Environmental Education Research

Encouraging ecological behaviors among students by using the ecological footprint as an educational tool: a quasi-experimental design in a public high school in the city of Haifa

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Encouraging ecological behaviors among students by using the ecological footprint as an educational tool: a quasi-experimental design in a public high school in the city of Haifa

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The aim of the current study is to explore whether the ecological footprint is an appropriate tool for encouraging ecological behaviors in students. In the quasi-experimental research that we conducted, four classes from one of the public high schools in the city of Haifa ($N = 130$) participated in an environmental education (EE) program (intervention program) based on the theoretical and practical aspects of the ecological footprint and the action competence approach in EE. Two classes ($N = 70$) constituted a control group. Ecological worldview (EW), perceived behavioral control (PBC), behavioral intentions (BI), personal norms (PN), pro-environmental behavior (PEB), and self-reported behaviors were measured by means of questionnaires completed by the students in their classes before and after the intervention program. The results show statistically significant differences between the experimental and the control groups in the variables PBC, PN and BI. However, no statistically significant differences were revealed in EW and PEB. The results indicate that incorporating the ecological footprint as an educational tool in high school might yield some predictors of PEB.

Keywords: pro-environmental behavior; ecological footprint; sustainability; education for sustainability; action competence

Introduction

In the last two decades, the 'western lifestyle' and its accompanying resource consumption emerged as major contributing factors to environmental deterioration and the depletion of natural resources (Daly 1990; Hobson 2003; Rees and Wackernagel 1996). Therefore, it has been argued that the depletion of natural resources is no longer the exclusive domain of scientific experts; it demands that all citizens act (Backstrand 2003). For the first time, citizens as consumers were held responsible for modifying their lifestyle for the sake of preserving global natural resources and of future generations (Barr 2007; Berglund and Matti 2006; Hobson 2003; Spaargaren 2003; Steg and Vlek 2009; Stern 2000).

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The identification of individual consumption as a cause of environmental problems is based on the ecological economics approach, which argues for a close interrelationship between economic and natural processes (the flow of energy and materials), in which human society occupies space in the biosphere. As industrial and consumption activities become more dependent upon extraction of fossil energy and natural resources, the greater is the risk of destroying life-supporting ecological systems essential for the existence of the human race on Earth, such as forests, air, and water (Ropke 2004). Therefore, it was argued that the agenda of sustainability is about values and behaviors that take into account the limits of the natural environment in terms of supporting human being (Daly 1990).

Since the UN 1992 Agenda 21 was adopted by 178 governments as an action plan for sustainability, education and capacity building have been increasingly recognized as critical means for promoting sustainability among local communities (Rowe 2007; UN 1993). In this context, education for sustainability has an important role to play in educating students as future citizens based on proactive, interdisciplinary, and transparent science that works in tandem with the needs of society and the environment (Backstrand 2003; Rees 2003). Environmentally literate citizens can make better decisions about what and how they consume and dispose (Lester et al. 2006). Yet, many educators feel that they should not only teach the science, but also engage students and encourage positive responsiveness toward the environment (Cross and Price 1999; Lester et al. 2006). Critics of conventional environmental education (EE) propose that curricula focused solely on science without personal and social connections may not be the most effective educational model for moving toward developing action competence and pro-environmental behaviors (PEBs) (Uzzell 1999).

Given the need to implement an innovative scientific method and content in the field of education for sustainability and engage students in pro-environmental concern and behaviors, we conducted an educational intervention program based on the ecological footprint approach. As defined by its developers Wackernagel and Rees (1996), the ecological footprint is the total area of ecological land space required to supply the various needs of the population in a defined region (such as a high school) and to absorb all the waste that the population produces on an ongoing basis. Although the ecological footprint has developed as an ecological indicator, as an educational tool it has not been established in schools, though its easily communicable nature suggests that it may be an effective mechanism for assisting students and their wider communities to learn and act in order to achieve environmental sustainability (McNichol, Davis, and O'Brien 2011).

The aim of the current study is to explore whether the ecological footprint might be an appropriate educational tool for encouraging PEBs among students. The study was conducted in a public high school in the city of Haifa during the course of the 2008/2009 school year. During that year, the first author inaugurated an educational program based on the ecological footprint approach in order to encourage PEBs of students.

Theoretical background

EE and the new role of scientific knowledge

EE appeared as a new field in the 1960s as a result of the concerns about environmental degradation. The initial entrance of EE into the formal education systems

was through natural and life science studies. The concept was that scientific knowledge and the developing technology can provide answers and solutions to the environmental problems that have emerged (Gough 2002). This concept was anchored in the world's first Intergovernmental Conference on EE that was held in Tbilisi, Georgia (1978). The Tbilisi declarations states that 'Education utilizing the findings of science and technology should play a leading role in creating awareness and a better understanding of environmental problems' (UNESCO-UNEP 1978). Environmental educators have perceived the role of teachers as to educate students toward a particular understanding of the state of the environment based on scientific knowledge and facts, while students are regarded as passive recipients. However, toward the beginning of the twenty-first century, it was argued that the function of education is the development of an informed citizenry and this requires that all students receive an education in science in order to be able to contribute to personal and local decision-making about issues that have a scientific dimension, such as, health and environmental issues (Jenkins 1999).

Similarly, the dominant perception of EE has been widely criticized, because of its emphasis on scientific knowledge, the absence of critical thought, and the failure to identify the social and political dimensions of the ecological crisis (Huckle 1999; Huckle and Sterling 1996; Jensen and Schnack 1997). As a result, it was argued that EE should be established on innovative content and methods that highlight civil skills, such as deliberation, critical thinking, decision-making, and action competence. Students as future citizens should explore and understand the reciprocity between the ecological and the human systems and the limits of growth and carrying capacity of earth and be able to act according to sustainability agenda (Jensen and Schnack 1997; Rees 2003).

In its essence, 'Sustainability' is about values and behaviors that take into account the limits of the natural environment in terms of supporting human beings. In other words, it refers to the ability of the human beings to continue maintaining a production level or quality of life for future generations (Daly 1990).

For achieving the goal of sustainability, Backstrand (2003) calls for a 'civic science' as an essential element in education for sustainability. Collaboration across disciplinary divides is a crucial component, both within and between natural science, social science, and humanities; further, decision-making relevancy including at local and institutional levels and holistic perspectives are the foundation stones of this new role of science in education for sustainability. Scientists have to engage more in communication with the public in regard to scientific inquiry and knowledge. However, as noted by Uzzell (1999) in the frame of the communication process, scientific knowledge is not given but rather socially constructed. Accordingly, the teacher's role is that of a facilitator of action competence, rather than just that of a simple provider of scientific knowledge.

Action competence, according to Uzzell (1999), is a way of thinking about and taking students through each stage of problem identification and solution generation.

Action competence is developed best if students obtain insight into environmental problems by interdisciplinary inquiry through working on projects (Jensen and Schnack 1997; Tal and Alkaher 2010; Tsevreni 2011). To achieve action competence, EE must have a goal related to citizenship behavior, especially ecological citizenship, which is about care and concern for the environment in the public and private spheres (Dobson 2003, 2007).

EE in Israel

Education about and for the environment has existed in various forms from the very beginning of Jewish-Israeli education at the end of the nineteenth century, in different settings, such as 'education for nature', 'nature and homeland studies,' or 'education for nature and heritage.' However, only since the 70s of the twentieth century has EE in Israel included content that emphasizes the involvement with and influence of human beings on the environment and hence the need to educate toward conservation of the environment (Tal 2009). In this context, EE in Israel has focused on the scientific aspects (physical, chemical, and biological), which explains environmental problems as involving mostly pollution and scientific knowledge (of water, air, etc.). As in other countries, also in Israel EE is not a mandatory subject in the school curriculum. The topics are included in the curriculum of other school subjects at elementary and junior high school levels, and environmental science is an elective major discipline in high school (Tal 2009). However, in the last decade, there has been a meaningful shift toward education for sustainability in schools, and the dominance of science classes as the main source of knowledge and activity in EE is under question. One of the triggers for that shift was the Ministry of Environmental Protection in Israel. In 2002, the Ministry drafted guidelines and indicators for 'Green Schools.' In this frame, schools are encouraged to integrate into the school curriculum environmental subjects across disciplines such as geography, science, and social studies. An additional criteria beyond those engaged in formal environmental studies is required to implement a community project aimed at increasing awareness of the environment and bringing about behavioral changes (Tal 2009). However, because of the lack of educational materials and teacher training programs in the field of education for sustainability, schools in Israel that wanted education for sustainability to be implemented among their students searched for content's solutions outside the formal education system (Tal 2009).

Therefore, as education for sustainability in Israeli schools has been receiving more attention in the last decade, it is necessary to develop innovative educational methods and contents in order to develop action competence and PEBs.

Against the above-mentioned backgrounds, the ecological footprint might be a suitable educational tool and concept.

The ecological footprint: from indictor to educational tool for sustainability

Ecological footprint accounting is one of the most comprehensive ecological indicators for measuring the fundamental conditions for sustainability. It is a resource and emissions accounting tool measuring direct and indirect human demand on the planet's regenerative capacity (bio-capacity) and comparing it with the bio-capacity available on the planet. This method of accounting biophysical resources is possible because flows of resources and wastes of a state, city, or even institutions (such as schools) can be tracked and expressed in terms of global hectares (Rees 1992; Wackernagel and Rees 1996; Wackernagel et al. 2006).

The ecological footprint is based on the assumption that different categories of human activity, such as energy and resource consumption and emission of waste, require a certain amount of productive or absorptive *land*. The total *land* required constitutes the ecological footprint of the population involved. In the present age of globalization, the area required to support the existence of a given human popula-

tion is much greater than and often very distant from the area in which that population lives (Barrett et al. 2005).

The ecological footprint has been calculated for nations, regions, products, and even the whole planet (Chambers, Simmons, and Wackernagel 2000; Kissinger and Gottlieb 2010; Lenzen and Murray 2001; Van Vuuren and Smeets 2000; Wackernagel and Rees 1996; Wackernagel et al. 2004). Such studies have highlighted the global impacts of consumption, but have not provided the intricate information at the institutional level (such as a school) needed for remediation. Detailed local information is particularly important for schools, which have the opportunity to mitigate their impact by reducing their ecological footprint.

In this context, we think that the ecological footprint is more than an indicator for sustainability. It has the merits of being an educational approach to sustainability, especially concerning overcoming some of the physiological perspectives of current global environmental problems. As noted by Uzzell (2000), the direct experience of global environmental changes at the human psychological level is unlikely because the physical signals of global environmental change are way below the threshold of discernibility of human sensory and memory mechanisms. Further, the time lapse between human actions (cause) and their noticeable effect on environmental change is measured in many years to decades (Uzzell 2000; Wackerangel and Rees 1996). As a result, citizens and future citizens who are disconnected in consciousness and by physical distances from the 'ecological space' that supports their daily life style are 'locked into' unsustainable behaviors and consumption patterns. Further, an individual who receives the benefits of an environmentally damaging action may not be the one who is likely to suffer the consequences of it and will probably be unaware of it (Uzzell 2000; Wackerangel and Rees 1996).

Therefore, global environmental issues such as global warming or diminishing of natural resources can be considered by students as abstract concepts, not connected to the local level or to their daily way of life style. This is partially because the knowledge is derived largely from 'dry science facts' taught by the teachers or transformed by the media, and partially because its usage in educational and scientific feedback that will pay attention to the above gaps is not common.

From an educational point of view, one of the ecological footprint's strengths is its ability to communicate effectively the notion that any society depends on ecological goods (resources) and services that might be beyond its local bio-capacity, and that we depend on the carrying capacity of supporting ecosystems that might be on the other side of the world. Calculating and exploring the school's ecological footprint enable students to discover their ecological space that is hidden from their eyes and from their consciousness, a space created by the interrelations between the students and the natural environment (Wackernagel and Rees 1996). In this sense, the ecological footprint as an indicator for sustainability might meet the demand for more transparent science that works in tandem with the needs of the society and the environment.

The ecological footprint as an educational approach reveals the story of how current behaviors and decision-making that are shaped by culture, globalization, trade, and economic expansion feed into the acceptance and rationalization of the exploitative relationship between industrial society and nature. In this context, the ecological footprint meets the aforementioned call for an interdisciplinary, decision-making relevancy, and holistic science in the frame of education for sustainability.

In sum, the ecological footprint as an educational tool was implemented on two complementary levels: (1) as an indicator for sustainability from which it is possible for school students to determine where the school's (students and institution) greatest impact is occurring and to rank-order consumption based on its contribution to the ecological footprint and (2) as an educational approach for conveying the message of sustainability based on interdisciplinary contents from the fields of sociology, ecology, and economics. Both levels aim to foster action competence and PEBs among students.

Action competence and PEBs

One of the overall objectives of EE is to build up students' abilities to act, or in other words, their action competence, with reference to environmental issues. The fundamental assumption is that environmental problems are structurally anchored in society and our way of living. For this reason, it is necessary to find solutions to these problems through changes at both the societal and the individual level (Barret 2006; Jensen 2002; Jensen and Schnack 1997).

According to Jensen and Schnack (1997), action competence has two main elements. The first element is that the student decides to do something (e.g. reducing consumption), alone or together with others, whether it is a question of a change in *behavior* or an attempt to influence the conditions of life (behavioral element). The second element is *activity* that is addressing the causes of the problem and solving it (inquiry element). In our study, for example, calculating the ecological footprint and exploring the relative impact of each component (e.g. food consumption, energy) on the total ecological footprint of the high school might be considered as an activity. Deciding on which operation to perform or behavioral patterns to carry out, in order to reduce the school's ecological footprint, is the action.

According to Jensen and Schnack (1997), action should not be equated to behavioral change. Behavioral change is a result of manipulation and 'telling the student how to behave.' It is characterized by efforts being made to influence students directly, outside the 'knowledge component,' and thus, not necessarily allowing them to make up their own minds and to decide on the intended behavioral change. On the other hand, the action is based on a student's inquiry and conscious decision and intention to act.

In the current study, we have developed the ecological footprint as an educational tool based on the action competence approach and we have measured its influence using variables taken from the field of environmental and social psychology dealing with PEBs.

PEB can be defined as the behavior adopted by an individual who consciously decides to minimize his/her negative impact on the natural and built environment (Kollmuss and Agyeman 2002; Rioux 2011). However, PEB does not evolve on its own. As Wackernagel and Rees (1996) note, uncertainty about the causes of ecological deterioration and about the future effects of current activities supports 'business-as-usual' strategies and behaviors. However, while citizens or future citizens may acknowledge the ecological footprint (their own, or of the school, or the community in which they live, etc.), their basic responsibility is to ensure that the ecological space is sustainable. This responsibility could be realized by developing sustainable behaviors in the private sphere, such as reducing consumption in general and changing consumption patterns (e.g. eating less meat), recycling

(e.g. recycling plastic bottles), preferring services (e.g. public transportation) over products (e.g. private car) (Dobson 2003).

The literature on PEBs is abundant with theories designed to explain the determinant factors underlying behavior (Darnton 2008; Monroe 2003). The variables that were employed by the present study are derived from three main theories:

(A) The Ecological Value Theory, according to which the term ecological values expresses an orientation among individuals toward the natural environment (Barr 2007). One of the early explanations of environmental behavior is the existence of an ecological worldview (EW) among individuals. In other words, individuals who hold environmental values are highly likely to behave in an environmentally responsible way. Different conceptualizations of values or environmental concern have been used, but environmental values have often been measured by the New Environmental Paradigm (NEP) scale (Dunlap et al. 2000; Dunlap and Van Liere 1978). The results of studies testing the above theory revealed that greater environmental concern is associated with acting more pro-environmentally, although the relationship is generally not strong (e.g. Poortinga, Steg, and Vlek 2004; Schultz and Zelezny 1998; Vining and Ebreo 1992).

(B) The Norm-Activation Theory claims that personal norms (PN) are the decisive factor in pro-social or altruistic behavior, including PEB, where PN are a strong moral sense of duty experienced by the individual regarding pro-social behavior. PN affect behavior only when they are activated. This occurs when individuals are aware of the consequences of their behavior on the welfare of other people and when they assume responsibility for these consequences. When these conditions are met, the personal norm is activated, leading to the desired behavior (Schwartz 1977). In a recent series of publications, Stern and co-authors (e.g. Stern 2000; Stern et al. 1995, 1999) applied a version of Schwartz's (1977) Moral Norm-Activation theory, developed, and tested the Value-Belief-Norm theory of environmentalism: a conceptual framework to explain environmentally significant behavior. According to the theory, there is a causal process in which acceptance of the New Environment Paradigm (values) is formally antecedent to beliefs (e.g. Awareness of Consequences, Ascription of Responsibility), which in turn activate PN and antecede actual PEBs (Stern 2000).

(C) The Planned Behavior Theory is based on a view of behavioral intentions (BI) as the factor that directly explains behavior (Ajzen and Fishbein 1980). BI are directly influenced by individual assessment of the required behavior. This assessment is related to, among other things, the degree to which the individual perceives the required behavior as within his or her control (perceived behavioral control, PBC). Several studies have demonstrated the usefulness of Planned Behavior Theory in predicting PEBs. For example, Boldero (1995) found that intentions to recycle newspapers directly predicted actual recycling and that attitudes toward recycling predicted the recycling intentions. In another study, attitudes toward green consumerism, subjective norms, and perceived control were all significantly related to the intentions of individuals to consume organic vegetables (Sparks and Shepherd 1992). Also in line with the theory, Taylor and Todd (1995) revealed that PBC was positively related to individual recycling and composting intentions.

It should be noted that while the above-mentioned theories were developed to explain PEBs by determinant or antecedents variables, in the current study we are interested in exploring the influence of the ecological footprint as an educational

tool by comparing between two groups of students: experimental and control. We measure the influence by using selected variables from the above mentioned theories as dependent variables in the current study (EW, PN, PBC, BI, and PEB).

Developing action competence by educational intervention program

In many schools' EE programs, the idea of involving the action competence approach is becoming increasingly important (Jensen and Schnack 1997). Yet, it should be asked: what are the contents and activities of such educational programs that might develop action competence and PEBs? Uzzell (1999) suggests an approach that is based on 'eight dimensions' in order to grasp environmental problems as structural and interdisciplinary problems. The 'eight dimensions' are the follows: (1) Choosing the subject of concern; (2) Specifying the specific nature of the problem; (3) Identifying the causes and consequences of the problem; (4) Identifying the relevant attributes and conditions to be changed; (5) Identifying the action possibilities; (6) Specifying constraints and barriers to change; (7) Establishing priorities for action; and (8) Selection of appropriate and sustainable actions.

According to Uzzell (1999), an EE program based on the above 'eight dimensions' captures the social and natural environment rather than simply the acquisition of learning or opinion formation. In this context, an EE program based upon the action competence approach is holistic and treats the environment as an integrated system.

Concerning the 'eight dimensions', Uzzell (1999) indicates that one might see each of the dimensions not simply as a developmental sequence of steps but rather as a set of dimensions where the educational process is iterative and can spiral back on itself, bringing the students back to a previous stage of their thinking. In this educational framework, students obtain insight into problems best as they themselves are allowed to experience the eight dimensions through working on a project. This also means that the teacher's role is that of a facilitator and consultant for the students rather than just a simple provider of knowledge.

Research hypotheses

Based on the theoretical background, our hypothesis is:

> If the ecological footprint is an appropriate concept for building action competence and encouraging PEBs among high school students, then we expect to find that students who are exposed to an intervention program will become students who are motivated to behave in a way that reduces their ecological footprint.

Our null hypothesis (H0) is that there will be no statistically significant difference between the two groups on each dependent variable.

The hypothesis was tested by comparing students exposed to an intervention with students who were not exposed and will be considered a control group. The effect of the intervention program was evaluated with respect to the following variables: EW, PN, PBC, BI, and PEB in the private sphere. We expected to find interactions between each of the measured variables and thereby provide evidence that the intervention program results in a significant difference between our experimental and our control group, and that a difference would be found between the students in the experimental group and those in the control group in terms of time

('before' and 'after') in all the measured variables (i.e. EW as measured using the NEP, PN, PBC, BI, and PEB).

A quasi-experimental design in municipal high school 'E' in the city of Haifa

Background

The present research was conducted in a public high school in the city of Haifa, Israel, during the course of the 2008/2009 school year. During that year, at Municipal High School 'E', the first author inaugurated an educational program based on the ecological footprint approach.

Municipal high school 'E' in Haifa is the largest public high school in the city. The city of Haifa is located near one of the extensive industrial zones, with its shore-based oil refineries and chemical plants, which have led to pollution of the bay water and the air. Though air pollution in the region is expected to be significantly reduced, during the last decade, the image of Haifa as a polluted city which suffers from high levels of air pollution has become permanent among its residents. The twin cooling towers of the Haifa oil refinery (which are no longer actually used) are a nationally recognized icon of Haifa as a polluted city and a local icon of the responsibility of the industry for the air pollution as well as for its remediation activities. Against this background of air pollution that is considered to be a highly rated local environmental problem, implementing educational programs based on sustainability issues is significant.

EE program

In order to incorporate the ecological footprint in the school, the students in the tenth-grade cohort were selected to be taught the ecological footprint subject. The

Table 1. EE program.

No.	Dimension (Uzzell 1999)	Main contents
1	Choosing the subject of concern	From local to global: environmental problems in the twenty-first century; the ecological footprint of the high school
2	Specifying the specific nature of the problem	Resource consumption in school (e.g. food, energy, materials) and ecological footprints; theoretical foundations of the ecological footprint
3	Identifying the causes and consequences of the problem	Economic growth and globalization vs. ecological economics
4	Identifying the relevant attributes and conditions to be changed	Data collection at school (energy, food, materials, transportation); school's ecological footprint: calculation and analysis
5	Identifying the action possibilities	Developing 'changing consumption scenarios' based on ecological footprint results
6	Specifying constraints and barriers to change	Globalization, trade and consumerism, habits
7–8	Establishing priorities for action and selection of appropriate and sustainable actions	Developing an action plan to reduce school's ecological footprint

first author integrated the educational program into the geography course and personally taught the classes. The educational program consisted of two main components: (1) a theoretical, inter-disciplinary component based on content material from the social sciences and ecology fields; and (2) a practical one that included the calculation of the ecological footprint of the school and exploring ways to reduce it. The educational program was developed based on the 'eight dimensions' concept suggested by Uzzell (1999), as can be seen in the following table.

The process

The educational program began in October 2008 and continued until May 2009. In its framework, the first author met regularly for 1 h a week with four of the tenth-grade classes that participated in the program (total: 20 meetings). The teaching method was varied and included lectures, films, discussions, and experimental work assignments. The students were exposed to interdisciplinary content material that is not included in the regular teaching curriculum of the school.

The theoretical groundwork was meant to impart to the students an awareness and understanding of the unconsciously perceived link between the patterns of consumption, pro-environmental behavior, and their influence on life-supporting ecological systems. During December 2008, the students and the first author calculated the ecological footprint of the high school in four main spheres: food, energy, transportation, and materials. The results indicated that the ecological footprint size of the school was 320 Ha for the year 2008/2009. The main components were food (38%, 120 Ha) and electricity (35%, 113 Ha), followed by materials (19%, 62 Ha) and transportation (8%, 25 Ha).[1] For the first time, the students were exposed to an ecological space hidden from their sight and consciousness, a space created by the interrelations between the students and the natural environment, which could be quantified by the ecological footprint.

The realization that the ecological area 'consumed' by the school students (320 Ha) was significantly greater than that of the physical area of the school (2 Ha), and the understanding of the students regarding the reasons for this made it possible to advance to the next stage: the development of an action program to reduce the ecological footprint. The action plan was suggested by the students themselves during February 2009. It was based on changes in behavior consumption patterns in each of the ecological footprint domains, that is, food, energy, transportation, and materials. For each calculated domain, we were able to present an estimated calculation of the school ecological footprint size, so that it could be determined where actual changes should be made in consumption patterns. For example, in the domain of food, the students suggested encouraging the consumption of food based on egg and cheese sandwiches, and fresh fruit and vegetables rather than processed food. In the domain of energy, they suggested reducing the use of air conditioners in the classrooms. In the domain of transportation, it was suggested that students who lived within a radius of 2 km of the school should be encouraged to arrive on foot or by public transportation, and students who lived at a distance greater than 2 km should use public transportation to reach the school. In the domain of materials consumption (plastic and paper), solutions were suggested based on a reduction in consumption and an increase in recycling. The students also suggested that in order to internalize these changes in behavior among the school community, a 'Green Council' should be established, composed of representatives

of different age levels in the school, with the task of suggesting methods of action based on supervision and enforcement (in the domain of energy), and on education and information (food, transportation, and materials). The educational program in the school ended in April 2009.

Methods

Population and participants

Municipal high school 'E', in Haifa, was established in 1962. Today, it is the largest public high school in Haifa, with 1520 students and 47 classes from seventh to twelfth grade (12–18 years old). The majority of students are Jewish, including new immigrants from the Ex-Soviet Union and Ethiopia, but there are also Druz and Arab students. The majority of the students come from the near neighborhoods whose population is considered to be working and middle-class.

Out of 1520 students in the high school, six tenth-grade classes (16–17 years old) were chosen to participate in the research ($N = 216$).[2] The main reason for choosing these tenth-grade classes was the possibility of transmitting the program in the framework of geography lessons taught as a part of this grade's curriculum. Four classes were assigned randomly to the experimental group ($N = 130$), and two classes were allocated to the control group ($N = 70$). Both groups filled in identical questionnaires at the same time 'before' and 'after' the intervention program (whereas the control group experienced no intervention). It should be noted that while the experimental group was exposed to the educational program based on the ecological footprint approach, the control groups continued with the regular geography classes according to the formal curriculum.

Limitations of the study

As a quasi-experimental study, there are certain limitations that emerge from the setting of the research design. First, the limited sample size in our research does not allow for generalization of the presented findings. We acknowledge that larger sample sizes would reinforce the findings.

Second, we did not collect information as to whether the school's teacher of the control group may or may not have introduced methods that resembled any portion of those used with the treatment classes. This might reflect a potential internal validity threat in the current study. Third, as a quasi-experiment research that was held in a social setting (the high school), there is a (risk) potential for cross-contamination between experimental and control groups, for example, when content of the educational program diffuse from the experiment group to the control groups, thus 'treating' them, too. As a result, any difference that was detected between the experiment and control groups may theoretically be reduced. Fourth, because of the limited period of the environmental program, there was no follow-up to the study after the termination of the educational program, and therefore, evidence is not available to suggest that any (positive) influences continued to have an effect. A further limitation refers to the fact that PEBs were reported by a questionnaire. Therefore, the results of this study need to be read with the caution that they rely on young people's self-reported behavior or stated intention to act, rather than observed evidence of their action.

Variables

EW was measured by the NEP scale. (Total: 15 items) (Dunlap et al. 2000). Response options ranged from 1 (strongly disagree) to 5 (strongly agree). The internal consistency calculated in the current research indicated a high level of reliability before and after the intervention (Cronbach's alpha = .81 Cronbach's alpha = .74, respectively).

PBC was measured by five items that addressed the students' beliefs that they, personally, have the will to engage in actions that can help solve environmental problems. Response options ranged from 1 (strongly disagree) to 5 (strongly agree) (Ajzen and Madden 1986; Axelrod and Leheman 1993). The internal consistency calculated in the current research indicated a high level of reliability before and after the intervention (Cronbach's alpha = .79, Cronbach's alpha = .75, respectively).

PN: Following Schwartz (1977), the items concerning PN were preceded by a prompt emphasizing that the respondent should give a personal view concerning pro-environmental behavior. The concept was measured by five items, using Vining and Ebreo's (1992) items assessing PN: 'I feel a strong personal obligation to …' Response options ranged from 1 (strongly disagree) to 5 (strongly agree). The internal consistency calculated in the current research indicated a high level of reliability before and after the intervention (Cronbach's alpha = .79, Cronbach's alpha = .81, respectively).

BI: Answering on a 5-point rating scale ranging from 1 (strongly not ready) to 5 (strongly ready), participants completed a series of 23 items designed to assess the degree of their intentions to behave in a pro-environmental way in the private sphere. The internal consistency calculated in the current research indicated a high level of reliability before and after the intervention (Cronbach's alpha = .91 Cronbach's alpha = .92, respectively).

PEB was measured by 23 items based on the General Ecological Behavior scale asking about private-sphere environmentalism (Kaiser 1998). The internal consistency calculated in the current research indicated a high level of reliability before and after the intervention (Cronbach's alpha = .88 Cronbach's alpha = .88, respectively).

Results

A MANOVA was conducted in order to test preliminary differences between the experimental and the control group in pre-test dependent variables. Prior to testing group differences, a homogeneity of variance Leven's test was conducted, indicating no significant differences between groups on variance of all of the dependent variables. An additional test of normality was conducted in order to examine the normality of the dependent variables. The results showed a deviation from normality in the variables of EW, PN, and PBC (K-$S_{(200)}$ = .08, p = .01; K-$S_{(200)}$ = .11, p = .001; K-$S_{(200)}$ = .10, p = .001, respectively). The results of the between groups comparison indicated nonsignificant differences (Multivariate F (5,194) = .94, p = .45). As the assumption of normality was violated, additional nonparametric Mann–Whitney tests were conducted, yielding no significant differences between groups as well.

Table 2. Descriptive statistics among experimental and control groups regarding outcome variables.

Variables		Exp		Con		
		Mean	SD	Mean	SD	Cronbach's alpha
EW	Before	3.37	(.57)	3.40	(.52)	0.81
	After	3.35	(.85)	3.30	(.96)	0.74
PBC	Before	3.35	(.85)	3.30	(.96)	0.79
	After	3.30	(.78)	2.98	(.90)	0.75
PN	Before	2.62	(.81)	2.55	(.89)	0.79
	After	2.88	(.84)	2.45	(.81)	0.81
BI	Before	3.13	(.64)	3.01	(.70)	0.91
	After	3.30	(.64)	2.95	(.86)	0.92
PEB	Before	2.49	(.61)	2.51	(.70)	0.88
	After	2.55	(.61)	2.45	(.73)	0.88

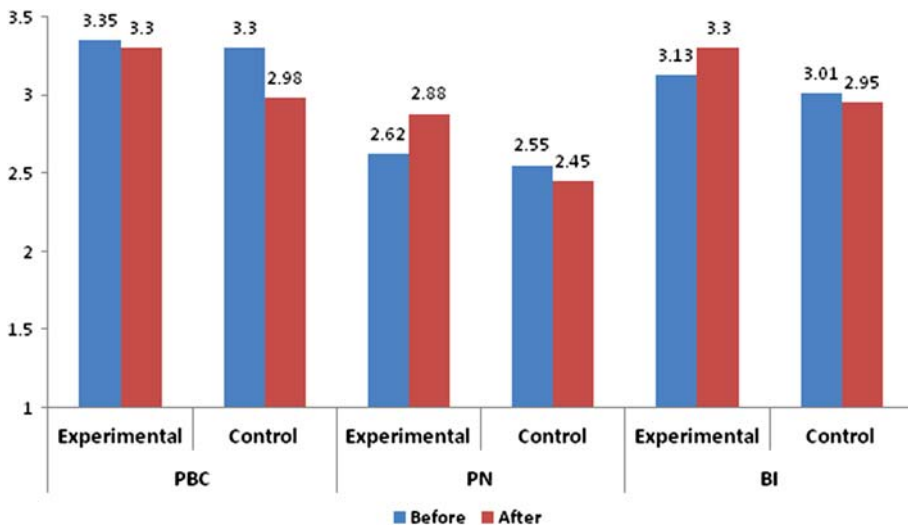The header "Group experiment vs. control" spans the Exp and Con columns.

Figure 1. Mean scores of PBC, PN, BI, before and after intervention program.

The research hypothesis was tested with ANCOVAs. Each of the pre-test variables was used as a covariate and the respective post-test variable was used as a dependent variable. Group was the independent variable (Table 2).

EW

No significant effect of group ($F(1,197)=3.38$, $p=$ N.S) was noted for NEP.

PBC

A significant effect of group ($F(1,197)=8.08$, $p=.005$) was noted for PBC. Means in Table 1 indicate that the experimental group attained almost similar scores in the

post-test and the pre-test ($M = 3.30$; $M = 3.35$, respectively), while the control group attained lower scores on post-test than on pre-test ($M = 2.98$ in post-test and 3.30 in pre-test). The magnitude of change in the experimental group was a reduction of 1% (from $M = 3.35$ to $M = 3.30$ out of maximal score of 5) as compared to a reduction of 6% (from $M = 3.3$ to $M = 2.98$ out of maximal score of 5) in the control group (Figure 1).

PN

The ANCOVA results indicated a significant effect of group ($F(1,197) = 12.96$, $p < .001$). As can be seen in Table 1, while the experimental group attained a higher PN score after the intervention than before, the control group mean was lower. The magnitude of change in the experimental group was an improvement of 5% (from $M = 2.62$ to $M = 2.88$ out maximal score of 5) as compared to a reduction of 2% (from $M = 2.55$ to $M = 2.45$ out of maximal score of 5) in the control group.

BI

The results indicated a significant effect of group ($F(1,197) = 10.39$, $p = .001$). The experimental group attained a higher score for BI after the intervention; the control group mean was almost unchanged.

The magnitude of change in the experimental group was an improvement of 3% (from $M = 3.13$ to $M = 3.3$ out of maximal score of 5) as compared to a reduction of 1% (from $M = 3.01$ to $M = 2.95$ out of maximal score of 5) in the control group.

PEB

The results show no significant effect of group ($F(1,197) = .25$, N.S).

In sum, the results show that concerning EW and PEB, there is no significant difference between the experimental and control groups. However, concerning PBC, while the experimental group maintained a similar level of PBC, in the control group there was a decline in reported levels of PBC. Therefore, the results show a significant difference between the experimental and control groups. Concerning PN and BI, the results show significant difference between the experimental and control groups.

Therefore, the null hypothesis was rejected regarding the variables PBC, PN, and BI.

Discussion

The aim of the current research was to evaluate the effects of an ecological footprint–based educational program on the EW, PN, PBC, BI, and PEBs of students in one public high school in the city of Haifa. For the first time, during the educational program students were exposed to an ecological space hidden from their eyes and from their consciousness, a space created by the interrelations between the students and the natural environment, which can be quantified by the ecological footprint.

The main reason for the lack of a significant difference between the experimental and control groups for EW could be a relatively high degree of environmental

consciousness among the students. In recent years, EE in Israel has been developing rapidly in schools through the initiative of teachers in the schools or by 'importing' educational programs developed mainly by environmental NGO's and the Ministry of Environmental Protection (Tal 2009; Yavetz, Goldman, and Pe'er 2009). Students are also exposed to the environmental agenda via the electronic and printed media, which began to cover these issues consistently during the last few years. Therefore, it is not surprising that no difference was revealed in EW between the experimental and control groups after the educational program ended.

One of the interesting outcomes of this study is concerned with PBC. While the experimental group maintained a similar level of PBC between the pre- and the post-intervention measurements, in the control group there was a decline in reported levels of PBC. Although, a significant difference was revealed between the groups, we expected that there would be an improvement in the level of PBC in the experimental group in the post-intervention measures. In fact, the educational program prevented a decline in PBC levels among students who participated in the program.

Traditionally, the science-oriented approach to EE was criticized for overwhelming students with knowledge about how bad things actually are, resulting in contributing to the feeling of powerlessness felt by students (Jensen and Schnack 1997). In the present study, the program's failure to increase levels of PBC among students in the experimental group might suggest that the path to pro-environmental behavior in our case may be through moral or PN where significance differences were found between the experimental and control groups after the intervention program was ended. The educational program based on the ecological footprint enabled students to explore critically the influence of their behavior on ecological resources and services by developing an action plan based on ecological footprint calculations. A strong moral commitment (e.g. PN) among students in the experimental group to implement pro-environmental behavior indicates that the course to encourage ecological behavior might be to activate altruistic norms (i.e. PN) using messages that highlight the social or environmental consequences of specific behavior, and that the importance of individual action might be an effective approach in promoting pro-environmental behavior. As one of the students in the 'experimental class', expressed it:

> When the teachers spoke to us about global climate change, the melting of icebergs, and the danger that threatened the polar bears and environmental resource depletion and pollution, I was unable to understand the extent of my own personal responsibility for this. I always thought that, since the large corporations were responsible for the environmental degradation, they were also responsible for rectifying it. (10th grade student)

Therefore, EE that is directed to raise environmental consciousness is not sufficient for promoting personal responsibility and BI toward the environment. Rather, a perceived connection between personal behaviors and the natural environment should be (re)established. The ecological footprint concept might be an appropriate starting point for achieving this goal. As we can see from the results of our study, while in BI, a significant difference between groups was noted after the educational program was ended; however, in self-reported behavior, no significant difference between groups was noted. The literature on social psychology noted the intention–behavior gap, by highlighting that the relationship between intentions and actual responsible behavior is weak (Kollmuss and Agyeman 2002). It seems to be that more factors

influence pro-environmental behavior, such as 'situational factors', which include economic constraints, social pressures, and opportunities to choose different actions (Barr 2007; Hines Hunferford, and Tomera 1986; Stern 1999). The theories discussed in the current study focus on individual motivations influencing environmental behavior. Obviously, human behavior does not depend on motivation alone. Many 'situational factors' may facilitate or constrain environmental behavior and influence individual motivations. For example, the availability of recycling facilities in the school, the quality of public transport between the school and the home, the market supply of goods (for example, school's cafeteria), or pricing regimes can strongly affect people's engagement in pro-environmental behavior (e.g. Van Diepen and Voogd 2001; Vining and Ebreo 1992). In some cases, constraints may even be so severe that a behavioral change is very costly and motivation makes little difference in the environmental outcome (e.g. Corraliza and Berenguer 2000; Guagnano, Stern, and Dietz 1995). Another explanation might be the short period of the intervention program, which encouraged the development of PN and BI but did not evolve into significant change in PEB.

From an educational point of view, we think that the incorporation of the ecological footprint concept into school teaching curricula will have a number of benefits. First, ecological footprint might be an important part of the education for sustainability agenda in schools. Within the framework of this vision, the school imparts to its students understanding, critical thought, and mental and behavioral sensitivity toward the environment and its natural resources that constitute part of the common world wealth and heritage. Second, with regard to monitoring and raising awareness, in order to calculate the ecological footprint, a school community will have to monitor its current material and energy consumption. This monitoring generates valuable information about the relative contribution of specific activities and behavior patterns to the overall school ecological footprint. Being able to draw up a balance sheet of the school's ecological footprint enables students to understand that the impact of their activities and lifestyles goes beyond the narrow limits of the school boundaries or the family, community, and state in which they live. Third, with regard to self-governing and action, education for sustainability based on the ecological footprint analysis has the potential to provide, in addition to knowledge, the capacity to plan and manage changes toward sustainability within the school community. A school does not become 'green' by conserving energy, collecting batteries, or sorting waste. The crucial factor must be what the students learn from participating in such activities and decisions (Jensen and Schnack 1997). Ecological footprint calculation provides data using which the students can make responsible informed decisions and set targets to reduce the ecological footprint of their high school. Furthermore, these students are also members of families that may be influenced by their children to reduce the ecological footprint of their households.

In Israel, EE programs in the natural sciences include environmental materials, especially in elementary and intermediate schools. The topics are usually concerned with environmental pollution (in air, water), but very little attention is given to the social and behavioral aspects that should be at the center of interest in EE for sustainability. Therefore, the ecological footprint, both as a measuring tool on the one hand, and as an educational perspective on the other, can bridge the gap between the natural sciences and the social disciplines, which means dealing with the connection between environmental problems and the critical examination of social, economic, political, and behavioral issues.

Future research is necessary to allow generalization of these preliminary results. Research involving classes from broader age groups, larger sample sizes, and replications within various schools are required. Future research might also implement the ecological footprint indicator as a measure 'before' and 'after' the intervention program in order to monitor changes stemming from actual PEBs of students.

Notes
1. For details on school's EF calculations, see: Gottlieb et al. (2012).
2. Sixteen pupils dropped out as they did not complete the pre or/and the post questionnaires.

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Appendix

Sample of questions from the research's questionnaire attributed to students (experimental and control groups).

Variable	Item	Strongly agree	Mildly agree	Neutral	Not agree	Strongly disagree
EW	We are approaching the limit of the number of people the earth can support	5	4	3	2	1
PBC	It is hard for someone like me to do anything for the sake of the natural environment	5	4	3	2	1
PN	Because of my personal norm, I feel personal obligation to purchase local products in order to preserve the natural environment	5	4	3	2	1
BI	I intend to purchase local products in order to preserve the natural environment	5	4	3	2	1
PEB	I purchased local products in order to preserve the natural environment	5	4	3	2	1