific backgrounds.

Another result of this study suggested that although social collaboration has promoted the elaboration of environmental concepts of the PSTS, only by means of collaborative interaction, the PSTs could not replace everyday knowledge with formal explanations unless the necessary conditions are met. For the effective EE, the PSTs should be aware of the complex and interdisciplinary nature of EE. This situation may be the reflection of the presentation of the environmental concepts in the school curriculums and textbooks. Thus, the integration of environmental concepts in to school curriculum and textbooks may be organized through activities prepared by field based collaborative inquiry. The implementation of social learning environments including collaborative inquiry and negotiation of ideas may be a sustainable solution for effective EE (Palmer, 1998).This is achieved by implementation of learning task that makes learners to think about environmental knowledge with its all aspects. While integrating the environmental concepts in to the EE curriculum, rather than only pointing out the ecological disciplines, other aspects (physical, chemical, social, economic) of environmental problems should be given in a holistic way (UNESCO-UNEP, 1978). By this way the learners will be accustomed to use other scientific disciplines by interpreting and evaluating environmental problems so in turn the PSTs can internalize the environmental knowledge.

The results derived from pre-test and post-test data revealed that the environmental learning tasks prepared by using field-based collaborative inquiry, have provide an environment for researchers to understand the dispositions of participants in terms of how using environmental knowledge for answering the questions. While dealing with an environmental problem, the PSTs in group discussions negotiate on proposed ideas and tried to find the most logical explanation to a specific environmental case. So after conducting the learning tasks, rather than using everyday explanation for supporting their ideas, the PSTs proposed explanations mainly based on causes and results and derived from scientific principles. Thus, these results were interpreted as that the field-based collaborative inquiry environmental learning tasks has mediated the PSTs environmental explanation construction process by making them aware of the fact that interpreting environmental problems and issues is a complex issue and needs basic science knowledge in order to be understood. Due to complex and interdisciplinary nature of environmental knowledge, it should be given to learners with an organized and structured way. In this learning environment, the understandings of learners should be checked during the learning process and necessary support should be given in order to ensure improvement in environmental understandings of learners. The environmental knowledge should not be seen as similar as ecology knowledge and the teaching strategies and methods that address all aspects of the complex and multidisciplinary nature of environmental knowledge should be used for more effective EE. In this study, the environmental knowledge was given to learners with an inquiry oriented approach in which learners could elaborate the skills such as constructing hypothesis, data collection, interpreting data, etc. (Crawford, 2000). The teachers should use of everyday knowledge during teaching processes of environmental knowledge very carefully in order to prevent learners to think environmental knowledge is simple and related with science. The knowledge derived from daily life experienced should be controlled in a way to support learners' construction of more formal explanations.

5.3 Recommendations for further study

This study has suggested variety of useful topics for further studies. Since effective EE should begin from early ages, the similar study can be conducted with a sample from different grade levels including pre-school, elementary and middle schools. The results of the study may also differed by the knowledge levels of learners, so the similar study can be conducted with two different samples that have different knowledge levels. Since in inquiry based collaborative learning environment the role of teacher is important, the factors that promotes the contributions of teacher in order to mediate environmental knowledge constructions of learners. Especially, the relation between self efficacy of science teachers on EE and the process of environmental knowledge can be studied for promoting conceptualization of environmental knowledge deeply. In current study field based instructional activity is integrated in to collaborative inquiry activities, the similar study can be conducted by integrating different teaching strategies in to collaborative inquiry activities in order to promote environmental constructions of the learners.

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APPENDICES

APPENDIX A

LABORATORY MANUALS

BIOLOGICAL DIVERSITY
FIELD TRIP

Assistant Name **:** .... **Date:**

Group Members **:** ...., ...,

.................................., ...,

.................................., ...

1. Introduction

The first field trip has been focused on investigating the concept of biological diversity and its relatedness with human activities.

2. Background

Millions of different species of plants, animals, fungi and microorganisms that lives in an ecosystem is part of the web of life including humans. Each species of vegetation and each creature have a place on the earth and play a vital role in the circle of life. The activities of all these organisms together maintain the atmosphere, develop new soils, break down wastes, store and filter water, pollinate our crop, provide us with food, and protect us from disease. This biological diversity provides the basic necessities of life for all living things. However, in the last century human activities have greatly influenced this natural process in a negative way with the loss of biological diversity. As a result, it is crucial to have a clear understanding of biological diversity and effects of human activities on it.

According to World Resources Institute, World Conservation Union, and United Nations Environment Programme (1992), biological diversity is totality of genes, species, and ecosystems in a region. It involves three different concepts.

1. Genetic diversity (the diversity of genetic characteristics within a population or species)
2. Ecosystem diversity (the diversity of ecosystems in a given unit area)
3. Species diversity
    a. Species richness (the total number of species)
    b. Species evenness (the relative abundance with which each species is represented in an area)
    c. Species dominance (the most abundant species)

Regarding to the target of the first field trip to Eymir Lake, it is planned to measure and evaluate biological diversity in Eymir Lake. Although there are three concepts of biological diversity, in this field trip only species richness will be taken into account to make inferences about biological diversity.

Species richness monitoring:

- Select 2x2 meter squares area.
- Count the number of species (not the number of individuals) in the area.

Tip **:** To gather in depth data the area can be divided into smaller areas, each of which can be examined with different group member.
Note : It is important to identify the number of different species rather than identifying species' name.

Be Careful!!! Before going to field, do not forget to determine the laboratory materials and equipments that you may need in the field while collecting data.

Your research study should include;

1. State your group hypothesis about human effects on biological diversity.

   ....

2. Determine materials you will use

   ....

3. Describe the locations where you will collect data. Explain why you choose those areas.

   Area 1:
   ....
   Area 2:
   ....

4. Fill the table below according to your observations.

Area 1: ……………………..	The number of species belong to plant kingdom	The number of species belong to animal kingdom	The number of species belong to other kingdoms
Rough Observation			
In depth Observation			

Area 2: ……………………..	The number of species belong to plant kingdom	The number of species belong to animal kingdom	The number of species belong to other kingdoms
Rough Observation			
In depth Observation			

BIOLOGICAL DIVERSITY

DISCUSSION WEEK

Assistant Name **:** .... **Date:**

Group Members **:** ...., ..., ..., ..., ..., ...

The following questions will be answered according to your group discussion.

1. Fill the table below.

Manipulated Variable	Responding Variable	Controlled Variable

2. Which human activity did you identified as threats to biological diversity in your area?

____

3. What threatens biodiversity in the world?

____

4. What are the effects of **each** human activity on biological diversity in an ecosystem?

____

5. Was your procedure to test your hypothesis scientific? Explain your answer.

____

6. If you have a chance to test your hypothesis, how would you make your testing procedure more scientific?

____

7. What can be done to protect biodiversity in Eymir Lake ecosystem?

____

PHYSICAL AND CHEMICAL PARAMETERS IN SURFACE WATERS

FIELD TRIP

Assistant Name : .... **Date:**

Group Members : ...., ...,

.................................., ...,

.................................., ...

1. Introduction

This field trip has been designed to help to investigate the concept of surface waters and related water quality characteristics, in terms of, physical (temperature and pH) and chemical (dissolved oxygen) water quality parameters.

2. Background

2.1. Water Quality of Surface Waters

Lakes, rivers, reservoirs, ponds, etc., are termed surface waters. They receive water directly from precipitation and surface run-off. These various bodies of water also receive a portion of their total amount from underwater springs connected with the groundwater supply. The previous diagram (Groundwater Water Zones and Belts) shows how the bed of streams extends below the groundwater level.

Surface waters are generally lower in mineral content. On the other hand, they possess far more contamination and are unsafe to use for human consumption unless properly treated.

Pollution of water comes from many sources. Municipalities and industries sometimes discharge waste materials into bodies of water that are used as public sources of supply. This is a most serious source of contamination. Surface run-off also brings mud, leaves, decayed vegetation together with human and animal wastes into streams and lakes. In turn, these organic wastes cause algae and bacteria to flourish.

Water quality is a term used to describe the chemical, physical, and biological characteristics of water, in relationship to a set of standards. These standards are created for different types of water bodies (rivers, lakes, streams and wetlands) and for a particular purpose (drinking water, recreation, and agriculture). Although scientific measurements are used to define water's quality, it's not a simple thing to decide about the quality of water. When an average person asks about water quality, they probably want to know if the water is safe to use at home, to drink, etc., or if the quality of natural waters is suitable for aquatic life.

Standards set for the water quality are composed of several sets of parameters as physical, chemical, biological parameters. In the Turkish legislation the water quality parameters have been set by the by law titled Water Pollution Control Regulation, WPCR (Su Kirliliği Kontrol Yönetmeliği –SKKY). Concentrations of all parameters are presented in the Table 1.

As was presented below, WPCR organizes the fresh waters in 4 classes according to their quality.

TABLE 1: WATER QUALITY PARAMETERS FOR SURFACE WATERS

	WATER QUALITY CLASSES			
WATER QUALITY PARAMETERS	I	II	III	IV
A) Fiziksel ve inorganik- kimyasal parametreler				
1. Sıcaklık (^{o}C)	25	25	30	> 30
2. pH	6.5-8.5	6.5-8.5	6.0-9.0	6.0-9.0 dışında
3. Çözünmüş oksijen (mg O_2/l)[a]	8	6	3	< 3
4. Oksijen doygunluğu (%)[a]	90	70	40	< 40

	WATER QUALITY CLASSES			
WATER QUALITY PARAMETERS	I	II	III	IV
5. Klorür iyonu (mg Cl^-/l)	25	200	400[b]	> 400
6. Sülfat iyonu (mg $SO_4^{=}$/l)	200	200	400	> 400
7. Amonyum azotu (mg NH_4^+-N/l)	0.2[c]	1[c]	2[c]	> 2
8. Nitrit azotu (mg NO_2^--N/l)	0.002	0.01	0.05	> 0.05
9. Nitrat azotu (mg NO_3^--N/l)	5	10	20	> 20
10. Toplam fosfor (mg PO_4^{-3}-P/l)	0.02	0.16	0.65	> 0.65
11. Toplam çözünmüş madde (mg/l)	500	1500	5000	> 5000
12. Renk (Pt-Co birimi)	5	50	300	> 300
13. Sodyum (mg Na^+/l)	125	125	250	> 250
B) Organik parametreler				
1. KOİ (mg/l)	25	50	70	> 70
2. BOİ (mg/l)	4	8	20	> 20
3. Organik karbon (mg/l)	5	8	12	> 12
4. Toplam Kjeldahl-azotu (mg/l)	0.5	1.5	5	> 5
5. Emülsifiye yağ ve gres (mg/l)	0.02	0.3	0.5	> 0.5
6. Metilen mavisi aktif maddeleri (MBAS) (mg/l)	0.05	0.2	1	> 1.5
7. Fenolik maddeler (uçucu) (mg/l)	0.002	0.01	0.1	> 0.1
8. Mineral yağlar ve türevleri (mg/l)	0.02	0.1	0.5	> 0.5
9. Toplam pestisid (mg/l)	0.001	0.01	0.1	> 0.1
C) İnorganik kirlenme parametreleri[d]				
1. Civa (µg Hg/l)	0.1	0.5	2	> 2
2. Kadmiyum (µg Cd/l)	3	5	10	> 10
3. Kurşun (µg Pb/l)	10	20	50	> 50
4. Arsenik (µg As/l)	20	50	100	> 100
5. Bakır (µg Cu/l)	20	50	200	> 200
6. Krom (toplam) (µg Cr/l)	20	50	200	> 200
7. Krom (µg Cr^{+6}/l)	Ölçülmeyecek kadar az	20	50	> 50
8. Kobalt (µg Co/l)	10	20	200	> 200
9. Nikel (µg Ni/l)	20	50	200	> 200

	WATER QUALITY CLASSES			
WATER QUALITY PARAMETERS	I	II	III	IV
10. Çinko (μg Zn/l)	200	500	2000	> 2000
11. Siyanür (toplam) (μg CN/l)	10	50	100	> 100
12. Florür (μg F^-/l)	1000	1500	2000	> 2000
13. Serbest klor (μg Cl_2/l)	10	10	50	> 50
14. Sülfür (μg $S^=$/l)	2	2	10	> 10
15. Demir (μg Fe/l)	300	1000	5000	> 5000
16. Mangan (μg Mn/l)	100	500	3000	> 3000
17. Bor (μg B/l)	1000[e]	1000[e]	1000[e]	> 1000
18. Selenyum (μg Se/l)	10	10	20	> 20
19. Baryum (μg Ba/l)	1000	2000	2000	> 2000
20. Alüminyum (mg Al/l)	0.3	0.3	1	> 1
21. Radyoaktivite (pCi/l)				
alfa-aktivitesi	1	10	10	> 10
beta-aktivitesi	10	100	100	> 100
D) Bakteriyolojik parametreler				
1. Fekal kolifrom (EMS/100 ml)	10	200	2000	> 2000
2. Toplam koliform (EMS/100 ml)	100	20000	100000	> 100000

(a) - Konsantrasyon veya doygunluk yüzdesi parametrelerinden sadece birisinin sağlanması yeterlidir.

(b) - Klorüre karşı hassas bitkilerin sulanmasında bu konsantrasyon limitini düşürmek gerekebilir.

(c) - pH değerine bağlı olarak serbest amonyak azotu konsantrasyonu 0.02 mg NH_3^-N/1 değerini geçmemelidir.

(d) - Bu gruptaki kriterler parametreleri oluşturan kimyasal türlerin toplam konsantrasyonlarını vermektedir.

(e) - Bora karşı hassas bitkilerin sulanmasında kriteri 300 μg/1'ye kadar düşürmek gerekebilir.

Water quality parameters and corresponding values for each Class I, II, III, and IV was presented in Table 1. In order to be included to one of these water classes, a water source should satisfy all defined parameter values.

The water sources for each class can be used for different purposes presented in Table 2.

Class I High-Quality Water	Class II Less-Polluted Water	Class III Polluted Water	Class IV Very-Polluted Water
a) Drinking water supply with only disinfection process b) Recreational purposes (like swimming requiring body contact) c) Salmon fishing d) Animal and plant farming e) Other purposes	a) Drinking water supply with proper purification process b) Recreational purposes c) Fishing except salmon d) Irrigation purposes satisfying the criteria in "Teknik Usuller Tebliği" e) Other purposes except Class I	Industrial purposes with a proper prufication process except food and texile industries needs high quality water	Includes low quality surface waters than the parameters defined for Class I, II, and III.

Thus, regarding to the target of this field trip to Eymir Lake, a surface water, it is planned to measure and evaluate the following water quality parameters (temperature, pH, and dissolved oxygen) in Eymir Lake. Although it is not possible to understand the quality of surface waters by measuring just 3 parameters, due to time allotment of the course and the availability of materials you will be able to investigate the quality of surface waters with these three parameters.

2.2. Description of the Water Quality Parameters

a. Temperature

How is temperature measured?

Temperature is measured by using a thermometer and is recorded in either degrees Celsius (°C) or Fahrenheit (°F). Scientist usually record temperatures in Celsius, because this is the unit designated by International System of Units.

What are the factors affecting temperature?

Temperature of water can be affected by many factors. For example, the color of the water, the depth of the water, the amount of shade received from shoreline vegetation, the time of the year and day, the volume of the water, flow rate of the water, the outflow of sewage, discharge of the cooling water, groundwater inflows to the stream, etc.

b. pH

What is pH?

pH represents the effective concentration (activity) of hydrogen ions (H^+) in water. The pH scale ranges from 1 (highly acidic) through 7 (neutral) to 14 (highly basic). The pH of rainwater forms part of a dynamic system controlled by a range of buffering reactions occurring in solution and at the solid solution interface, which produce or consume H^+.

What are the factors affecting pH?

There are many factors affecting pH of water. For example, the concentration of carbon dioxide in the water, geology and soils of the watershed, drainage from mine sites, air pollution, acid rain containing nitric and sulfuric acids, the presence of algae, chemicals discharged by communities and industries, etc.

How is pH measured?

The pH of water can be measured with a pH meter, which is an electronic device with probe. It can also be measured with pH meter or by adding a reagent (indicator solution) to the water sample and recording the color change.

c. Dissolved Oxygen

What is dissolved oxygen?

Dissolved oxygen (DO) is the amount of gaseous oxygen (O2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis. Oxygen is removed from the water by respiration and decomposition of organic matter.

What are the factors affecting dissolved oxygen?

The amount of DO in water depends on several factors, including temperature; the volume and velocity of water flowing in the water body; and the amount of organisms using oxygen for respiration.. Human activities that affect DO levels include the removal of riparian vegetation, runoff from roads, and sewage discharge.

How is dissolved oxygen measured?

The amount of oxygen dissolved in water is expressed as a concentration, in milligrams per liter (mg/l) of water.

Your research study should include;

Be Careful!!! **<u>Select one factor resulted from an human activity for each parameter and test its effect on that particular parameter.</u>**

1. State your group hypothesis for each water quality parameter.

<u>Temperature</u>

Factor:……………………………………………………………………………………

Hypothesis:…………………………………………………………………………………

<u>pH</u>

Factor:……………………………………………………………………………………

Hypothesis:…………………………………………………………………………………

<u>DO</u>

Factor:……………………………………………………………………………………

Hypothesis:…………………………………………………………………………………

2. Define your variables and write in the below table.

	Variables
Manipulated	
Responding	
Controlled	

	Variables
Manipulated	
Responding	
Controlled	

	Variables
Manipulated	
Responding	
Controlled	

3. Determine materials you will use to test your hypothesis for each water quality parameter

Temperature:..

pH:...

DO:...

4. Describe the location where you get your measurements. Explain why you choose that place.

<u>Temperature:</u>

Area 1: ……………………………………………………………………………

Area 2: ……………………………………………………………………………………

pH:

Area 1: ……………………………………………………………………………………

Area 2: ……………………………………………………………………………………

DO:

Area 1: ……………………………………………………………………………………

Area 2: ……………………………………………………………………………………

5. Write the procedure you will follow for testing your hypotheses for each water quality parameter.

Temperature:...

pH:...

DO:..

6. Draw a table that includes your measurements for each water quality parameter.

7. Write your overall conclusion about this field.

……………………………………………………………………………………

PHYSICAL AND CHEMICAL PARAMETERS IN SURFACE WATERS DISCUSSION WEEK

Assistant Name **:** .... **Date:**

Group Members **:** ...., ...,

................................., ...,

................................., ...

1. What do you think about water quality class? Explain with reasons.

Eymir Lake

Yalıncak Lake

---

2. What are some ways that pollutants could get into the water? Is the source always visible? What are some examples?

---

3. What could pollute water? Explain with reasons.

Eymir Lake

Yalıncak Lake

---

4. What are the effects of human activities on surface water parameters? Explain with reasons.

---

5. If you were given a water sample, how might you determine if it was polluted?

6. As far as the quality and quantity of water is concerned, how do you make a relation with the quality of water with your daily lives?

APPENDIX B

PRE-TESTS AND POST-TESTS

Name: .... **Date: ....**

1. What is “biological diversity”? Please write what you know about biological diversity (the importance of biological diversity for environment, effect of human activities on biological diversity, etc…)

APPENDIX C

INFORMED CONSENT FORMS

INFORMED CONSENT FORM

This is a study which includes both qualitative and quantitative research techniques, which is conducted by Assoc. Prof. Dr. Özgül Yilmaz-Tüzün, Dr. Gaye Teksöz and Res. Assist. Cihan Gülin Cihangir. The aim of the study is to investigate the pre-service science teachers' construction of environmental explanations in the context of field base collaborative inquiry. Participation in the study must be on a voluntary basis. Your discussions that will be held on both in field and classroom discussions will be recorded by audio recorder with your permission. Your answers, personal identification information and the transcripts of the audio records will be kept strictly confidential.

The data collection process does not contain questions that may cause discomfort in the participants. However, during participation, for any reason, if you feel uncomfortable, you are free to quit at any time. In such a case, it will be sufficient to tell the person conducting the survey (i.e., data collector) that you do not want to involve in the study data. Your answers and transcription of audio records will be evaluated only by the researchers; the obtained data will be used only for scientific purposes.

After all the data are collected back by the data collector, your questions related to the study will be answered. We would like to thank you in advance for your participation in this study. For further information about the study, you can contact Assoc. Prof. Dr. Özgül Yilmaz-Tüzün from the Department of Elementary Education (Room: EF-111; Tel: 210 64 14; E-mail: ozgul@metu.edu.tr), Dr. Gaye Teksöz from the Department of Elementary Education (Room: EF-105; Tel: 210 64 15; E-mail: gtuncer@metu.edu.tr), or Res. Assist. Cihan Gülin Cihangir (Room: EFA-37; Tel: 210 75 08; E-mail: cgulin@metu.edu.tr).

I am participating in this study totally on my own will and am aware that I can quit participating at any time I want/ I give my consent for the use of the information I provide for scientific purposes. (Please return this form to the data collector after you have filled it in and signed it).

Name Surname	Date	Signature	Course Taken
	----/----/-----		

APPENDIX D

ENGLISH AND TURKISH VERSIONS OF THE USED QUOTATIONS

Original Quotations in Turkish	**Translated Quotations in English**
Bence nehirden uzak ve yol kenarında bir alan seçmeliyiz.	I think it would be good if we select an area far from the lake and near the road.
Dokunulmamış bir alan bulmak zor olacak Eymir Gölündeki heryer insanlar tarafından kullanılıyor, biz sadece insanlar tarafından daha az etkilenmiş bir yer bulabiliriz.	It will be hard to find an untouched area since everywhere in Eymir Lake are used by human, we can only find a place that have been less affected by human.
Gölden uzak olmak üzere iki alan seçtik, biri yolun yakınında biri uzağında.	We choose two areas that should be far away from Lake; one is near the road one is far from the road.
Mantıklı değil, insanların gelip piknik yaptığı ve gölden uzak bir alan bulamayız.	It is not logical, we cannot find an area that people come and picnic far from the Lake.
Aşağı kısımlar göl ekosistemine çok yakın olduğu için oradan bir alan seçemeyiz, diğer türlü iki alandaki türler arasında karşılaştırma yapamayız. İki alanı da aynı ekosistemden seçmeliyiz.	Since the lower sides are too close to the Lake ecosystem we should not take an area from there, otherwise we cannot compare species in these two areas. We should select two areas from the same ecosystems.
Bence bu alan uygun çünkü otların boyu yüksek.	This area is suitable I think since the length of the grasses is high.
Herkes kendi etrafındaki türleri sayabilir.	Everybody can count the species around own self.

Ama böylede diğerlerinin saydığı türlerden haberdar olamayız ve aynı organizmayı tekrar tekrar yani irden fazla sayabiliriz.	But in this case we cannot be aware of each others' counted species and we can count same organism again and again I mean more than one times.
Bence her bulduğumux türü birbirimize göstermeliyiz.	I think we should show every species that we found to each other.
Ben ota benzer bişe buldum, ben sayıyorum bunu, bunu tekrardan yazmayın.	I found a grass like thing, I am counting it, do not write it again.
O alan insan aktivitelerinden etkilenmiş ti çünkü tuvalet ve depo vardı.	The area was affected by human activities because there were a restroom and a store.
Lastik izleride vardı.	There was also tear skits.
Alanın etrafında hiç çöp yoktu.	There was no rubbish around the area.
Bitkiler büyümez.	The plants do not grow.
Bir binanın ve yolun biyolojik çeşitlilik üzerine farklı etkileri vardır çünkü yol insan gelme sıklığını arttırır yani yolun biyolojik çeşitlilik üzerinde bir binadan daha yıkıcı etkileri vardır.	A building and a road have different effects on biological diversity since the road increases the frequency of human existence so the road has more destructive effects on biodiversity than a constructing a building.
Alanları yolun aynı tarafından seçtiğimiz için, habitat fragmentationun etkisini test eemedik.	Since we selected the areas from the same side of the road, we could not test the effect of habitat fragmentation.
Habitat lossun biyolojil çeşitlilik üzerindeki etkisini test edemedik çünkü etrafımızda habitat loss probleminden	We did not test the effect of habitat loss on biological diversity since there was not any area around us facing with the habitat

etkilenen bir alan yoktu, yol hariç Eymir gölündeki ekosistem genellikle habitat degredationdan etkilenmişti.	loss problem, except from the road the ecosystem in Eymir Lake generally affected by habitat degradation.
O zaman habitat degredation azaldıkça biyolojik çeşitlilik artar diyebiliriz.	Then, we can say that the biological diversity will increase with the decreasing habitat degradation.
Hayır, hala test edilebilir değil çünkü fazla insan aktivitesi fazla habitat degredation, bunu eklemeliyiz.	No, it still not testable since we should include that the more human activity, the more habitat degradation.
Ama test etmedik.	But we did not test it.
Biodiversity bizim responding variablemız, onu hipotezimize eklemeliyiz.	Biodiversity is our responding variable so we should include it to our hypothesis.
Bence gölü doldurmalıyız böylece insanlar buraya gelmeyi tercih etmez.	I think we should fill the lake so people will not prefer to come there.
Bence habitat loss a neden olacak aktiviteleri önemlemek en önemli şey.	I think the most important act that we should do is preventing the actions that resulted in habitat loss.
Tamam o zaman, DO için sewage discharge' ı ele alalım. Restoranlar kesinlikle pisliklerini göle atıyorlardır.	Ok then, let consider sewage discharge for DO. The restaurants absolutely throw their dirtiness to the lake.
Böylece alanları kolayca seçebiliriz, restorana yakın ve uzak.	By this way we can select areas easily, near the restaurant and far from the restaurant.
Ben sewage dischargın test etmek için gerçekten iyi bir faktör olduğunu	I also think that sewage discharge is really a good factor to test.

düşünüyorum.	
Şimdi bir hipotez kurmalıyız.	Now we should construct a hypothesis.
Sewage discharge arttıkça, DO azalır.	The more sewage discharge, the less DO.
Keşke suyun içindeki microorganizmaları gözlemleme şansımız olsaydı. O durumda daha doğru sonuçlara varardık.	I wish I could have a chance to observe microorganisms in the water. In that case, we would make more accurate conclusions by this way.
Burada kötü bir koku var.	There is a bad smell here.
Bence bu yeşilimsi şeyler bu alanın kirli olduğunu gösteriyor.	I think the green like things show that the area is dirty.
Ama yeşil şeylerin kirlilik göstergesi olup olmadığını bilmiyoruz.	But we do not know whether the green things are indicator of water pollution.
Bence insanlar burda kesinlikle piknik yapıyorlardır ve pisliklerini atıyorlardır.	I think people definitely picnic here and throw their rubbish in to the lake.
Evet haklısın baksanıza şurda bir şişe var yani burda insan varmış.	Yes you are right, look there is bottle there so there was human here.
Biz pH ın asidik olmasını beklemiştik çünkü discharge from community'nin asidik kimyasallar içerir.	We expected pH will be acidic since the discharge from community includes acidic chemicals.
Genellikle temizlik maddeleri suyu asidik yapar dedik.	We said generally the cleaning material make water acidic.
Neden temizlik maddelerinin asidik yaptığını söyledik?	Why do we say that cleaning materials are acidic?

Bence testedilebilir çünkü herşeyi düşünerek kurduk.	I think it is testable since we constructed it by considering everything.
Bence bizim hipotezimiz testedilebilirdi ama biz test edemedik çünkü gölün derin taraflarına ulaşamadık.	I think our hypothesis is testable but we could not test it since we could not reach the deeper sides of the lake.
Ama biz zaten suyun derinliğini sabit tuttuk, yani suyun derinliği yaptığımız ölçümü etkilemedi.	But we even kept the depth of water constant so the depth of the water did not affect the measurements that we make.
Bence önce pH değerine bakmalıyız.	I think we should first look at its pH value.
Bizim sıcaklık değerimiz 9 ve hiçbiryere uymuyor.	Our temperature value is 9 and it does not fit anywhere.
Yani bu çok mu kötü demek?	So, it means, is it too bad?
Bence mevsimsel değişikliklere bağlı olabilir.	I think it may be due to the seasonal changes.
Ve suyun içindeki O2 kullanıyorlar.	And they use O_2 in the water.
Suyun içindeki kimyasallar yüzünden suyun kalitesi düştüğü için insanlar kanser oluyorlar.	The people become cancer if the quality of the water decreases since the chemicals inside the water increases.
Suyun kalitesi düştükçe insanlar için kullanabileckelri su azalıyor.	While the quality of water decreases, the available water for people usage is decreasing.