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USING A FIELD TRIP TO A WETLAND AS A GUIDE FOR CONCEPTUAL UNDERSTANDING IN ENVIRONMENTAL EDUCATION – A CASE STUDY OF A PRE-SERVICE TEACHER'S RESEARCH

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ABSTRACT: This paper describes a pre-service chemistry teacher in her senior year at the university, who attended an environmental education (EE) course, in which within a project assignment, she studied her peers' and other college students' conceptions of the swamps in Israel. In her study she discovered that the students held naive conceptions about the swamps as filthy-hazardous places that must be drained for improving the public health. A visit to the swamp, which included observations and investigation of its water quality, caused a conceptual change that allowed the students to understand the ecosystem better and to re-assess their pre-conceptions. The pre-service teacher, who was at the focus of this study challenged her own and her colleagues conceptions and used the conceptual change as a lever for her own professional growth as an environmental educator. Her project provides a better insight on pre-service environmental education experiences. The changes that the prospective teacher identified are discussed in the context of constructivist learning and teaching in EE, suggesting that pre-service training in EE must include actual outdoors learning experiences, which allow students to challenge previous knowledge and practice effective teaching methods. [*Chem. Educ. Res. Pract.*: 2004, *5*, 127-142]

KEY WORDS: *naive conceptions; conceptual change; constructivism; environmental education; professional development*

INTRODUCTION

This paper describes a pre-service teacher in her senior year at the university who chose to study other college students' ideas about swamps in Israel. The student participated in an Environmental Education (EE) course, which was taught by the author. This case study is a study within a study (an *action research*) of a pre-service teacher's use of her naive perception in order to study other students' perceptions, and to use her understanding for future development as a science and EE teacher.

The purpose of the study was to learn how the pre-service teacher's study engaged her in EE, and what the possible implications for pre-service programs in EE could be.

Wetlands in Israel – a cultural-historical background

Although Israel's location is in a semi-arid area, in the 1880's, when the Jewish people's return to the country began, much of the land, especially in the valleys and the plane

areas was covered with swamps. The drainage of these wetlands became a symbol for modern development in the Israeli national history and culture.

The settlers, who were seeking water, established their villages near the water, not realizing that they exposed themselves to the threat of malaria. Years of a constant battle against the disease, led them to understand that the only solution was draining the swamps. This era has created many myths about the pioneers who struggled with the wetlands and won. Every Israeli student is studying this "draining the swamps" chapter in history and geography of the country in the elementary school.

Although most of these drainage projects ended at the beginning of the 20th century, the most famous project was conducted in the 1950s when the newly established state of Israel decided to drain the lake and the adjusted swamp of Hula. The Hula Valley, nowadays an agricultural region in northern Israel with abundant fresh water, provides an example of the delicate balance between nature and human initiated development.

Until the late 1950s the Hula Valley (altitude: 62.00–70.00 m above MSL) was covered by old Lake Hula and its surrounded swampy area, mostly covered by dense vegetation. The swampy area was completely water-covered in winter and partly covered in summer.

During the 1950s, the whole Hula wetland complex was dried and more than 65×10^6 m^2 of natural wetland area, with a unique natural composition of fauna and flora of exceptional diversity, was turned over to agricultural use to serve as an income source for residents of the northern part of the country (Gophen, 2000).

In the 19th and the beginning of the 20th century, generations of people who lived in Hula valley suffered a great deal from malaria. Whole families died, and every person experienced a loss. This regional and historical background was the necessary framework for the huge drainage project. For years, students around the country studied about this effort, and learned to appreciate this chapter in their national history.

Though initially perceived as a great national achievement for the fledgling State of Israel, with time it became evident that the benefits from transforming a "wasteland", Lake Hula and its swamps, into an agricultural "blessing" were limited. Nowadays, after 45 years of unsuccessful struggle to utilize the drained valley's resources, the State of Israel has finally recognized that successful development can endure only if a balanced compromise between nature and development is achieved. About 10% of the peat area went through processes causing soil deterioration and subsidence where agricultural utilization became noneconomical and nutrient flux from the peat soil into Lake Kinneret was enhanced. This part of the valley was flooded and converted from an agricultural function to ecotourism as an income resource for the land owners. (Hambright & Zohary, 1998; Gophen, 2000).

A survey of Israeli school textbook indicates that the human achievement of developing a wilderness into a fertile agriculture region is the most emphasized idea regarding this region.

Field trips and teachers' training

Field trips have always been an important means of teaching, as evidence of a long tradition in the history of education. Field trips are usually arranged by schools, have educational purposes, and take place in an interactive setting (Krepel & Durral, 1981; Hofstein & Rosenfeld, 1996) all of which have been shown to increase learning. Rudman (1994) argues that the aims of the field trip have not changed much through history. She claims that the field trip may serve as a tool for improving thinking skills, interest and success in science learning.

Outdoor environments, which can be used for field trips include natural systems, museums, zoos, urban areas and so forth (Orion, 1993; Orion & Hofstein, 1994; Hofstein & Rosenfeld, 1996). The major potential of the field trip should be the possibility of having concrete experiences through using:

- a transitional learning stage from simple to complex concepts;
- a direct experience with concrete phenomena and materials; and
- the ability of hands-on activities for construction and amplification of abstract concepts.

Field trips as complex learning settings enable binding the curriculum to the environment and combining cognitive and affective aspects of learning. The field trip allows using observations, conducting short investigations and group discussion in an informal learning environment (Tal, 2001). Baldwin (2001) indicated that although there are field-based college-level courses, most of them are long field-labs. Activities that last three to four hours are not common although they could offer a variety of learning activities. One major problem about field trips is the inadequate training of teachers in out of school settings (Orion & Hosftein, 1994; Cox-Petersen & Pfaffinger, 1998; Tal, 2001). Pre-service science teaching programs at the universities include very few field experiences, in which the students are exposed mainly to ecological content knowledge and rarely deal with educational aspects of the field trip. In most of the programs of the teaching-colleges in Israel, that prepare most of the elementary school teachers, there is hardly one course that exposes the prospective teachers to all the aspects of the educational field trip.

THEORETICAL BACKGROUND

Constructivism and learning in science and environmental education

Questions such as what might learning and teaching look like in environmental education (EE) are at the focus of current EE discourse (Dillon, 2002, 2003). Traditionally, EE aims to provide learners with the ability to act toward the protection of their environment. According to various existing definitions, EE must provide students with opportunities to acquire the knowledge, values, attitudes, and skills needed to protect the environment (UNESCO-UNEP, 1976, 1978, 1998; NAAEE, 1999). Various shifts in the focus of EE emphasized either the behavioral or the knowledge domains of EE. Issues of focus on content vs. skills are central in the long tradition of science education as well. Nevertheless, relationships between environmental education and science education went through several changes in the last decades (Zoller, 1991, 1992; Pedretti, 2002a; Zoller & Scholz, 2004). Starting from emphasizing cognitive domains (Gayford, 1986), EE moved into the field of developing scientific skills, and focusing on values (Dillon & Teamey, 2002). Involving discourse about values during the 1990's had some problematic aspects in the context of conventional representations of science as value-free search for the truth (Gough, 2002). Nowadays, discussing values is not strange to science education (Allchin, 1998, 1999) and many educators seek new relationships between science education and environmental education, suggesting to apply a systemic holistic approach that uses ecological approach to science education (Keiny, 1991; Hart, 2002, Dillon & Teamey, 2002).

It is widely accepted that learning in EE and science depends on previous held knowledge and perceptions of the learner, and that learning occurs mainly in social context, when learners interact and share ideas, thoughts and actions. All these are in accord with the constructivist view of learning that focuses on the learners, and recognizes that they have to

be active in the process of learning. The social constructivism emphasizes interactions among learners that enable asking questions, sharing ideas, debating, arguing, concluding and collaborating while creating products and artifacts. All these create a discourse pattern that supports knowledge construction and metacognitive skills (Brown & Campione, 1994; Driver et al., 1994; Osborne, 1996; Duschl & Osborne, 2002). Furthermore, the constructivist view of learning recognizes that humans' present conceptions are a product of diverse experiences, observations, events, culture, language and schooling history. Such conceptions are not necessarily in accord with scientific knowledge (Driver, Guesene, & Tiberghien, 1985; Mintezes & Wandersee, 1998). Students tend to develop and hold alternative conceptions of scientific ideas, and quite often, these conceptions are very strong. Studies of students' science conceptions have found that students hold alternative understandings of the phenomena in question (Posner, Strike, Hewson, & Gertzog, 1982; Driver et al., 1985; Strike & Posner, 1990).

In this study, we claim that in EE, challenging a new phenomenon or a concept includes the actual experience with the phenomenon or the concept in question. Hence, the field trip could provide this active experience with phenomena. We believe that informal former experiences might interfere with the learning process and that in order to learn the phenomena, the students ought to experience some sort of conflict with their previous experience (Driver et al., 1994). We adopted Posner and colleagues' (1982) view that the student must review the new information against the conceptions he/she already holds. This accommodation process allows the desired conceptual change.

Teacher development

In order to introduce the changes both science education and environmental education go through, and in order to challenge the very basic views teachers hold, a radical professional development must focus not only on contents and methods, but on issues such as philosophical positions as well (Dillon & Teamey, 2002).

Teachers' content knowledge and pedagogical skills are necessary, but not sufficient for a major reform. According to Putnam and Borko (1998), teachers require changes in their knowledge, beliefs and practice in order to achieve goals such as helping students to construct understanding, develop expertise and encourage the use of higher order cognitive skills. This effort is not just a case of learning new strategies or techniques, but changing the overall perception of teaching, and acquiring a new set of beliefs that direct future practice. Significant differences between teachers of various content backgrounds and experience with regards to STS views, beliefs and literacy were reported by Zoller and Ben Chaim (2002). High demands of inquiry-oriented teaching were reported by Fishman, Marx, Best and Tal (2003). They claimed that teachers' subject-matter knowledge must be deeper and broader than in traditional recitation teaching in order to accommodate students' questions and investigations.

In this study, a prospective chemistry teacher challenged the views of other pre-service teachers about the concept of wetlands, and in doing so she developed herself as a teacher who is committed to investigate her own conceptions in a relevant social context.

THE STUDENT'S STUDY

The student, Nasarin, participated in an Environmental Education (EE) course, which was taught by the author. Content wise, the course included the following themes: a) the most relevant environmental issues in Israel; b) EE as a framework for interdisciplinary approach in teaching; c) EE as a learning environment that encourages problem solving and decision

making skills; and d) suitable teaching methods in EE. The participants in the course were requested to conduct mini research projects, which allowed either to design and enact a short learning unit, or to explore the public understanding and involvement in environmental issues.

Nasarin was a prospective chemistry teacher in her senior year. In her junior year, she enrolled in two other Science-Technology-Society (STS)[1] courses, which led her to enroll in this EE course as well. The course included a field trip to a wetland nature reserve that offers many educational activities for students at all levels. Some of these activities were described elsewhere (Tal, 2001).

The other participants were chosen by Nasarin for her research project. Two groups of college students participated in Nasarin's study. The first group consisted of 11 pre-service science, math, and technology teachers who joined the EE course and eventually visited the swamp. The second group (the control) consisted of 13 students, most of them pre-service teachers, majoring in different areas. This group of students neither participated in an EE course nor visited the swamp.

The problem

Nasarin aimed to address two problems related to teachers' training in EE: a) acquiring field experience (Michie, 1998; Rudman, 1994; Tal, 2001); and b) students' misconceptions (Meadows & Wiesenmayer, 1999; Dillon, 2002). Nasarin was fascinated by the diversity of the wildlife, habitats, and the beauty of the swamp that offers so much for the public in general, and for educationalists in particular. She was amazed to realize that her perception of swamps in Israel prior to the visit to the swamp was negative. She thought that swamps are “polluted areas” that contain dirty water, muddy soil, mosquitoes and are dangerous for the public health. She even referred to her own learning experience of the swamps in the elementary school. In a later stage of her study she examined her younger sister's textbook in order to examine her memories. The conflict with what she actually experienced made her describe what she experienced as a "cognitive conflict" (Piaget, 1929; Dreifus, Jungwirth, & Eliovitch, 1990). In the interview, Nasarin explained that this conflict was the first reason for choosing her research project. The other reason was some criticism she developed about her pre-service studies that developed her skills and knowledge mainly in chemistry teaching.

METHOD

As mentioned earlier, this study was an action research of a pre-service teacher’s use of her naive perception in order to study other teachers and educationalists’ perceptions, and to use her understanding for future development as a science and EE teacher. Feldman and Capobianco's (2000) explanation for action research was used in this study. They describe action research as a systematic inquiry that is collective, collaborative, self-reflective, critical and undertaken by participants of the inquiry, with the goal of understanding of practice in order to improve that practice. The form of action research that was adopted here was practical-theoretical, which served professional and personal purposes (Rearick & Feldman, 1999). This approach is in accord with Pedretti (2002), who called for incorporating reflective methods in STSE pre-service programs.

[1] In this study the terms STS, STES, STSE were used inseparably; they were used according to the context or with regards to the cited reference.

The purpose of the study was to learn how Nasarin's study engaged her in EE, and what the possible implications for pre-service programs in EE could be.

Hodson's (1994) four levels of sophistication in STS served as a framework for analyzing Nasarin's development. According to this model, in the first two levels, a person becomes aware of the complex relationships between science, technology and society, and understands that various interests affect the distribution of wealth and power. In the third level, a person develops his/her own views and value positions. Getting prepared for action expresses the fourth and highest level.

Borrowing from the qualitative tradition in science education (Gallagher, 1984, 1991), the meetings with Nasarin were documented during and after each meeting in the researcher's diary. I used an interpretative research methodology (Erickson, 1986; Gallagher, 1991; Treagust, Jacobowitz, Gallagher & Parker, 2001) that allowed a minimal interference in the process. Nasarin came over to consult about the topic she decided to study, about her research question, and about the questionnaire she developed. Then, she was interviewed about her own experience and about the reasons for choosing her research project. At the end of her study she was interviewed again about her insights, conclusions, and recommendations. Although the nature of the study was an "insider research" (Pedtetti & Hodson, 1995), and as such, was subject to bias, it reflected the process Nasarin went through and the approach and attitude she developed regarding teaching EE.

In addition, further data, mainly students' statements and comments was collected in a more detached mode. While visiting the swamp on the course field trip, field notes were taken and the statements of the students were documented by the author. In the following year, five volunteer students were interviewed about their experience, using Nasarin's questionnaire as a guiding protocol. In this way, the internal validity of the questionnaire Nasarin used was increased, and more data was collected. Still, it is important to emphasize that the study examined particular views of the participants and was strongly influenced by their perceptions of the educational context.

Data

Nasarin's plan

Nasarin's goal was to document and describe other pre-service science teachers' perceptions about swamps, and to use their perceptions for planning future learning experiences in EE. She began with the broader question about the common knowledge about swamps in Israel, and later on, refined it to: *What are the types of students' knowledge (main themes) before and after the visit to the wetland?*

Settings. As indicated earlier, Nasarin addressed two groups of students: the first group participated in a field trip, and the second group, the control, did not experience a field trip.

The field trip to the swamp took place at the middle of the semester. It was a six-hours activity that included: 1) a climb to the pick of a nearby hill for an observation, in which the students used maps and guiding signs in order to identify location of various geographical units. After this activity, they discussed some of the environmental problems of the region as were observed and perceived by the participants; 2) fresh water sampling and chemical examinations, in which the students monitored variables such as water salinity and pH, turbidity, and levels of nitrates and phosphates in the water and in the soil near the water; 3) using field guides to identify the plants; 4) observing birds and the wild buffalos; 5) concluding discussion at the visitor's center about sustainable development. Some of the activities were conducted as a whole class activity, while others were small group activities.

The field trip was guided by the course instructor (the author) and the nature reserve's educational coordinator.

Questionnaire

At that point of Nasarin's studies, she was aware of various approaches for assessing students' knowledge and attitudes towards ideas or concepts. In previous projects, she assessed her own and her classmates' work. In this study, she decided to use open-ended questionnaires in order to get a broader picture of the students' perceptions. She was aware that the students would cooperate only to some extent; therefore, she decided that the questionnaires should not be too long.

As a student-teacher, Nasarin did not aim to apply principles of scientific study that have to fulfill standards of validity and reliability. She decided to use questionnaires instead of interviews, because of practical reason: she preferred documenting ideas and insights of all the students. The questions were articulated based on her own experience in the swamp habitat. She used the term "control" while describing the group of students that did not participate in the course. The open-ended questionnaire that Nasarin has developed was administered to both groups before learning about, and visiting the swamp nature reserve. Then, a second questionnaire was administered to the first group after the visit to the swamp. The questions in the pre-visit questionnaire included some of the following:

1. What do you think about when you hear the word "swamp"?
2. In the past, large areas in the country were covered with swamps. These swamps were drained years ago.
    a. What, in your opinion, are the advantages of this drainage effort?
    b. Do you think that there are any disadvantages about this drainage?
    c. After thinking about both sides, do you think that the advantages are greater than the disadvantages?
3. Please advise what to do with the remains of these swamps.

In the post visit questionnaire, additional questions included:

4. Is your understanding of swamps after the visit different than before?
5. If your answer to the previous question was positive, can you tell what made you change your perception?
6. As a future teacher, can you tell what part of the field trip caused this change?
7. Do you think that a similar process that your future students would go through, would contribute to their EE? If yes, what is the possible contribution?

Although initially Nasarin was not considering issues of validity, eventually she applied content analysis approach for defining analysis criteria and asked another student to help her with validatating the criteria she obtained, as well as with with the final classification of the students' responses.

Nasarin's findings

Pre-visit questionnaire

In order to answer Nasarin's question regarding the students' knowledge about the swamps prior to and after the field trip, the data addresses the following sub-issues: what

swamps are; and, what are the advantages and disadvantages about draining the swamps in the past are.

What swamps are?

The pre-visit questionnaire shows no difference between the two groups. In both groups the students thought that swamps are places with dirty, standing water, that carry diseases, ugly, with no benefit for humans. Very few students mentioned that there were plants and animals in the swamps. Table 1 presents the naive conceptions of both groups about swamps, and some examples of students' responses.

TABLE 1. *Students' naive conceptions about swamps (N=24).*

Naive conception and examples of responses	**Total number of responses**
Accumulation of standing turbid water: *"A swamp is a place of standing water. Once all the country was covered with swamps, which were drained."*	8
A dirty place that carries diseases, with no benefit: *"The swamps caused malaria and other diseases because of the mosquitoes."*	7
A deserted pond with water and mud that causes pollution, ugly, with no benefits: *"A swamp is a polluted little lake. It's good we got rid of them."*	4
A place with shallow dirty water: *"Swamps are different than lakes because they hold shallow water."*	3
A place that has plants, animals and a habitat: *"There are many birds and plants in the swamp. It's a habitat of wetland creatures."*	6

Advantages and disadvantages about draining the swamps in the past

Prior to the field trip, almost all the students claimed that all the citizens earned a lot from draining the wetlands because *"we got rid of diseases and insects and because we were able to use the land for better purposes such as agriculture and construction."* The majority (70%) argued that there was not any drawback about the drainage. Only 30% mentioned the wildlife that was harmed as a consequence of the drainage. However, these people still supported the drainage effort and suggested to preserve the wildlife in artificial habitats (nature reserves).

What to do with the remains of the swamps?

Table 2 presents the different attitudes towards the remains of the swamps. In response to this question, Nasarin found a difference between the two groups with somewhat more "environmental" approach of the control group. However, what seemed as 70% support for preserving the wetlands, resulted in vague, incoherent arguments.

TABLE 2. *Distribution of suggestions and arguments for future treatment.*

General argument	Group 1 (*experimental*) detailed arguments	Group 2 (*control*) detailed arguments
We ought to dry the remains of the wetlands in order to cultivate the soil and prevent diseases.	45.5%	30%
We should preserve the wetlands.	18% Only if they are far away from residential areas. We ought to leave a living example of the swamps. 27% We should keep and clean them, and reintroduce the animals that deserve a place to live too.	70% Very vague explanations. Sometimes they contradicted their previous responses. They could not really suggest applicable solutions.
Do not know what to do.	9.5%	

We suggest that most of the students in both groups represented the common perception about swamps of muddy, filthy places that are dangerous because of the presence of insects and diseases. In an attempt to understand the 70% who supported the preservation but could not provide a coherent reason, Nasarin interviewed some of the students. After identifying many inconsistent ideas, she suggested that these students might have wanted to please her with their responses, assuming that she expected pro-environmental responses.

Post-visit questionnaire

The vast majority of the students who participated in the field trip (10 out of 11) stated that *"the swamp is a habitat for many species of plants and animals"*, and that it has a unique ecological significance. Only one student stated that, "*the swamp is a place that causes some diseases, but it has some benefits as well*."

In response to the question what to do with the remains of the swamps, 9 students (82%) suggested to preserve the remains and to declare the wetlands as official nature reserves, so that the unique habitats would not disappear. One student suggested increasing and monitoring the wetland areas. Only one student did not have any idea about the issue.

The learning process and Nasarin's conceptual change. In response to question 5 about what caused the change, the ten students that stated that they changed their understanding provided the following reasons:

- *The actual experience in the field changed my understanding.*
- *The excellent field-center facilitator, who explained everything and used so many models and representation*
- *The facilitator caused a cognitive conflict, which resulted in changing my mind.*

- *The discussions we had during the visit.*

They all agreed that a similar learning process is suitable for their future students. In addition, explaining that experiencing phenomena in the field is recommended, even if just being there and observing the area can lead to the expected shift.

Nasarin's conclusions

Nasarin's conclusions were:

a) The students' knowledge about wetlands, prior to the field trip was insufficient. As a consequence of the Israeli curriculum, which glorifies the pioneers who drained the swamps, the students develop an early pre-conception about the swamps as polluted habitats that must be drained and developed into cultivated fields or constructed areas.
b) After the visit to the swamp, the participating students acknowledged that the area is a beautiful natural habitat that serves as a refuge for many rare species of animals and plants. They appreciated the fact that this wetland attracts families who walk the trails and observe the birds.
c) Finally, she assumed that the field trip allowed the prospective teachers to challenge their naive conceptions. Nasarin suggested the cognitive conflict mechanism as a cause for a conceptual change. Nasarin added a written description of the strong experience she had:

> "It is amazing how little I knew (understood) about this ecosystem. I did not realize that right near the city there are springs that create such rich habitats. In only few hours I learned to identify so many species of plants and birds… What was really amazing is to understand the management problems of this habitat. It is all surrounded by cultivated fields, that are treated by fertilizers and pesticides… The towns around are interested mainly in using the area for real estate purposes, while the public seeks "green lungs"… But above all, the **feeling of entering a fascinated place** and the **deep understanding I experienced** made the field trip so unique."

The underlined (by the author) words refer to concepts or main ideas which were emphasized during the field trip. The bolded phrases emphasize the affective experience, which is an important aspect of the field trip as an educational means. At that stage Nasarin added that her own environmental awareness and concern improved substantially as a result of her project and that she felt that she was more committed to act (see further indications in the sequel).

THE CONCEPTUAL CHANGE

The importance of the process Nasarin went through does not lie in her study's innovation in the field of EE. The fact that Nasarin is a student-teacher, who started her action-research project as a result of her new experience during the field trip, and the questions she raised about her future science teaching career are worth emphasizing.

In the interviews with Nasarin I aimed to follow up her own development as a science teacher, using Hodson's four levels of sophistication. This scale, which includes the four sages: appreciating…recognizing…developing views…and preparing for action, suits the process Nasarin went through. Table 3 presents Nasarin's engagement according to this model.

TABLE 3. *Nasarin's engagement in EE according Hodson's (1994) levels.*

Hodson's Levels	Nasarin's engagement
(1) Appreciating the social impact of scientific and technological change, and recognizing that science and technology are to some extent, culturally dependent.	Nasarin's research question resulting from her previous school-based knowledge about the pioneers "heroic efforts" in draining the swamps.
(2) Recognizing that decisions are taken in pursuit of particular interests… Recognizing that scientific and technological development is linked with the distribution of wealth and power.	She is aware of the cognitive conflict she experienced. Nasarin is concerned about her student colleagues' attitudes and wishes to study their perceptions.
(3) Developing one's own views and establishing one's own underlying value positions.	Even before, and mainly after her study, Nasarin is aware that: she held misconceptions that influenced her view. She acquires a new point of view, and hope that the field trip to the swamp would change other students' views.
(4) Preparing for taking actions.	While she is in a job-interview, Nasarin tries to convince a principal to introduce EE to his school. She participates in a follow-up professional development activity in the ecological garden, and writes learning materials.

Nasarin's interest in environmental issues has developed during her pre-service studies in several methods courses and in special courses that focused on EE and outdoors learning experiences. She stated that as a consequence of her accumulating experiences in EE, she found herself explaining its importance, in one of her job-interviews, in which the school was looking only for a chemistry teacher, but she tried to convince the principal to hire her as an EE teacher as well, claiming that doing both would contribute to her chemistry teaching as well. Although Nasarin thought that she already developed considerable environmental awareness prior to this project, she experienced the gap between her previously held conceptions and the new ones she developed as a consequence of her study. When Nasarin was asked about anchoring her study in the Conceptual Change theory, she replied:

> "I came to this idea after I read the paper of Ballantine and Packer (1996). As a prospective secondary school teacher, I felt that there has to be a strong connection between attitudes and knowledge. During the field trip, when N' the teaching assistant, mentioned the idea of a paradigm shift, I felt that I wanted to study this shift."

It is worth mentioning that Israeli pre-service teachers rarely read international science education literature, mainly because of language obstacles. Nasarin read a lot and was able to discuss and debate about the literature she read.

In summarizing the development of her EE attitudes, Nasarin spoke about her own experience in teaching chemistry and about her observations of her young sister who studies in an elementary school:

> "After all the experiences I had, I do not understand how one could teach only chemistry and avoid all the environmental consequences of industry, modern agriculture and our way of life. I am sure that it is possible to connect many environmental issues and to incorporate them into the curriculum. I had a great experience with the "Air Quality Module" (Dori & Herscovitz, 1999), which was developed here (at the Technion), but I am not so sure if I'd be able to teach it as a chemistry teacher…I watch my younger sister who studies in 5th grade. I am sure that her teacher could incorporate much more EE than she does. These kids use mainly textbooks instead of using their actual physical environment as a resource for learning…You know, in order to verify the memories I had about what we have learned about the swamps I checked her textbook. Although it's much nicer than the one I used, it contains the same inadequate and misleading information."

Nasarin shared her concern about future career in chemistry teaching, and about avoiding discussing EE issues in various levels of the educational system. She thought that EE encourages interdisciplinary problem-oriented teaching. She did not understand why teachers in the elementary school are avoiding EE, although from her own experience, this is what interests the students the most.

The following year's study

The interviews with five prospective teachers, using Nasarin's questionnaire as a guiding protocol, took place after the visit to the swamp in the following year. All the students stated that the field trip made them realize that their previous naive knowledge about wetlands was wrong. They all appreciated the field experience they gained. As mentioned earlier, this finding was not surprising. However, the students addressed the educational contribution of the field trip. Three of them referred to a paper, which was discussed in class. The paper, written by Orion and Hofstein (1994) describes factors that influence the field trip in natural settings. The students acknowledged that the introductory and the wrap-up activities contributed a lot to the success of the field trip. Three of the students, who majored in chemistry and biology teaching, stated that it is only natural for them to incorporate field experiences in their future teaching. Nevertheless, they claimed that they did not have enough courses that prepare them to teach their students in the field.

DISCUSSION

Many of the issues discussed in the literature were evident in Nasarin's case. These issues include conceptual development, incorporating field trips and introducing outdoor experiences into EE curriculum, and professional and personal development.

Nasarin, as a prospective science teacher was able to identify the conceptual change as a key issue in EE. She combined the article of Ballantine and Packer (1996) that she read, with her own personal cognitive conflict experience, in order to come up with an idea for her own research project in the course. The data she collected, her conclusions and her reflections, as described in the interviews allow concluding that Nasarin acquired the awareness of the need of EE as integral part of the Israeli curriculum. Nevertheless, Nasarin expressed her own will to incorporate EE as integral part in her own teaching.

The field trip to the swamps made a great educational impact on Nasarin, her course mates, and the five interviewed students in the following year. Their experience included both cognitive and affective domains, and they even reflected on the field trip as teachers, who evaluate its educational merit. The impact of the field trip is in accord with Baldwin (2001) who reported on a college level field trip and Farmer and Wott (1995) who studied fourth graders. Despite of the different age groups, they both emphasized the relationship between the affective experience and a deep conceptual learning. The students' reflective and critical response and their tendency to be involved in EE programs are promising. This finding is supported by Tal (2001) who showed that pre- and in-service teachers who participated in a field trip, while critically examining its contents, learning activities and organization are likely to use the field trip as a routine teaching approach.

Following Hodson's scale of sophistication, we acknowledged that Nasarin not only realized that there are complex relationships between scientific, social and environmental factors, while choosing her project; she certainly developed her own solid view about the swamp habitat, the preferred learning approach, which is the field trip, and about the common learning materials. She expressed a hope that she would be able to practice EE in her future teaching, although she was qualified as a chemistry teacher. The sequence of learning experiences that Nasarin experienced and described answered the initial question, which was how Nasarin's study engaged her in EE. This finding is supported by Pedretti and Hodson (1995) who identified two important characteristics: ownership and empowerment, that lead to effective action. Nasarin's project certainly empowered her as an environmental educator.

Nasarin is not a teacher yet, and her project was enacted during her junior university year; however, she became a partner in community of teachers who study their own conceptions and practice. This might contribute substantially to her pedagogical content knowledge. According to Bell (1998), teachers go through three main stages of development: professional, social, and personal-reflective. Since Nasarin's project was an individual course-based project and she is not a member of a teaching team yet, we could not identify social growth; however, she certainly expressed professional and personal-reflective development while she was engaged in her research project.

As a final statement, based on Ballantine and Packer (1996) and Meadows and Wiesenmayer (1999), I would claim that a substantial growth for EE teachers' practice relies on deep understanding of conceptually based EE. Understanding the background and mechanisms of conceptual change is necessary for substantial EE teaching. Nasarin's study of her peers' and her own conceptual understanding might contribute a lot to EE pre-service programs, by involving the pre-service teachers in research projects in which they study their own understanding and practice.

Recommendations and further study

As a result of this action research experience, we developed a group action research in EE. We chose the ecological garden of the Technion as an "outdoors lab" for experiencing various learning opportunities with students and adults. The participants developed and enacted their own learning materials, and critically discussed them in the group. The result of this effort was a published booklet of all the developed learning activities. For further study, we aim to develop group action research as a continuous professional development in EE, and to follow up the professional growth of the participating teachers.

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