ESD Pedagogy: A Guide for the Perplexed

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ABSTRACT: The present article addresses issues regarding implementation of Education for Sustainable Development (ESD) within the formal education systems. In particular, it aims at identifying the basic essential components of ESD pedagogy. We present a theoretical pedagogical framework based on accumulating theory and experience in the field. The framework aspires to encompass the majority of prevailing pedagogies within a simple set of four basic principles. It will be argued that the four principle pedagogies are basic and indispensable prerequisites for achieving the goals of ESD. As such, lack of one suffices to undermine the ESD's pedagogical construct.

KEYWORDS: Education for sustainable development (ESD), environmental education (EE), pedagogy, responsible environmental behavior (REB), sustainability literacy, environmental literacy.

Introduction

Recent literature on education for sustainable development (ESD) and environmental education (EE) ascribes an avalanche of highly diverse pedagogies for formal schools' EE/ESD[1]. However, this high diversity is perplexing in terms of pedagogical framework of implementation. Stevenson (1987) brought to the center of attention the discourse–practice gap and argued that one of the contributing factors is that issues of practice have been silenced within the discourse of the field (Stevenson, 2007). In line with this claim, we would like to argue that throughout the three decades of EE practices within school systems and the later entree of ESD, the contents of the curricula have undergone profound changes, but the practiced pedagogy has not. Today, in most schools in

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[1] See box 1 for comments regarding the use of the terms EE and ESD in reference to the issues discussed in the present assay.

Box 1: The terms EE and ESD with regards to the present discussion of pedagogy

The discourses of EE and ESD have been for years an on-going site of struggle (Stevenson, 2007) regarding issues of educational policies, goals, scope, and strategies of implementation. The relationship between EE and ESD as seen in the literature can be described by either one of the following figures.

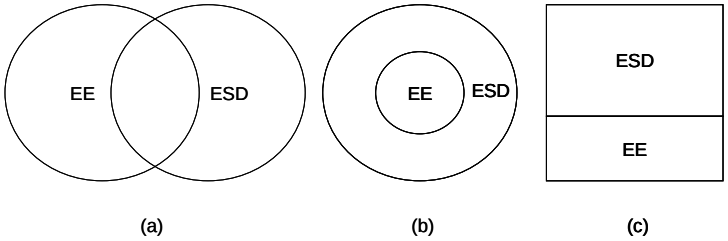

Figure 1 (a-c): Illustrations of different perceptions on EE – ESD relationship

In figure 1(a), EE and ESD are perceived as separate fields of education with areas of overlap (Breiting et al., 2005; Fien and Tilbury, 2002). In figure 1(b), ESD is perceived as engulfing EE. ESD, according to this perception, is a field that absorbed EE and expanded its boundaries (De Haan and Harenberg, 1999). In figure 1(c), EE and ESD are perceived as two separate fields, where EE comprises the foundation of ESD, yet, the later has evolved as an educational practice on its own (Fien, 1997; Huckle, 1999; NSW Council on Environmental Education. 2006; Tilbury, 1995).

Sauvé (1996) described some aspects of the above relations in the following words: *'For some, sustainable development is the ultimate goal of environmental education. For others, sustainable development refers to specific objectives, which should be added to those of environmental education'* (p. 18). Stevenson (2007) claimed that over the past twenty years, the discourses of ESD have largely displaced that of environmental education in international policy circles. Scholars debate whether this transition is progressive or regressive. According to Stevenson (2007) the discourse of ESD creates a broader and more complex agenda than environmental education, which is simultaneously more ambitious and more ambiguous.

Alongside with the expansion of the scope of EE/ESD a question arose regarding the relationship between education and EE/ESD. David Orr claimed that '*all education is environmental education*' (p. 90). In recent years researchers and policy statements called for reorienting education towards sustainable development (Fien, 1997; Fien & Tilbury, 2002; Hopkins & McKeown, 2002; NSW Council on Environmental Education, 2006; Tilbury, 1995; UNESCO, 1995b) Thus discarding all together the boundaries between education and EE/ESD.

The writers share Orr's view that high quality education is equivalent to EE, as well as ESD and the hub of it lies within the pedagogical practices. Within the contestant views regarding EE, ESD, and education, it is believed that regardless of the differences in the ways in which these terms are understood, they all share some core components regarding skills acquisition through high quality pedagogy. The pedagogical principals proposed in this assay refer to this area of overlap, hence allowing us to use the terms EE and ESD interchangeably.

developed and many developing countries students are exposed to some sort of environmental education or rhetoric. This was not the case at all 30- 40 years ago. But though the contents of learning have changed, the prevailing pedagogy is still the same as it was throughout the 100 years in which the environmental crisis was developing. In this aspect, Stevenson (1987)'s words are true today as they were 20 tears ago. Teachers are still continuing to carry out "*pedagogical practices of transmitting discrete disciplinary-derived factual information and unproblematic 'truths'*" (p. 140).

The rhetoric – pedagogy gap can be demonstrated in the following examples: UN's Draft Implementation Scheme (IIS, 2004) for the Decade of Education for Sustainable

Development (DESD) laid forward fifteen strategic perspectives, which are organized in three spheres - socio-cultural, environmental, and economic. Each perspective (respectively) includes subtopics such as: Gender equality, climate change, and poverty reduction. The IIS directs that the strategic perspectives which comprise the scope of ESD, and the connections between them, should be addressed in the process of education and learning for sustainable development. Similarly, UNESCO's all encompassing vision perceives ESD as equally addressing three pillars - society, environment, and economy, adding culture as an essential underlying dimension (UNESCO; n.d.). Gough (2006) referred to the complexity of the strategies' applicability, by questioning whether the UN's DESD agenda is too broad for implementation within such programs as sustainable schools; and if so, how should it be implemented in schools?

Examining the evolution of EE/ ESD's goals over time reveals that the two following major goals, have been a serious concern among researchers during the past three decades: (a) Acquisition of *responsible environmental behavior* (REB) (Goldman et al., 2006; Hines, Hungerford, & Tomera, 1987; Hsu, 2004; Hungerford & Volk, 1990; Marcinkowski, 1989; Marcinkowski, 2004; Negev, et al., 2008; Sia et al., 1986;Simmons, 1991), and (b) *active citizens' participation* (Breiting et al., 2005; Lundegård & Wickman, 2007; Meinhold & Markus, 2005; Pettigrew & Somekh, 1994; Posch, 1999; UNESCO, 1978; Uzzell, 1999). These goals of REB and active participation have been widely researched both in the informal and formal education contexts. Behavioral changes and intention to act have been associated with influencing factors such as: Gender, length of exposure to EE programs, socio-economic status, and environmental knowledge and attitudes (Chawla & Cushing, 2007; Rickinson et al., 2004; Zelezny, 1999). In spite of the importance attributed to REB and active participation, there is still an open question regarding the underlying pedagogy that should be employed in order to achieve these goals.

The REB-participation dilemma and the perplexing rhetoric regarding policy and strategy implementation, can be farther demonstrated by referring to the concluding recommendations of UNESCO-UNEP's 4th International Conference on Environment Education (Ahmedabad, 25-27, November, 2007). The working group on "Reorienting formal education towards ESD: Strategies, pedagogy, and assessment" did not help in clearing the clouds, and remained within the vague zone. The final recommendation was that "*Pedagogical practices leading to improved curricular outcomes should be focusing on high levels of intellectual quality, and importance of the learning environment in which*

learners can see the significance of learning…..A set of principles relating to ESD should be developed by each nation using the appropriate pedagogy" (ICEE; n.d.). Stevenson (2007) previously referred to such recommendations as aspirations which are devoid of context. Stevenson claimed that the ESD discourse describes ideals and lofty aims but leaves out *'the circumstances necessary to their fulfillment'* (Goodlad, 1997, p. 14). The above recommendations regarding ESD pedagogy, immediately elicit questions such as: What are "high levels of intellectual quality"? What is "appropriate pedagogy"? And what is "learning environment in which learners can see the significance of learning"?

The present situation of discourse-practice gap poses serious obstacles for schools in their attempts to move forward and implement ESD curricula. Stevenson (2007) called for transforming the policy discourse into teachers' own discourse of practice, and most importantly, into pedagogical actions.

Within this context of ambiguity in the area of pedagogy on one hand, and overarching all encompassing policy and strategies on the other hand, the questions that arise are:

a. Can we aid practitioners by specifying what should be considered as the fundamentals of ESD pedagogy in the formal education system?
b. Is it possible to define key features that can be considered as comprising a dividing line between ESD and non-ESD?
c. Is it possible to offer education practitioners a clear and rather simple set of "rules of thumb" for easily determining whether they are carrying out ESD or not?

This article aims to present such "rules of thumb", which define ESD pedagogy's basic and essential components. These ESD pedagogical essentials will later be viewed in the context of other prevailing pedagogies that are currently recommended.

The essentials of ESD pedagogy

The process of identification of the essential components of ESD pedagogy followed two paths:

a. Analysis of EE/ESD programs that were described in the literature and evaluated with regards to achievement of behavioral changes; and,
b. development of a pedagogical framework that meets the conclusions of the above analysis and builds a four layers theoretical structure.

In the present article we will present the process in a reversed order. First, we will present the theoretical foundation of the pedagogical framework. This will be followed by analysis presentation of EE/ESD programs, which will provide empirical grounding for the theoretical concepts. As will be discussed ahead in the closing remarks of the assay, farther meta-analysis is required for empirical establishment of the presented concepts.

The four pedagogical essentials are introduced in layers, beginning from an initial phase of traditional prevailing academic learning pedagogy, which was termed by Orion (2003) as "non-natural learning". It advances by gradually adding pedagogical components which are considered in the literature as essential to reorienting education towards ESD. In order to illuminate how these pedagogical components work, it is useful to describe them on the background of a learning context. For example: A class of students somewhere between 11-15 years old, a teacher, and water pollution - as a sustainability issue being learned. Within this setup, beginning at step 1 and culminating at step 4, an attempt will be made to formulate the essentials of ESD pedagogy. At each step, one additional essential component will be introduced. Each one of the components is regarded as essential but not exclusive. It will be argued that all four essential components need to be implemented together in order to achieve the goals of ESD.

Step 1: Traditional Academic Style of Teaching and Learning - Non Natural Learning

One aspect of pedagogical approaches to EE/ESD concerns the introduction of elements of natural learning processes into the classrooms. Orion (2003) distinguished between two extreme types of learning styles. He defined them as "natural learning" versus "non–natural learning". Non-natural learning is the prevailing academic style of learning which was characterized by Orion (2003) as: "Taking place in a closed space that has no relation to any learnt subject; only rarely includes real life concrete experiences with the subject to be learnt; has no immediate relation between the subject to be learnt and learner's relevant world; verbal communication replaces the experience through description of imaginative situations; the learning is carried out among a large group; and it is very difficult to adjust the learning for individuals' (specific needs)" (p. 58). All these characteristics are opposite to those found in "natural learning" which is situated at the end of a continuum.

Orion's "non-natural learning" is chosen as a starting point, since it describes well the pedagogy which was most dominant when EE was emerging some 30 years ago. It is

still characteristic of most prevailing schools' education pedagogies today. An example of such a learning pedagogy would be as follows: A chemistry teacher stands in front of the class and lectures about water pollution. Students take notes. She/he lists polluting agents and their effects on various water sources, the chemical composition of these agents, and their characteristics. She/he presents on the board figures and graphs. Later on, the teacher demonstrates how detergents, heavy metals, and sewage affect water composition and the negative effects of polluted water.

This academic teaching pedagogy, a product of the *Age of Enlightenment*, supports development of analytical-rational modes of intelligence. However, would this suffice to constitute ESD? Increasingly, EE and ESD research indicates that the answer is "no". This answer is in practicality self evident, since this educational pedagogy has been dominant in the formal education systems throughout the years in which the environmental crisis was developing. The next steps (2-4) to be considered would therefore be pedagogical approaches in the realm of "natural learning".

Step 2: Multidisciplinary Learning (Inter and/or Cross Disciplinary)

An example of inter/multidisciplinary teaching-learning pedagogy would be as follows: A teacher, or a few different professional teachers, would teach the students chemical, biological, and physical characteristics of water, as well as their socio-economic implications. In the laboratory, students will conduct experiments and tests, demonstrating characteristics such as: Freezing and boiling points, pH, water hardness, nitrogen ions, total chlorine, bacterial growth indicators, effects of detergents on surface tension and on nutrients enrichment, and effects of water softeners on mineral composition. Further on in their learning, they will take samples from a water source near by school (lake, river, or ground water) and analyze it in the lab or in the field, identify fauna and flora, and assess the effects of water pollution on the current state of the ecosystems, as well as on society and the community's economy. They will examine aspects such as effects of pollution on recreation and health, and estimate the economical costs of pollution.

The above pedagogy combines knowledge from a variety of disciplines: chemistry, physics, biology, sociology, and economics. Inter/multidisciplinary approaches to learning are considered in the literature as capable of supporting acquisition of system thinking and the formation of linkages between causes and effects within systems. The importance of system thinking with regards to ESD is highly emphasized in the literature (Breiting,

Mayer, & Mogensen, 2005; Fien & Tilbury, 2002; Hopkins & McKeown, 2002; Mogensen & Mayer, 2005). Mogensen & Mayer (2005) claimed that multi-perspective analysis is needed if students are to gain in-depth knowledge of environmental problems. Coyle (2005), in his report on "What ten years of NEETF/Roper research and related studies say about environmental literacy in the U.S.", stressed that the lack of understanding of complex causal relationships is the single biggest problem in the environmental knowledge gap in the US. Porritt (2007), in his book "Capitalism as if the world matters", also emphasized the major problem that is created by the difficulty in seeing things as systems rather than as discrete elements within those systems.

Looking back at Orion's (2003) continuum**,** the inter/multidisciplinary pedagogy described above could score as highly immersed in "natural learning". But can this pedagogy actually produce the goals of ESD? Would these learning processes lead students to change their daily behavior towards water conservation? Would they actively exert influence on their families in order to change their daily habits, such as usage of detergents, water reuse, and so on?

Research indicates that acquisition of environmental knowledge and attitudes do not necessarily lead to change in behavior (Hines et al., 1987; Hungerford & Volk, 1990; Marcinkowski, 2004). Furthermore, while attitudes cannot predict behaviors, conversely behavior cannot predict attitudes. (Abelson, 1972; Doyle, 1997; McGuire, 1985; Wicker, 1969). The lack of inference relationship between attitudes and behavior has also been researched in a broader context of cognitive psychology, which showed existence of complex relationships between these factors (Doyle, 1997). A meta-analysis of 797 studies of psychological literature found that situational constraints, such as perceived social pressure and perceived difficulty, weaken the relationship between attitudes and behaviors (Wallace et al., 2005).

It is most likely that system thinking would not directly influence behavior either. Since system thinking is an aspect of cognitive knowledge, it is still in the frame of "knowing the world". Evidence is emerging that complex cognitive structures, such as mental models of systems, are not necessarily related to behavior in ways that can be predicted *a* priori (Broadbent, 1977; Doyle, 1997; Norman, 1983). As such, multidisciplinary learning alone is an important parameter, but not sufficient to directly influence behavior.

Step 3: Multidimensional Learning

Consider step 1 - the academic learning, step 2 - the multidisciplinary system learning, with the addition of time and space dimensions. The example is as follows: Students visit various water sources in their community and conduct comparative analysis of water samples. They learn how these watersheds are connected and interrelated, how and why they differ, and how and why they are similar. The teacher asks the students to go to visit the town's archive and bring historical documentation of the water sources, including social, physical, and biological watershed parameters - fauna, flora, and the community's physical, biological, and cultural practices in historical times. Back in the class, on the basis of current data and available knowledge, the children create a time scale to project changes which occurred in the ecosystem. Children create multidimensional presentations (e.g. charts, models, artistic presentations) in time and space showing the flows of effects between systems. They look at special dimensions such as the interconnectedness between the studied water systems and other external systems such as air, soil, fauna, and flora, human constructions, society, culture, and economics.

Looking at systems in multidimensional ways, both in time and in space, allows development of contextual ways of thinking (Hopkins & McKeown, 2002; Breiting et al., 2005), and acquisition of abilities to think "out of the box" and investigate systems in their relations to other systems, other spaces, and other times. It allows visioning change and development of an intuitive sense of non-linear changes in time and space. The interactions within and between complex adaptive systems are often more important than the discrete actions of the individual parts. These interactions are the generative core of productive, valuable, new, and unpredictable capabilities, that are not inherent in any of the separate systems acting alone (Lane & Maxfield, 1996). System thinking alone can often overlook these generative processes, whereas multidimensional combined with system thinking, can uncover phenomena that were overlooked otherwise. Gunter Pauli (ZeriLearning; n.d.) stated that "If we only teach our children what we know, they will only do as badly as we have". This statement alongside with Albert Einstein's saying that "The significant problems we face cannot be solved by the same level of thinking that created them", calls for equipping children with the skills needed to leap "out of the box"', out of the western traditional mechanical, rational, one-dimensional, and linear learning and doing patterns.

The troubling question still remains: Does this pedagogy foster behavioral changes? Do these pedagogical elements constitute the basic demands for ESD? As in the previous step, the answer is that multidimensional learning is similar to multidisciplinary learning in the sense that both of them (as well as traditional academic learning) form cognitive mental structures. As has been stressed above, mental structures do not generate motivation for change. Evidence (presented above) indicates that cognitive understanding is not enough to foster behavioral changes.

Step 4: Emotional Learning

Consider step 1, 2, and 3, with the following addition: The children are encouraged to express their feelings about the changes that occurred in relation to the polluted water source. They are asked: (a) To express it in artistic ways, in debates and court cases; (b) to interview elderly people in the community about the water sources, and to communicate the feelings of the elderly to other members in the community; (c) to plan a community activity that addresses the water pollution issue; and (d) to negotiate between their emotions towards the issue and their academic knowledge. Furthermore, they are motivated to do activities which make them feel any type of emotion that ranges from enjoyment to distress with regards to the water source under examination and its effects on community's fabric of life. In other words, they are led on a path of emotional learning - to care.

Involvement of emotions in a learning activity activates simultaneously processes of value and ethics clarification. These processes are both cognitive and emotional (De Sousa, 1987). Traditionally, "non-natural" learning has expelled emotions out of the classroom under the charges that they cause biased thinking, they are unreliable, not rational and worse – they pose the threat that students are being "brainwashed" by their teachers. Snook (1972) described this connection in the following way: "Indoctrination belongs to a family of concepts which includes "teaching", "education", "instruction", and "learning"…It also has affinities with concepts such as "bad", "dishonest", "unjust", and "immoral" (P. 1). In line with this concept, ethical and value clarification were also expelled since they too, were considered a threat to clear "uninfected" rationality.

Altogether, emotions were excluded as irrelevant to learning. Gradually, throughout the years, they crept back in through a synergy of processes, which include: (a) The introduction of the theory of constructivism and the realization that children need to

be involved in their learning processes (Ausubel, 1968; Novak, 1976), and (b) the development of the notion of *Emotional Quantity* (EQ) as a prerequisite for success at work and in life (Goleman, 1998; McClelland, 1973). The evolvement of new learning theories, alongside with the emergence of EE and later ESD, opened an unofficial entrance to emotional learning. These processes are reflected in EE and ESD literature as well. Posch (1999), in his definition to the term *school ecologisation*, explained that "*Ecologisation means shaping our interaction with the environment in an intellectual, material, spatial, social, and emotional sense, to achieve a lasting/sustainable quality of life for all*" (p. 341). Breiting & Mogensen (1999), when referring to the *action competence approach* to EE, found co-variances between emotional and cognitive aspects that contribute to the formation of action competence among students. Breiting et al. (2005) claimed that in the context of ESD, cognition is not only rational but also emotional and values-based. Mogesen & Mayer (2005) argued that action-taking in a natural environment allows linking emotions to values and to rational thought. The philosopher, Ronald de Sousa (1987), described emotions as a *philosophical hub*, which leads us to problems of epistemology, ontology, logical form, and ethics. He posed a question, "*what would someone be like if he had no faculty of emotions?*" De Sousa answered that the faculty of emotions is actually required for the more conventional mechanisms of rationality to function. Emotions, through their role as a hub, also act as motivators for action taking and by thus expressing one's most active self. De Sousa (1987) claimed that "*Emotions concern what gives meaning to life; they frame, transform and make sense of our perceptions, thoughts and activities*" (p. 2). By this, emotions inherently involve raising questions of values and ethics, which form a central part in any educational effort towards sustainable development.

Goleman (1998) stressed that emotional learning means managing feelings so that they are expressed and controlled appropriately and effectively. Teaching children to negotiate between their IQ and their EQ, between their rationality and their feelings, intrinsically involves ethical and value clarification. Emotional learning could be most effective in training children for effective team work and cooperation smoothly toward common goals. The ESD literature provides some examples for ethical clarification that arises through a combined cognitive and emotional learning. One example is given by Breiting et al. (2005) who described how a grade 8 class investigated the villagers' use of pesticides in their local community. They visited a local farmer and interviewed him. To

their surprise, they found that the farmer was selling onions in the market that were grown with pesticides, but for his own family's consumption he grew onions that weren't treated with pesticides. Back in class the students had negative feelings about the farmer, because they found he had double moral standards just to get money. The teacher helped them to see the farmer's dilemma as a personal conflict and moved the attention of the students to the concept of the "market mechanism" (p.14). The example continues to unfold as the children's feelings and cognitive assessment interact through a process of ethical clarification and evolve into active participation led by the teacher's guidance.

Incorporation of emotions as an essential part of learning at school is particularly important, since unlike the more rigid IQ, our level of emotional intelligence is not fixed genetically, nor does it develop only in early childhood. EQ seems to be largely learned and it continues to develop throughout life experiences (Goleman, 1998). So where else is the best place to start, if not at schools?

In the above section the four essentials were unfolded layer by layer. It is argued that academic learning, inter/multidisciplinary learning, multidimensional learning, and emotional learning are four essential principles of EE/ESD pedagogy, that when implemented together in a given learning program, regardless of the specific program's components, a synergy would be created in which the final outcomes are greater than the sum of the parts. One of the expected outcomes of the synergistic process concerns ethics and values. In recent EE/ESD discourse, ethical and value clarification evolved as a highly desired outcome of the educational process (Breiting et al., 2005; Devall & Sessions,1985; Hopkins & McKeown, 2002; IUCN, 2005, internet site; Mogesen & Mayer, 2005; Uzzell, 1999), yet the literature scarcely provides practical pedagogies for producing such a process. It is argued that when the above four pedagogical principals are co-implemented, one of the synergy's intrinsic outcomes, would be ethical and value clarification.

The following section analyses outcomes of co- implementation of the four principles.

Analysis of EE/ESD programs in the context of the pedagogical principles

We argue that when the four above pedagogical principles are co-implemented, the ultimate goals of EE/ESD, which are behavioral changes in the forms of REB and/or active participation, are achieved regardless of the specific program that is applied. For

illustration of this claim, we chose six EE/ESD programs for analysis. The criteria for choosing a program for analysis were variation in: learning strategies; subject matters; educational setup; length of implementation, and age groups. The process of analysis included extracting evidences indicating whether the four principles were implemented in the learning processes. Five out of the six analyzed programs are described in appendix 1. These descriptions include the following aspects of the programs: Programs' objectives; relevant methodological features; results; and conclusion of analysis. Due to space limitation, we present here the full analysis of one program only. Nevertheless, a summary of the analysis of all six programs is presented in Table 1.

Analysis of EE program with regards to the four principles

Following is an analysis of an educational program that was described in Bodzin's (2008) article: "Integrating instructional technologies in a local watershed investigation with urban elementary learners".

General description of the EE program: The author describes an after-school science club program for urban 4th-grade students that integrated instructional technologies to investigate a pond ecosystem in the local schoolyard. The goals of the after-school program were to (a) engage students in a long-term local watershed investigation using essential features of inquiry, (b) promote student learning about the local environment of the pond and how it is part of a greater watershed area, and, (c) foster environmental stewardship and promote civic responsibility.

Analysis of Pedagogy: Content analysis was used for analyzing the program. It followed the following stages: (a) Identification of all the pedagogical components as expressed overtly in the methodology section; (b) identification of non-overt pedagogical components through their reflection in the results section or other parts of the article; (c) allocation of relevant pedagogical components to four categories comprised of the four pedagogical principles; and (d) assessment of the program's EE goals achievement, with regards to implementation of the four principles. As discussed above, the co-implementation of the four principles creates a synergy in which one of its expected outcomes is value and ethics clarification. This occurs because of the need that arises to negotiate between emotions and cognition, and at times to resolve cognitive dissonance. In the process of analysis, evidences of ethics and value clarification were searched for, and

used as supplementary indication for integrated implementation of the principles. The main results of the program's analysis are as follows:

a. *Academic learning*: "A variety of inside (classroom) activities were conducted to help students understand basic water quality parameters, become familiar with using Pasco GLX data collection probes, and learn to use a taxonomic key for identifying macro-invertebrates." (p. 50). Abstract knowledge was taught through traditional pedagogy of top-down teaching in an academic way.

b. *Inter/multidisciplinary learning*: "The driving investigative question of the program was how healthy the school's pond was" (p. 50). The pedagogy is issue based rather then discipline based, supporting development of system thinking through interdisciplinary pedagogy.

c. *Multidimensional learning – Time dimension*: "A primary objective of the program was to have students investigate the ecology of the pond over the course of three seasons…. The students analyzed their pond data, identified seasonal variations in the pond ecosystem" (p.50). The pedagogy is based on hands-on experiences and enables acquisition of understanding changes within systems over time.

d. *Multidimensional learning – Space dimension*: "In the Bucket Buddies project, elementary school students identify macro-invertebrates in a local pond, contribute their data to a larger Internet database, and compare their findings with other ponds in the world" (p. 50). The pedagogy is based on minds-on/hands-on inquiry. The comparative analysis enables students to acquire understanding of differences and similarities between systems and the spatial dimensions of systems. "They then used Google Earth to display an image of the school, pond, and Cedar Creek feeding into and out of the pond. The teacher then expanded the image to include the confluence of Cedar Creek with Little Lehigh Creek. He expanded the image again to show where Little Lehigh Creek emptied into the Lehigh River. The students then traced the path of the Lehigh ….into the Delaware Bay and ultimately into the Atlantic Ocean. In the subsequent sessions, students used Google Earth ... to virtually explore other areas of the watershed." (p. 50). The pedagogy employs instructional technology tools in a way that supports students' spatial perception of systems' interconnectedness.

e. *Emotional learning*: "By the end of October, the science club students displayed a sense of ownership of the pond and began referring to it as 'our pond'." (p. 52). A sense of ownership is an affective expression of emotional learning and one of the expected outcomes of the four pedagogies' synergistic processes. "Pollution in the pond became a

concern of the students during the pond study, students displayed positive affective behaviors that included emotions about and feelings toward the local environment." (p. 53).

f. *Ethics and value clarification*: "Students wrote many questions in their field notebooks pertaining to this issue: (a) Why is this area in the pond cleaner? (b) Why is there litter? And (c) why do people pollute the pond? (p. 52). Students' self documentation reflected spontaneous arousal of ethical questions. This is also expressed in the following citation: "A discussion arose about why people would do that to our pond." (p. 53).

Conclusion of analysis: The EE program's description provides clear evidences for implementation of all four pedagogical principles in synergy. In accordance, the program was successful in achieving EE/ESD goals of behavioral change.

TABLE 1. Analysis of Educational Programs: Implementation of the Four Principles and Achievements of EE/ESD Goals.

Program number	1	2	3	4	5	6
Article's authors	Ballantyne, Fien, & Packer (2001) (2 programs)		Knapp & Poff (2001)	DiEnno, & Hilton (2005)	Bodzin, (2008)	Schneller, (2008)
Evidences of academic learning	Positive evidence	Positive evidence	Negative evidence	Positive evidence	Positive evidence	Positive evidence
Evidences of inter/ multidisciplinary learning	Positive evidence	Positive evidence	No evidence in the article[2]	Negative evidence[3]	Positive evidence	Positive evidence
Evidences of multidimensional learning	Positive evidence	Positive evidence	No evidence in the article	No evidence in the article	Positive evidence	Positive evidence .
Evidences of emotional learning	Positive evidence	Positive evidence	Positive evidence	No evidence in the article	Positive evidence	Positive evidence
Level of achievement of behavioral change	51% of students reported behavior change	45% of students reported taking actions about environment	Not achieved	Not achieved	achievement of high commitment and action competence	50% of the class began practicing one new REB, and 25% began two new REBs

[2] The article does not provide any evidences - neither positive, nor negative.
[3] Unlike the above term "no evidence", "negative evidence" indicates that the article provided evidences that a learning pedagogy **did not occur**.

Table 1 reveals that in programs in which the four principles were implemented, environmental goal of behavioral change was achieved. When elements of the four principles were missing, this goal was not achieved. The results also demonstrate the claim the co implementation of the four essentials was influential regardless of the educational strategy, subject matter, age group, and circumstantial factors of the learning setup. The pedagogy seemed to determine the difference between success and lack of success in the six case studies.

An integrated ESD pedagogy

By using a pedagogy that implements academic; multidisciplinary, multidimensional, and emotional learning in an integrated way, one might be looking at an holistic learning experience that is on one hand clear and simple enough for implementation, and on the other hand, integrative enough to accomplish the goals of ESD. Another way of looking at the holistic ESD pedagogy is as "a prism" in which the light beam (ESD pedagogy) can be broken down to two opposing ends of refractions (see figure 1). At one end are basic literacy components, and at the other end ESD supplements which are required for attaining sustainability literacy.

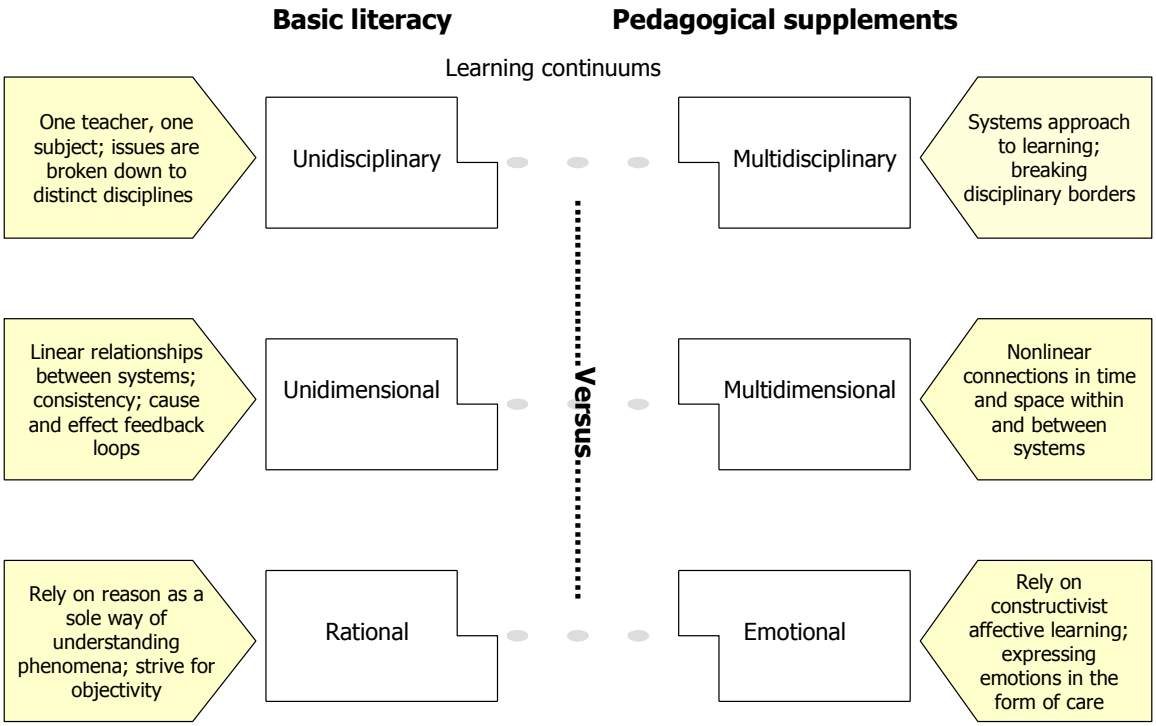

Figure 1. Learning Continuums Comprising ESD Pedagogy

It is important here to clarify that although basic traditional literacy is located on the extreme end of the pedagogical supplements, one should treat these two extremes as complementary derivates of the same light beam. Orion (2003), with regards to his "natural" versus "non- natural" learning characteristics, referred to this concept by stating that abstract concepts (for example, quantum theory) cannot be taught through "natural learning" pedagogy, and therefore, one should be careful not to cross the line between pedagogy and demagogy. Likewise, it should be emphasized, that although it is important to incorporate new methods of learning and teaching in order to confront the world's urgent sustainability needs, human knowledge cannot do without traditional ways that were thoroughly developed throughout the centuries.

Zimmerman, et al. (1998) postulated that creative progress towards a difficult goal can emerge from a few, flexible, simple rules, or so called minimum specifications. With regards to ESD, the claim is that when the four essential pedagogies exist in any given ESD program, it follows that the vast majority of recommended pedagogies that appear in the literature would also be present as natural derivatives of the four essentials. This is not expected to be the case when one or more of the essentials are missing.

ESD pedagogies as derivatives of four elements

When examining EE/ESD discourse, it is noticeable that the most prominent recommendations for EE/ESD pedagogies are all inclusive and natural outcomes of the four basic principles that were described above. To demonstrate this claim, three prominent EE/ESD pedagogies that appear regularly in most EE literature were chosen. These include (a) student-centerd learning, (b) minds-on and hands-on learning, and (c) active participation.

a. *Student-centered Learning*: The main idea underlying the Student-centered approach to learning is that learning is most meaningful when topics are relevant to the students' lives, needs, and interests, and when the students themselves are actively engaged in creating, understanding, and connecting to knowledge (McCombs & Whistler 1997). Student centered approach is rooted in the works of John Dewey (1916), Jean Piaget (1954), and Lev Vygotsky (1978). In spite of its broad acceptance among education professionals, a variety of barriers prevent its full assimilation in practice. Implementation of the four principle pedagogies holds great potential for overcoming these barriers. Once academic,

inter/multidisciplinary, multidimensional, and emotional learning are introduced to the learning process, it is very difficult, if not impossible, to teach an issue through a non student-centered approach. Once an educator refuses to dissect an issue into compartmental disciplines, the most convenient way to approach it, is through project–based learning. Inherently**,** the students become "active learners", involved in autonomous knowledge construction. This is not an expected outcome, when each of the components is implemented independently**.** This claim can be demonstrated through the following examples: "Modeling" is a highly interdisciplinary topic taught in university courses through lecturing. Modeling of bio-physical processes requires concerted implementation of mathematics, physics, and biology at the least, and often it requires involvement of social sciences, such as in modeling species extinction processes. Regardless of the fact that modeling is interdisciplinary in nature, it can, and is mostly taught, through "non student-centered pedagogy". This occurs when the university course of modeling, implements only three out of four principle pedagogies (academic, inter/multidisciplinary, and multidimensional learning) leaving out emotional learning. Another example is on the other side of the spectrum – implementation of emotional learning while leaving out the other four principles. This occurs for example, in cult activities such as "Landmark Forum" (Landmark Forum; n.d.) seminar that often gathers together over a hundred learners for an emotional preaching session. The learners are exposed to emotional learning but the learning is not student-centered since students are not autonomously active in constructing their own emotional knowledge. Unlike the above two examples, when the four pedagogical essentials are implemented together, student centered pedagogy can rarely be exempt from being implemented as a natural derivative of the learning process. This is so, because when both analytical skills and emotional skills are simultaneously activated in the learning process, students become active learners through the need to harmonize these sometimes antagonistic processes.

b. *Minds-on and Hands-on Learning*: Educational reforms of the last three decades have been emphasizing the development of educational environments in which learning occurs through active processes of inquiry (American Association for the Advancement of Science [AAAS], 1993; National Research Council [NRC], 1996, 2000). The term "hands-on" refers to aspects of inquiry which involve experimentation, preferably in real world problems. The term "minds-on" refers to

cognitive and meta-cognitive skills, such as critical thinking, which are complementary to hands-on inquiry of authentic issues (Chinn & Malhotra, 2001; National Science Education Standards, 1996). Both hands-on and minds-on are natural outcomes of project learning and multidimensional learning. Projects, in general, require some level of inquiry. When an issue is examined through a multidimensional perspective, it simultaneously involves processes of hands-on/minds-on data collection and analysis. When students are requested to negotiate between their emotions and cognition, the minds-on process becomes less technical and more meta-cognitive and reflective. This meta-cognitive minds-on involvement activates processes of value and ethical clarification which can act as a motivator for active participation.

c. *Active Participation*: When students participate in a multidisciplinary and multidimensional learning experience, they cognitively understand connections between systems and their effects on human lives in present and in the future. Through emotional learning processes, they are simultaneously weaved into the issue being learned through development of identification, sense of belonging, sense of responsibility, and other affectionate processes. The combination of cognitive learning and emotional learning can help students understand an issue and feel strongly about it, and by thus, empowering them to act or influence action. Breiting and Mogensen (1999), with regards to "action competence", described these combined processes outcomes, as students becoming more keen on dealing with solving environmental problems, since they believe that they've acquired the knowledge and skills to do so. Active participation can be an effective pedagogy that supports the goals of ESD, when it is implemented as a derivative of the four principle pedagogies. This same important pedagogical component can become an obstructing component when implemented out of the "four principle pedagogies" context. For example, Bull (1992) showed that students became disempowered when they were involved in an "action research" and "community problem solving", in which they failed to achieve their main goals. This happened most likely due to a lack of multidimensional learning, by which they would have been able to cognitively analyze their actions within multi-systems contexts.

Returning to the prism metaphor, ESD pedagogy can be viewed as analogous to a light beam that can be broken into different component pedagogies (wave lengths) when

analyzed at different angles. Each one of the components can be further broken down into finer refractions that are natural derivatives of a given spectrum (as the examples given above). But the light beam is one, and so should be ESD pedagogical construct - multi-componential, yet one whole with regards to its expected outcomes and impacts.

Discussion

In any learning process, pedagogy constitutes a hub and a generator of the educational experience. It projects far beyond the learning situation itself. It influences outputs, outcomes, impacts, and all other components of the education strategy. ESD scholars have been advocating for years for implementing changes in pedagogies. Despite this call, while the curricula have been evolving and responding to the policy discourse, educators are continuing to implement old pedagogies in the service of knew contents of the curricula. Stevenson (2007) pointed out to the ambiguity and "lofty aims" of the ESD discourse. We would like to stress that a lack of clear guidelines with regards to EE/ESD pedagogy contributes to this ambiguity and the lag of practice behind the rhetoric. This ambiguity carries with it not only problems of implementation but also problems concerning effective evaluation which is essential for advancement in the field.

The main objective of the present article is to offer teachers, educators, and scholars, a simple practical framework that explicitly outlines the basic elements of EE/ESD pedagogy. This framework is viewed as a generalist umbrella, under which all effective ESD pedagogies, currently operating in the field, can gather. If further research confirms this framework as an effective ESD pedagogy, then numerous advantages to ESD would follow. These include:

a. *Help in assessing effectiveness of school programs*: Once it is established that the four components are essential for achieving ESD's goals, evaluation could be simplified. It would require checking whether each one of the four components is implemented in the program. As explained above, the mere existence of the four components implies a much broader existence of other recommended pedagogical components, which are natural derivates of the above four. Expanding on the light beam metaphor - the existence of the four major wavelengths, naturally implies the existence of the finer refractions of these wavelengths without needing to break them down and show each one's existence separately. Therefore, the need to assess the fine details of schools' pedagogy will be spared. From the perspective of system

approach to evaluation and Marcinkowski (2004) logic model for resource education program, using qualitative indicators to evaluate the co-implementation of the four principles, ensures the collection of a broad range of information by only focusing on a few elements within the delivery approaches.

b. *Enable schools, SD educators, and scholars to concentrate on the big picture rather then getting lost within the fine details*: As more diverse and broad ESD goals become, so do ESD programs, sometimes to the point of educators' despair. The proposed pedagogical model can be viewed as a compass that can aid schools in the process of reorienting towards ESD. It can help distinguish between the trees and the forest. In other words, by using this simple framework, a practitioner can know that it doesn't matter which program the school is leading, as long as the four pedagogical components are there, they are on the track of ESD.
c. *Give more freedom of initiation to schools*: Once the basic pedagogical framework is understood, schools might feel more free to imagine and create new programs, which otherwise they will not dare venture because of fear to lose the very ill defined track which they are currently following (as has been demonstrated above by the vagueness prevailing with regards to ESD pedagogy).
d. *Help achieve ESD goals more effectively*: Many practitioners feel lost within the ambiguity that exists around the question of what it takes to do ESD (for example, see above UNESCO-UNEP's conference recommendations). If researchers in the field can provide simple principles on strategic aspects, it would help practitioners in their attempts to strive forward and close the discourse – practice gap.

Recommendations

The proposed pedagogical framework undoubtedly requires testing and verification. It would be worthwhile to conduct posteriori meta-analysis of more then only six published EE/ESD programs. In addition, empirical testing is required in order to ground the proposed principles in empirical data that would be derived from a study pre designed for this cause. Two of the article's following claims need farther examination and more substantial grounding: (a) That simultaneous integration of the four principles in a learning program, creates a synergy in which environmental behavioral changes occur, as well as other EE/ESD educational goals, mainly ethical and value clarification; and, (b) that a lack

of any one of the four principles is enough to obstruct achieving the goal of environmental behavior change.

In the present article claims (a) and (b) were tested through meta-analysis of six diverse EE/ESD programs. We found that regardless of the programs' differences, when the four pedagogical essentials were co implemented, the programs were successful in eliciting behavioral changes. Another approach to testing these claims would be by analyzing results of national EE/ESD programs around the world with relation to their achievements and to policy guidelines. For example, since 2004, the Israeli Ministry of Environmental Protection has been leading an environmental education program, accrediting schools as *green-schools*. Schools who wish to join the program need to meet three administrative criteria: (a) Carry out an environmental program of at least 30 hours per student per year, in at least two age strata of the school; (b) schools should present data showing improvement in resource consumption; and (c) carry out a community project that is aimed at creating changes in community's attitudes toward the environment. These administrative curricular requirements imply activation of academic and multidisciplinary pedagogies, but emotional and multidimensional pedagogies do not seem as necessary requirements for meeting the program's criteria. According to the claims in the present assay, it is expected that Israeli green schools would be unsuccessful in achieving EE/ESD's goals of behavioral change. A recent survey (Negev et al., 2008) conducted amongst Israeli green schools affirms this hypothesis. The students who participated in the *green-school* programs scored low on REB. Moreover, no significant difference was found between them and a control group which did not participate in any environmental education program.

Much information can be gained by comparing between EE/ESD schools' pedagogies in different countries in relation to implementation of the four pedagogical principles and achievement of goals, particularly with regards to the highly desired goals of behavioral changes. A prerequisite for carrying out EE/ESD pedagogical analyses as suggested above would be the development of *indicators* for detection of the four ESD pedagogical essentials in each of the programs under examination. Further on, these indicators could be developed into a set of practical guidelines for implementation of the four principles. It is recommended that guidelines for educators would be of an evaluative nature, rather then prescriptive, thereby allowing for local variations, educators' inputs, creativity and flexibility.

Conclusion

The section titled "Analysis of EE/ESD programs in the context of the pedagogical principles" presented six diverse EE/ESD programs. Four of these programs (see table 1) reported success in achieving educational goals of pro environmental behaviors. Common to all four programs was the co implementation of the four pedagogical essentials. Most of the other variables that were related to the learning environments were not in common. This success in achieving desired EE/ESD goals provides empirical support to the high importance of sound pedagogical model as well as to the diverse ways in which the principles can be implemented successfully.

Kartikeya Sarabhai (2007) director of the Center for Environment Education, India, compared ESD to the Indian Sari. A simple uniform piece of cloth, and yet so diverse and flexible, that it suits any woman's unique figure. The proposed model aims at suggesting such a garment for ESD's pedagogy – a basic general construct, on one hand, and highly specific and adaptable to diverse learning programs, on the other hand.

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Appendix 1

Description of five analyzed EE/ESD programs

Programs 1 & 2 - Ballantyne, R., Fien, J., & Packer, J. (2001). School environmental education program impacts upon student and family learning: A case study analysis.

Objectives of the EE/ESD program: The research used a case study approach to explore some of the learning outcomes, attitudinal and behavioral changes and intergenerational influence effects resulting from students' participation in school environmental education programs.

Relevant methodological features: The article focused on two programs in Australian schools. One, the "Story Walk program" (program number 1) conducted in a primary school with Year 5 and Year 7 students (aged 9± 12), the other, the "Six Thinking Hats program" (program number 2) conducted in a secondary school with Year 9 students (aged 13± 14).

The "Story Walk program" 1: aimed to develop students' environmental concepts, values and skills by exploring the theme "the past holds many stories about people and the environment that are essential to our understanding of the environmental situation we have today". The story provided the context within which students could explore connections between the personal, social, and natural world.

The "Six Thinking Hats program" 2: used DeBono's "six thinking hats" approach (De Bono, 1992) to explore a local environmental problem. According to this approach, there are six different modes of thinking, each of which is represented by a different color hat.

Results: A large percentage of students in both programs reported having changed their behavior as a result of participating in the environmental education program. Students in the "Story Walk program" reported having changed in their knowledge (14%), their attitudes (22%), and their behavior (51%). Students in the "Six Thinking Hats program" also reported changes in their knowledge (22%), attitudes (17%), and actions (45%) regarding the environment.

Conclusion of analysis: The descriptions of both programs provide evidences for implementation of the four pedagogical principles (See table 1). The writers stressed that

in all the learning stages of both programs, "engaging students' emotions appeared to contribute to the effectiveness of the learning experience" (P. 31).

Program 3 - Knapp, D., & Poff, R. (2001). A qualitative analysis of the immediate and short-term impact of an environmental interpretive program.

Objectives of the EE/ESD program: The study uses qualitative measures to investigate whether an environmental interpretive experience can enhance an environmental ethic.
Relevant Methodological Features: Twenty-four 4th graders participated in a field trip to a US Forest Service site near their school district. Methodologies utilized in this program included ranger-led discussions, facilitated explorations, and "nature games".

Results: The findings indicated that cognitive impact was limited and very little educational content was retained. There were no indications for behavioral changes. Students were less likely to perform environmentally responsible behaviors as time increased from the actual field trip. This was supported by the fact that no students voluntarily expressed an interest in, or the accomplishment of, this type of activity following the experience. Positive results were obtained in the affective domain. Children developed positive affect toward the resource site and retained game mechanics and the content imbedded in these games.

Conclusion of analysis: The results of the research specify a lack of academic learning. The program's description did not provide any evidences for implementation of inter/multidisciplinary learning and multidimensional learning in the program's pedagogy. There are evidences for implementation of emotional learning. With the absence of three out of four pedagogical principles, the program seems ineffective in achieving EE/ESD goals.

Program 4 - DiEnno, C. M., & Hilton, S. C. (2005). High school students' knowledge, attitudes, and levels of enjoyment of an environmental education unit on nonnative plants.

Objectives of the EE/ESD Program: The objective of the study was to determine whether a teaching methodology based on the constructivist learning theory would be an effective method for enhancing student retention of environmental material, creating positive attitudes toward the environment, and engaging students in the learning process.

Relevant Methodological Features: A week-long unit in nonnative plant species titled "Which Ones Do Not Belong? An Exploration in Nonnative Plant Species" was used for teaching two groups of students: constructivist group, and traditional group.

Results: The constructivist group significantly increased knowledge scores and attitudes, whereas the traditional group did not. The research does not examine behavioral change directly, but rather focuses on students' level of engagement in the project, which can be considered as a prerequisite for behavioral change. The two groups did not differ significantly on engagement.

Conclusion of analysis: The program included mainly academic learning facilitated by project learning and participatory approaches. There are no indications in the article for implementation of inter/multidisciplinary, multidimensional, and emotional learning. In spite of the fact that the program applied constructivist pedagogy which is highly emphasized in the EE literature, with the absence of three out of four pedagogical principles, the program was not successful in achieving the goals of EE/ESD.

Program 6 - Schneller, A. J. (2008). Environmental service learning: Outcomes of innovative pedagogy in Baja California Sur, Mexico

Objectives of the EE/ESD Program: The article reports on a study of a two-semester middle school environmental learning course that incorporated experiential and service learning pedagogical approaches. It was hypothesized that students exposed to environmental knowledge, coupled with student/community involvement, and environmentally based hands-on projects and personal experiences, would engage in further and more complex personal and community pro-environmental behaviors, and would be positively impacted emotionally, socially, and intellectually.

Relevant Methodological Features: A sample population of students included a group of 15 students (mean age 15.2) who voluntarily participated in the EE course. Students participated in a campout, a beach cleanup, conducted a visitor census; studied native plants; and participated in a recycled art project.

Results: In the short term, course participants acquired a heightened awareness of environmental issues, augmented their environmental perceptions and consciousness, and complemented all this with environmentally responsible behaviors. Two years after completing the experiential course, students retained pro-environmental attitudes and behaviors, and unexpectedly exhibited an expanded role in intergenerational learning.

Conclusion of analysis: The article does not specify the essential features of the learning pedagogy, but rather expands on outputs and outcomes of the program. Analysis of the results, provide posteriori clues of the pedagogy as described in table 1. All four pedagogical principles seem to be implemented within the program, and in accordance EE/ESD ultimate goals of behavioral change have been achieved.