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Student Teachers' Attainment of Environmental Literacy in Relation to their Disciplinary Major during Undergraduate Studies

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In light of the crucial role of teacher education in transforming education and society so that a sustainable future is possible, there is increasing interest in the relationship between academic major and development of student teachers' environmental literacy (EL). Since science disciplines are the common framework for incorporating environmental education, this longitudinal study investigated, in a paired pretest-posttest design, if student teachers majoring in the environment-related disciplines differ in the development of their EL from other majors. The differences in EL-variables between the two groups were enhanced during studies only in particular behavioral aspects (recycling efforts and citizenship action) and in basic environmental knowledge. Contrary to the expected, environment–affiliated students moved toward a more anthropocentric orientation during their studies, as reflected by decreased support for the 'value-of-nature'. Post-test environment-affiliated majors' opinions regarding the influence of studies to their EL emphasize the role of the disciplinary component, and its contribution mainly to their biophysical-ecological knowledge. Findings support the need to reorient the science disciplines to include a comprehensive environmental perspective and infuse environmental values education, in addition to content knowledge, within science disciplines. These should be explicitly stated within curricular goals of teacher-training programs, infiltrating down to courses and academic staff.

Keywords: Environmental education, environmental literacy, pre-service teacher education, disciplinary major

INTRODUCTION

Since the 1970s there is a consensus that environmental education (EE) is crucial for achieving the goals of sustainable development, by creating an environmentally literate citizenry capable and motivated towards environmentally responsible lifestyles (UNESCO, 1997; UNESCO-UNEP, 1978; UNESCO-UNEP, 1992). The magnitude of this challenge is such that in 2005, UNESCO launched the Decade of Education for Sustainable Development. Underlying this endeavor is the understanding that education is the driving force for the change needed (UNESCO, 2005a).

Teachers are the key to change in the educational system. The ability to address issues of sustainability depends on the teachers' competence in the subject matter and pedagogies relevant to EE, as well as their personal disposition towards sustainability which influences their function as role model (Clayton, 2004; McKeown &

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Hopkins, 2002; NAAEE, 2010; Pe'er, Yavetz, & Goldman, 2013). Teacher education institutions are, therefore, identified as crucial agents in transforming education and society so that a sustainable future is possible (McKeown & Hopkins, 2002; Tilbury, 1992; UNESCO, 2005b). For the past two decades the necessity to reorient teacher education towards sustainability and how to implement this has received considerable attention (Ferreira, Ryan & Tilbury, 2007; McKeown & Hopkins, 2002; UNESCO, 2005b). Two significant works in this direction are Guidelines and Recommendations for Reorienting Teacher Education to Address Sustainability (UNESCO, 2005b) and Guidelines for Initial Preparation and Professional Development of Environmental Educators (NAAEE, 2010).

Translation of such guidelines into practice presents significant challenges to teacher education institutions. For example, the holistic and interdisciplinary nature of EE raises the question what is the most suitable framework for integrating this field within teacher education programs. Since science disciplines (biology, agriculture, chemistry,) and geography deal with topics of ecology, natural resources and issues related to human impact on the environment, these disciplines are conventionally viewed as the most suitable frameworks for preparing environmental educators (Campbell, Medina-Jerez, Erdogan, & Zhang, 2010; Littledyke, 2008; McKeown-Ice & Dedinger, 2000; Van Petegem, Blieck, & Van Ongevalle, 2007). However, in view of differences between science education and EE, it is questioned whether training student teachers for science education also prepares them as educators of sustainability. On the one hand, science education has an important part in developing the understanding of scientific principles that underpin environmental issues, thus potentially leading to pro-environmental behavior. On the other hand, science is often viewed as a major contributor to environmental degradation, and also disconnected from the world and people's experience (Littledyke, 2008). Such negative attitudes do not contribute to enhancing environmental awareness. Another issue is that science education does not necessarily address the socio-political-cultural dimensions that are prerequisite to understanding, analyzing and dealing with environmental issues (McKeown-Ice & Dedinger, 2000; O'Donoghue & Russo, 2004). Compounding these issues, EE requires both cognitive and affective domains for developing a positive relationship with the environment, and it is questioned whether, in the framework of science education, components of the affective domain receive sufficient attention (Dillon, 2002; Goldman, Ben-Zvi Assaraf, & Shaarbani, 2013; Orr, 1992)

The perspective of sustainability is increasingly included in Higher Education as a strategic goal for improving education's quality and relevance to society, and institutions for Higher Education are increasingly aiming that all graduates will be capable and motivated to think and act in a sustainable manner and bring an environmental perspective into whatever profession they are engaged in (Anderson et al., 2007; Shephard, Mann, Smith, & Deaker, 2009; Stewart, 2010). In line with this and stemming from the consensus that EE should be disseminated throughout the educational system (Ministry of Education, 2007, 2011a), all student teachers should receive appropriate preparation in this field. Hence, an alternative approach is that EE not be limited to science disciplines, rather it should be included in all teacher education programs. This approach provides another advantage for preparing teachers: developing values, which is a fundamental goal and component of education (Kleinberger, 1961). EE is, in essence, value education (IUCN, 1970) - unlike many other areas of the curriculum, it is directly and overtly concerned with influencing learners' attitudes and behaviors, and it is widely held that values education is central to this process (Scott & Oulton, 1998; Pe'er et al., 2013). EE, therefore, provides a meaningful tool for educating for values and achieving a wide range of educational goals.

In Israel, government commitment to expanding EE within the public school system has not extended to teacher education, and to date no official guidelines have been put forth that address environmental literacy (EL) in teacher preparation. Integration of EE in teacher education programs in Israel is currently determined mainly by its placement in the school curriculum. Since EE is most commonly infused within the subjects of science and geography (Ministry of Education, 2011b), in teacher education colleges, as well, environmental subject matter is studied mainly in these disciplines. This situation raises the question which was the focus of this study: do student teachers majoring in the traditional science-related disciplines differ in the development of their EL from those majoring in other disciplines? Investigating the influence of disciplinary major aims to contribute constructive information towards effective integration of EE within the frameworks of existing teacher education programs. Strengths of this study lie in two methodological attributes: It was conducted in a paired pretest – posttest design. Most studies that have explored influence of academic studies on attributes of students' EL address students at only one time-point in their studies (Arnocky & Stroink, 2011; Ewert & Baker, 2001; Fusco, Snider, & Luo, 2012; Hodgkinson & Innes, 2001; Lang, 2011; Summers, Corney, & Childs, 2004; Tikka, Kuitunen, & Tynys, 2000; Van-Petegem et al., 2007). Second, the study is not limited to investigating the outcomes of a selected course or outdoor experience, which is the commonly reported situation (Bright & Tarrant, 2002; Brody, & Ryu, 2006; McMillan, Wright, & Beazley, 2004; Smith-Sebasto, 1995), rather it explores the influence of the whole academic experience.

Environmental Literacy and Environmental Education

EL is a key concept in achieving sustainability. There is no one universal definition of EL. Hollweg et al. (2011), in their framework for assessing environmental literacy define "…an environmentally literate person as someone who, both individually and together with others, makes informed decisions concerning the environment; is willing to act on these decisions to improve the well-being of other individuals, societies, and the global environment; and participates in civic life" (pp 2-3). One of the foundations for the EL assessment framework developed by Hollweg et al. (2011) was the framework described by Roth's for EL (1992). According to Roth (1992), an individual's EL is the outcome of a number of interplaying components which can broadly be grouped into cognitive, affective and behavioural. The cognitive domain refers to the individual's knowledge of ecological concepts and processes that provide the foundations for comprehending human impact on natural systems: environmental issues and environmental action strategies; as well as the cognitive skills for analyzing environmental problems and for the use of environmental action strategies. The affective domain refers to the individual's environmental awareness and sensitivity; attitudes, values and worldview regarding the environment; locus-of-control (sense of ability to influence a situation through personal behaviour, i.e. self-efficacy) and assumption of personal responsibility (sense of obligation toward the environment. i.e. personal commitment to environmentally corrective behaviors). Behavior is the ultimate expression of EL - the individual's EL should be reflected in his/her behavior concerning the environment. It can be inferred that developing EL is equivalent to developing responsible environmental behaviour, i.e. in the context of EL, knowledge, dispositions, and competencies enable and are expressed as behaviours (Hollweg et al., 2011).

The above described components of EL are common to most frameworks of EL (Hollweg et al., 2011; Simmons 2001) and correspond to the categories identified in the Tbilisi framework of environmental education (UNESCO, 1978). It is important to note that EL is developmental by nature - individuals' are neither environmentally illiterate nor literate, rather their EL develops along a continuum of capacities (Roth, 1992; Hollweg et al., 2011).

EE is the means for developing EL: the ultimate goal of EE is to create an environmentally literate citizenry (NAAEE, 2010; NEEAC, 2005; Roth, 1992). Environmental education has a well developed philosophy, set of goals and framework that were laid down in The Belgrade Charter (UNESCO-UNEP, 1976) and Tbilisi Declaration (UNESCO–UNEP, 1978) and which are still widely accepted in spite of development in the field (Hollweg et al., 2011; NAAEE, 2010; NEEAC, 2005).

Relationship between Environmental Literacy and Disciplinary Major

In light of the acknowledgement of the role of Higher Education in preparing graduates that are equipped to bring an environmental perspective into their professional function, there is increasing interest in the relationship between academic major and students' EL. Previous studies indicate differences in components of Higher Education students' EL across academic disciplines. Although the various studies compared different academic disciplines and programs, and different EL variables, the accumulating data support that environment-affiliated majors (such as resource recreation and tourism, biology, zoology, environmental studies and outdoor recreation) demonstrate higher levels of knowledge (Tikka et al., 2000), more pro-environmental attitudes (Anderson et al., 2007; Ewert & Baker, 2001; Harraway, Broughton-Ansin, Deaker, Jowett, & Shepphard, 2012; Hodgkinson & Innes, 2001) and a greater level of environmentally responsible behavior (Fusco et al., 2012; Tikka et al., 2000) in comparison to majors in other subjects. A question raised by researchers (Fusco et al., 2012; Lang, 2011), in view of these results, is: Do these differences between environment-related majors and other students reflect a transformative influence of their academic studies or may these differences reflect a predisposition of those students leading them to choose environment-related studies? According to the latter perspective, students' preexisting environmental beliefs, interests, sensitivity and worldview influence the majors and courses they select to study. Providing answers to this question is consequential for the effectiveness of Higher Education in preparing environmentally responsible graduates. By conducting a paired pretest – posttest design, the present study aimed to control for these influential factors.

Very few studies exploring the influence of academic major on students' EL have focused on teacher education programs. Summers, et al. (2004) compared geography and science student teachers' understanding of sustainable development in the UK and found that geography students had a more developed understanding of the environment and were more likely to address environmental, economic and social factors. Van Petegem et al. (2007) compared views on the environment and involvement in EE between students and teachers from traditional environment-related subjects (science, agriculture and geography) and other school subjects in three Zimbabwean secondary teacher education colleges. Science students demonstrated a more sophisticated and holistic perception of

the environment; Science students and their teachers were more concerned and better informed about the environment and reported that they were more active in environmental activities as compared to their counterparts. Students and teachers from all the disciplines expressed a view that science subjects are most suited for including EE. In view of the fact that at the time the present study was conducted, EE was mainly infused in environment-related schools subjects (science, geography, agriculture), the present study compared the development of EL between student teachers majoring in environment-related disciplines and other majors.

Stemming from this overall picture, the hypothesis of this research was: If academic studies constitute a significant factor influencing students' El, differences in EL between student teachers majoring in environment-related fields and other student teachers should increase during the course of their studies.

METHODS

Participants

The study was conducted in a paired pre-test –post-test design on a sample of 214 students from three teacher education colleges in Israel. The programs in these colleges extend four years and students graduate with a Bachelor in Education degree (B.Ed.) and a teaching certificate. The structure of the academic programs in these colleges is similar and is comprised of two components: (1) Disciplinary studies in one or two majors (2) Education and pedagogy studies (including practical training) designed according to the area of certification the student is training for (pre-school, elementary school, secondary school, non-formal education, special education).

Regarding the environmental component, the programs at these colleges can be categorized into two groups. One group includes programs that include no environmental courses, for example: Departments of literature, history, social-sciences, etc. The other group refers to programs in science, biology and geography. While their content addresses the environment, sustainability issues and educating for sustainability are not currently an emphasis of these programs. Students in all the programs are also exposed to various educational activities on campus that relate to the environment.

Sampling Procedure

The pre-test questionnaire was administered to 765 incoming students during the first month of their studies to ensure that the results reflected respondents' pre-study characteristics. The post-test questionnaire was conducted three years later, during the last month of the academic year with 454 students finishing their third year of studies. At both times, the questionnaires were administered, by the researchers, in classes representing the full range of disciplinary departments and certification tracts (pre-school through secondary school, special education and non formal). So, while numerically, the respondents reflect only a portion of the whole student body in each college, they represent a sampling of all the undergraduate teacher-training programs conducted. Of the pre and post-test respondents, 214 participated in both the pre-test and post-test (validated through ID). Hence this group comprises a paired pretest-posttest comparison. It is emphasized that this study is one component of a larger longitudinal investigation of the development of student teachers EL (Yavetz, Goldman, & Pe'er, 2009; Yavetz, Goldman, & Pe'er, 2014).

Background Data On The Population

Students' average age at onset of studies was 24+2.5. The majority (87%) were females. Based on their academic major, students were classified into two groups: Those that studied environment-affiliated fields such as environmental studies and agriculture, geography, biology, science and those that studied non-environment-affiliated fields such as history, arts, social studies, literature and mathematics. It should be noted that in the latter group students may study a few basic science courses. For example, all preschool teachers are required to study the course 'Introduction to Science for Preschool Children'. The majority of students (71%, n=149) majored in non-environment affiliated disciplines (termed NEAF-majors), and 29% (n=62) majored in environment-affiliated fields (termed NEAF-majors). Distribution of background data was similar for students in the three colleges.

Instrumentation

The research instrument was a questionnaire developed and validated in stages by the researchers (Goldman, Yavetz, & Pe'er, 2006; Pe'er, Goldman, & Yavetz, 2007; Yavetz et al., 2009): The first draft was developed partially

on the basis of previous research conducted by the researchers as well as other environmental education studies (Bradley, Waliczek, & Zajicek, 1999; Morrone, Mancl, & Carr, 2001; Schindler, 1999). A panel of six environmental science experts (faculty members in science, science education and environmental science departments) evaluated the content validity of the draft and the questionnaire was revised according to their comments. The content-validated draft was administered as a pilot study to 60 first-year students. The final questionnaire was constructed according to the results obtained in the pilot study.

The questionnaire included five sections: Four of them (a-d) were identical and administered to both pre-test and post-test groups, the fifth section (e) was administered only in the post-test. Following is a brief description of the questionnaire sections:

a) Environmental behavior: This section assessed self-reported environmental behavior by asking the respondents to rate the frequency they carry out 21 environmentally related activities, using a five-point Likert-type scale (from 1 = never to 5 = almost always). The overall behavior inventory had a Cronbach's alpha reliability coefficient of .79. Based on factor analysis, 20 of the items were grouped into the following six categories: 'Resource conserving actions with personal financial benefit', for example, conservative use of water and electricity (3 items, α=.51), 'Environmentally responsible consumerism', for example, reuse of plastic shopping bags and printed paper, purchase of environmentally-friendly products (3 items; α=.59), 'Nature-related leisure activities', for example, watching nature programs, reading nature-related articles, taking part in nature trips, (4 items; α=.68), 'Recycling efforts', for example, sorting trash (newspapers, bottles, batteries) and transferring it to specific collection sites (3 items, α=.64), 'Citizenship action', for example, reporting to authorities on environmental problems, participation in community clean-up projects, collecting litter from public property (5 items, α=.64), 'Environmental activism', for example, partaking in protests and petitions, active participation in environmental organization (2 items, r=.6; $p < .01$).

b) Environmental attitudes (affective variables): This section included 23 statements to which the students stated their extent of agreement using a 5-point, Likert-type scale (from 1 = strongly disagree to 5 = definitely agree). Twenty one of the attitude items were grouped into five categories: 'Importance of incorporating EE in the educational system', for example it is every teacher's responsibility to include environmental subjects and values in his/her teaching, Each student teacher should be required to study and environmental course during studies (5 items, α=.73), 'Priorities for national resource management policy', for example, Industry should be forced to reduce pollution emissions even if this entails higher consumer prices, Construction of marinas along the coast should be stopped (4 items, α=.67), 'Use of environmental legislation and enforcement as a tool for environmental management', for example, Factories should be penalized for environmental damage, Laws reduce damage to the environment (4 items, α=.52), 'Locus-of-control', for example, I believe I can contribute to the quality of the environment through my personal behavior, Actions conducted by the single citizen are useless because the authorities aren't impressed by the 'little citizen' (5 items, α=.59), 'Value of nature', for example, It is humanity's right to exploit nature's resources according their needs, The value of living creatures in nature is determined solely by their use for humanity (5 items, α=.67). The overall attitude inventory had a Cronbach's alpha reliability coefficient of .81.

c) Environmental and ecological knowledge: This section included 23 multiple-choice questions addressing four themes of ecological and environmental knowledge: Fundamental ecological principles and processes (7 questions), global environmental issues (7 questions), local environmental issues (4 questions), environmental action strategies (5 questions). The questions were constructed in two groups (basic - 9 questions, advanced - 14 questions) according to the knowledge level evaluated. Cronbach's alpha reliability coefficients of basic and advanced questions were .52 and .54, respectively. The overall knowledge section had Cronbach's alpha reliability coefficient of .78.

d) Background variables: Questions about students' age, gender and disciplinary major.

e) Views about influence of studies on self-perceived EL and environmental worldview: This section included three items evaluating students' positions regarding the influence of college studies on components of their self-perceived environmental behavior, attitudes and knowledge. Six additional items evaluated students' positions on the influence of specific factors (disciplinary studies, educational studies, internship, on-campus events and activities, events not related to academic studies, personal maturation) on development of a personal environmental worldview. The items were rated on a 5-point Likert scale (from 1 = no contribution to 5 = very strong contribution). Students were also requested to supplement their quantitative evaluations with written opinions on the contribution of their studies to their EL; to specify courses or activities they felt were most influential and to suggest what should be added to their studies to achieve a more significant contribution. For further information on the specific content of the questionnaire see Goldman et al. (2006),

Pe'er et al. (2007), and Yavetz et al. (2009). For an English version of the questionnaire, see Yavetz et al. (2009).

METHODS OF DATA ANALYSIS

For data analysis, students from all colleges were treated as one population, based on a one-way ANOVA which showed that students from the three colleges, in both the pre-test and post-test, did not differ in their environmental behavior, attitudes or knowledge. The SPSS Statistical Package for Social Sciences (SPSS 14) was used for data analysis. Means, standard deviations and percentages of sample were determined through descriptive statistics. Repeated measures multi-way analysis of variance (MANOVA) was conducted to examine major effects of the background variable - disciplinary major (EAF and NEAF) - on EL variables, and interaction between these and the time factor. T-test was used to examine differences between EAF and NEAF students' positions regarding the influence of studies on components of their EL. Content analysis was conducted on answers to the open ended questions in order to gain deeper understanding what were the students' reasoning leading to their ratings regarding the contribution of studies to their self-perceived EL and environmental worldview. Words or sections of text were labeled with descriptive words. These were grouped into categories.

RESULTS

Environmental Literacy

Self-reported behavior - Interactions between disciplinary major and influence of studies on students' environmental behavior are summarized in Table 1. In the pre-test, EAF-majors scored higher in the following behavioral categories: 'Nature-related leisure activities' and 'Environmental activism' as compared to other students. In the post-test, EAF-majors scored significantly higher than other students in these two categories as well as in the category 'Citizenship actions' and overall mean of behavior.

Repeated measure MANOVA provides indication of the relationship between disciplinary major and changes in environmental behavior during college studies. While the difference in overall behavior between EAF-majors and other students did not change during the course of studies, differences between these groups was significantly altered for 'Recycling efforts' and 'Citizenship action'. The change measured in 'Recycling efforts' may reflect the fact that EAF-majors scored lower (although not significantly) than other students at the onset of studies.

Table 1. Interaction between changes in students' environmental behavior after three years of studies and their disciplinary major. EAF – environment affiliated fields, NEAF- non-environment affiliated fields.

Environmental behavior category		EAF *Mean (SD)* (n=62)	NEAF *Mean (SD)* (n=146)	t	p	F (1, 206)	Sig.	Partial Eta Squared
Resource-conserving acions with personal financial Benefit	Pre	4.40 (0.74)	4.37 (0.65)	0.283	0.778	0.244	0.622	0.001
	Post	4.39 (0.69)	4.30 (0.72)	0.748	0.455			
Environmentally responsible consumerism	Pre	3.98 (0.91)	3.86 (0.91)	0.972	0.332	0.983	0.323	0.005
	Post	4.13 (0.76)	4.13 (0.70)	-0.08	0.937			
Nature related leisure activities	Pre	3.79 (0.71)	3.53 (0.71)	2.432	0.016	0.670	0.414	0.003
	Post	3.92 (0.70)	3.56 (0.66)	3.433	0.001			
Recycling efforts	Pre	2.57 (1.14)	2.82 (1.07)	-1.45	0.149	3.896	0.050	0.019
	Post	3.12 (1.13)	3.09 (1.09)	0.263	0.792			
Citizenship action	Pre	2.41 (0.76)	2.28 (0.67)	1.202	0.231	6.016	0.015	0.028
	Post	2.73 (0.82)	2.36 (0.68)	3.487	0.001			
Environmental activism	Pre	1.68 (1.10)	1.39 (0.65)	2.449	0.015	0.015	0.903	0.000
	Post	1.84 (1.06)	1.53 (0.80)	2.243	0.026			
Overall mean of the behavior items	Pre	3.25 (0.47)	3.14 (0.49)	1.398	0.164	1.724	0.191	0.008
	Post	3.44 (0.52)	3.25 (0.47)	2.683	0.008			

Note: Scores range from '1'-never, to '5'- almost always.

Attitudes - In the pre-test, EAF-majors scored higher in the category 'Importance of environmental education' as compared to other students. In the post-test, EAF-majors scored significantly higher in this attitude category but significantly lower than other students in the category 'Value of nature'.

Regarding the relationship between disciplinary major and changes in students' environmental attitudes, results indicate that for 'Value of nature' the difference between EAF-majors and other students increased significantly after three years of studies in comparison to the onset of studies, reflecting a decrease in EAF-majors' scores during studies.

Table 2. Interaction between changes in students' environmental attitudes after three years of studies and their disciplinary major. EAF – environmentally affiliated fields, NEAF- non-environmentally affiliated fields.

Environmental attitude category		EAF *Mean (SD)* (n=62)	NEAF *Mean (SD)* (n=149)	t	p	F (1,207)	Sig.	Partial Eta Squared
Importance of EE in educational system	Pre	4.27 (0.44)	4.06 (0.56)	2.566	0.011	0.180	0.672	0.001
	Post	4.42 (0.45)	4.23 (0.53)	2.369	0.019			
Locus of Control	Pre	4.07 (0.48)	4.14 (0.44)	-1.141	0.255	0.046	0.831	0.000
	Post	4.10 (0.49)	4.20 (0.45)	-1.285	0.200			
Environmental legislation and law enforcement	Pre	3.85 (0.60)	3.98 (0.60)	-1.439	0.152	1.568	0.212	0.008
	Post	4.11 (0.56)	4.11 (0.66)	-0.020	0.984			
Value of natural environment	Pre	3.77 (0.77)	3.88 (0.58)	-1.132	0.259	6.922	0.009	0.033
	Post	3.65 (0.88)	3.99 (0.59)	-3.316	0.001			
Priorities for national resource- management policy	Pre	3.60 (0.69)	3.50 (0.72)	0.894	0.373	0.534	0.466	0.003
	Post	3.94 (0.67)	3.76 (0.74)	1.579	0.116			
Overall mean of the attitude items	Pre	3.94 (0.37)	3.94 (0.39)	-0.138	0.891	0.054	0.817	0.000
	Post	4.04 (0.32)	4.06 (0.35)	-0.341	0.733			

Note: Scores range from '1'-strongly disagree, to '5'- definitely agree.

Table 3. Interaction between changes in students' environmental knowledge after three years of studies and their disciplinary major. EAF – environmentally affiliated fields, NEAF- non-environmentally affiliated fields.

Level of Question		EAF *Mean (SD)* (n=62)	NEAF *Mean (SD)* (n=149)	t	p	F (1,209)	Sig.	Partial Eta Squared
Basic (9 questions)	Pre	43.19 (21.49)	49.44 (22.24)	-1.878	0.062	5.436	0.021	0.025
	Post	52.69 (23.80)	49.22 (24.92)	1.000	0.319			
Advanced (14 questions)	Pre	35.60 (18.31)	31.45 (18.66)	1.480	0.140	0.046	0.831	0.000
	Post	40.44 (20.65)	35.57 (20.30)	1.580	0.116			
Overall mean of knowledge	Pre	38.57 (17.11)	38.49 (17.84)	0.030	0.976	1.983	0.161	0.009
	Post	45.23 (18.40)	40.81 (20.09)	1.493	0.137			

Note: Maximum score is 100.

Knowledge - Results indicate that the difference between EAF and NEAF students increased significantly during the period of studies in their basic level environmental knowledge (Table 3). This difference most likely reflects the marginally lower environmental knowledge of EAF-majors at onset of studies and the increase in this group's knowledge during studies, in contrast to no change in the knowledge of NEAF-students during studies.

Students' Views on the Influence of Studies on Their Environmental Worldview and Self-Perceived Environmental Literacy

EAF-majors acknowledged significantly greater contribution of studies to their self-perceived environmental knowledge, attitudes and behavior as compared to NEAF-majors (Figure 1a).

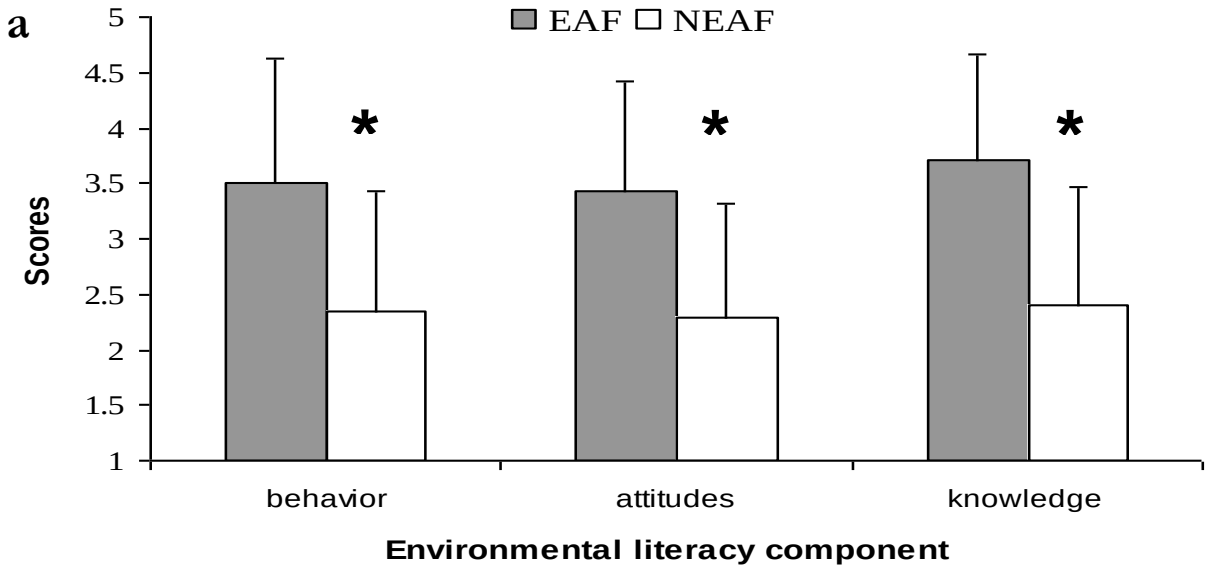

Figure 1. a) Students positions regarding the influence of college studies on their self perceived environmental behavior, attitudes and knowledge

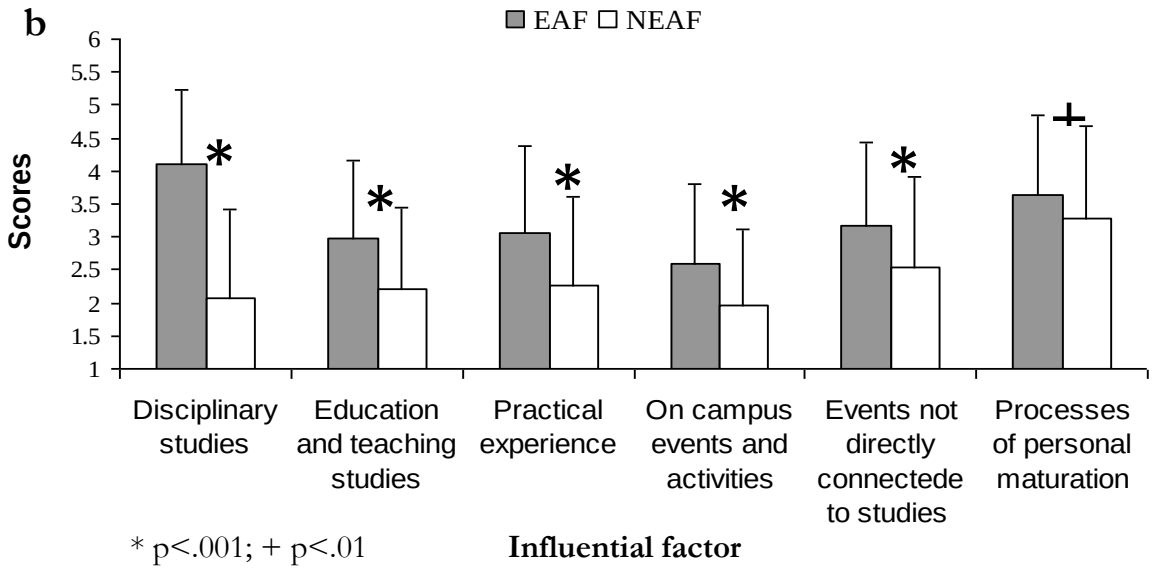

Figure 1. b) Students positions regarding the influence of various factors during their college experience to the development of a personal environmental worldview. EAF: n=62, NEAF: n=149

EAF-majors also attributed greater contribution of all influencing factors to development of their environmental worldview, identifying disciplinary studies as the most important influential factor (Figure 1b). On the other hand, NEAF-majors identified factors not related to their academic studies (personal maturation and events not directed connected to studies) as those most influential in developing their environmental worldview. Both groups of students identified on campus events and activities as the least influential factor (Figure 1b).

Analysis of the texts provided by 100 students describing their views on the influence of studies to their self-perceived EL and environmental worldview reveals that students' fall into one of two categories: Those that explicitly indicate an influence of their college experience and those that emphasize a lack of influence of the college experience. Ninety one percent of the EAF-majors specified influence of the college experience, whereas only 46% of the NEAF-majors indicated such an influence, the remainder pinpointing other sources as being influential. EAF-majors mentioned mainly academic courses as sources of influence and their answers also point to learning activities (such as reading articles, field-trip outings and participating in conferences) as contributing factors: "Courses in the science major contributed much and broadened my knowledge concerning processes in nature, pollution, and the effects of humans"; "…courses and field-trips on nature conservation, and reading papers".

Their answers also made evident that studies focused mainly on biological - ecological aspects with less emphasis on the man - environment interrelationship. It was also evident that most EAF-majors distinguished among knowledge, attitudes and behavior, and acknowledged a link between these variables: "During the years, the courses I studied expanded my knowledge. This knowledge aided in constructing a clear position regarding the environment and contributed to increased awareness which influenced my behavior"; "As knowledge of the subject increased my attitudes towards the environment became stronger due to knowledge of the subject. The course Man and the Environment and the college environment contributed to my understanding of the environment and to my behavior".

Several EAF-majors emphasized that studies focused on imparting content knowledge and not on the development of attitudes or behavior: "Since I am a science major, the different courses broadened my knowledge. The courses provided content but did not develop thinking or encourage attitudes"; "Although I studied courses related to the environment, behavior was not studied or discussed".

The majority of NEAF-majors indicated that influence of studies was insignificant while other factors such as their social environment, existence of an environmental activist student organization ('Green-Course') and campus activities concerning environmental management were influential: "In college, the subject is not seriously addressed except for one course and posters"; "Green-Course' activities, bins distributed on campus for recycling paper, batteries and cans and water conservation"; "In college the subject is not seriously addressed except for one course and posters".

Another point that emerged from NEAF-majors' answers was that they feel their EL had developed prior to college studies, resulting from other factors such as home, media, youth group, previous education or personal interest: "My love for the environment came from home"; "We didn't address the environment during studies, my behavior results from my local youth group"; "My attitudes regarding the environment were influenced by the media and from my personal environment'.

Students were also requested to suggest what they feel should be added to their studies so to enhance their contribution to environmental awareness. Exemplar suggestions include: "Studies of ethics in environment- to develop the awareness about mans' moral responsibility"; "A mandatory course on environmental quality"; "Field-trips, clean-up of nature-trails, creating student involvement"; "Conferences and workshops".

DISCUSSION

Research on the impact of university level environmental studies on students' EL has focused mainly on the influence of selected courses (Bright & Tarrant, 2002; Brody & Ryu, 2006; McMillan et al., 2004; Smith-Sebasto, 1995; Tomsen & Disinger, 1998). Less frequent are studies focusing on the influence of pre-service teacher education on student teachers' EL (Desjean-Perrotta, Moseley, & Cantu, 2008; Moseley, Reinke, & Bookout, 2002; Özden, 2008). Although participation in individual courses may influence students, meaningful academic education that can transform students is most likely an outcome of the integrated and accumulative effect of all components of the academic experience. Therefore, this longitudinal study investigated the influence of undergraduate teacher programs in colleges of education in Israel on the development of student teachers' EL.

The research question focused on the role of academic major, namely: Did majors in environment-affiliated disciplines attain a higher level of EL as compared to majors in non-environment affiliated subjects? According to the hypothesis of this study, it would be expected that if academic studies constitute a significant factor influencing learners' EL, the differences between the two groups of students should increase in the course of their studies. With

respect to behavior, differences between the two groups were significantly changed only for specific behavioral categories such as 'Recycling efforts' and 'Citizenship action', with greater increase in the involvement of EAF-majors in these behaviors. Although such increase was not found in all the behavioral categories, the fact that it occurred in behavioral categories that reflect greater environmental commitment (Goldman, Yavetz, & Pe'er, 2006; Yavetz, Goldman, & Pe'er, 2009) provide some support for our hypothesis. Nonetheless, the extent of their involvement in these behavioral categories towards the end of their studies still reflects limited responsible environmental behavior (Table 1).

Based on the overall mean values (Table 2), both groups of students demonstrated environmentally supportive attitudes as has been reported in other studies on the Israeli society (Goldman, Ben-Zvi Assaraf, & Shaarbani, 2013; Negev, Sagy, Garb, Salzberg, & Tal, 2008). Since their attitudes were already pro-environmental as beginning students, this leaves less room for improvement during the course of their studies. This was the case for most attitude categories with two exceptions: advanced EAF-majors, acknowledged, as could be expected, greater 'Importance of environmental education' as compared to other students. Deviating from the expected was the decrease in scores and significantly less environmentally supportive attitudes among EAF-majors expressed in the category 'Value of nature' after studying environment-related disciplines (Table 2). This category contained items based on the NEP-scale which specifically evaluate fundamental values towards non-human components of nature, and help characterize students' orientation on the anthropocentric-ecocentric worldview continuum (Dunlap, 2008; Dunlap, Van Liere, Mertig & Jones, 2000). Another framework for analyzing the students' values is the values-beliefs-norms theory of environmental concern and behavior (Dietz, Fitzgerald, & Shwom, 2005) which defines three fundamental values that influence environmental concern: Egoistic (self-interest, concern for personal well-being), humanistic altruism (homocentric, concern for human beings in general) and biospheric values (ecocentric, concern for welfare of nonhuman species). Based on both these typologies, it would be expected that as a result of exposure to environment-related studies, the shift in students' environmental values would be towards more biocentric values. The opposite shift found in this study may be explained as follows: at the onset of studies, the students demonstrated intuitively supportive attitudes towards nature, whether as true values or due to social desirability bias or environment desirability bias (Ewert & Galloway, 2009; Newhouse, 1991), but without fully grasping the personal and practical implications of such an outlook. Studies may have prompted a reevaluation and clarification of values, as suggested by other research (Anderson et al., 2007; Harraway et al., 2012; McMillan et al., 2004). But, if these studies did not provide sufficient in-depth understanding of the interdependence between natural and human systems, or sufficiently address the social and economic implications of nature's life-support systems, students (subsequent to studies) may still not fully comprehend and appreciate the importance of biodiversity and ecological integrity to human welfare. This partial understanding of the interrelationship between nature and human society, combined with a critical stance expected of students towards the end of their studies (Harraway et al., 2012), may have upset their initial intuitive support for 'Value of nature'. The limited ecological-environmental knowledge EAF-students demonstrated (Table 3) supports this conclusion that towards the end of their studies they still lack the knowledge foundation necessary for developing a more ecological worldview and less anthropocentric orientation. Limited environmental knowledge of university science majors has been also found in other studies (Robinson & Crowther, 2001), leading the researchers to raise the question how can solutions to environmental issues be achieved when educated people have such a basic level of knowledge?

The value-beliefs-norms theory implies a relationship between environmental values and behavior. Studies conducted on students from different countries have demonstrated a positive relationship between biospheric value orientation and pro-environmental behavior, and a negative relationship between self-interest and pro-environmental behavior (Milfont, Duckitt, & Cameron, 2006; Schultz, Gouveia, Cameron, Tankha, Schmuck, & Franek, 2005). Based on this, the shift found in this study in the environmental values of EAF-majors away from a biocentric value orientation corresponds to the limited and modest changes measured in their reported environmental behavior.

The environmental knowledge and attitudes elucidated by quantitative methods correspond to other findings pertaining to the same student population which used a qualitative approach to explore their conceptualization of the environment (Yavetz et al., 2014). The combined picture emerging from both studies is that student teachers' comprehension of the environment is basic, at the onset but also towards the culmination of their studies, raising the question of the competency of these future teachers to function as effective educators of sustainability. This situation has been described for other pre-service teachers: Desjean-Perrotta, Moseley, and Cantu (2008) and Moseley, Desjean-Perrotta, and Utley (2010) reported that undergraduate pre-service teachers demonstrated a limited and underdeveloped understanding of components of the environment and the interactions among them, concluding that the students lack knowledge and this impedes their ability to meet NAAEE guidelines for environmental educators.

As expected, environmental-affiliated majors acknowledged significantly greater contribution of studies to their EL (Figure 1a) especially the influence of the disciplinary component (Figure 1b). These results are in line with the greater 'Importance of environmental education' acknowledged by these students towards the end of their studies (Table 2). Results also indicate a discrepancy between the EAF-majors' self-assessment of the contribution of studies to their EL and worldview (Figures 1a and 1b), and the actual impact of studies on their EL-proficiency (Tables 1, 2 and 3). Their answers to the open-ended questions provide some insight into the factors that may underlie the insufficient development of their EL. Their answers emphasized contribution of studies mainly to biophysical and ecological content knowledge and when asked to specify which courses they felt were most influential, they referred only to courses in the sciences (biology, ecology, geography and agriculture), while no mention was made to courses in education, social studies or humanities. Only few students remarked that courses influenced their attitudes or behavior. These answers mirror the current situation in teacher education colleges in Israel in which environmental subjects are infused mainly within science disciplines. This situation is similar to that in other countries (Campbell et al., 2010; Simmons, 1989; Van Petegem et al., 2007). Furthermore, the emphasis of the curricula of the majority of environment-affiliated programs included in this study is on the cognitive domain of disciplinary content knowledge, with focus mainly on the physical, biological or ecological aspects of the environment. This issue of emphasis on science-based content knowledge in environmental curricula has been raised by others (McKeown-Ice & Dedinger, 2000; Orr, 1994; Robertson, 1993) as it has implications for the development of individuals' EL and holistic perspective of sustainability issues. The EL-outcomes of EAF-students towards the end of their studies, as well as their views on the influence of studies, support the conclusion that ecology education is not synonymous with EE (McKeown-Ice & Dedinger, 2000; Van Petegem et al., 2007; Yavetz et al., 2014). EE covers a number of realms, not just natural systems: Sustainability issues cannot be understood, or addressed, in isolation from social, political, and economic dimensions that mold the way people interact with the environment (McKeown-Ice & Dedinger, 2000; O'Donoghue & Russo, 2004; Tilbury, 1995). Educational programs limited to the study of concepts from the natural sciences are insufficient in enabling students to analyze and fully comprehend the complex environmental-social-moral issues of the world and daily life so that these will be reflected in a more biocentric orientation and involvement in behaviors reflecting greater environmental commitment. This is all the more crucial with respect to student teachers so they will: (a) Be equipped with the tools necessary for addressing EE in the school system, i.e. education that addresses dilemmas that arise when values are challenged or there are conflicting interests between different stakeholders of an environmental issue (McKeown-Ice & Dedinger, 2000; Summers & Childs, 2007); and (b) Provide a role model for their students in their personal environmental behavior. Cultivating EL, as a component of teacher preparation, requires, in addition to building a knowledge base, developing the values, attitudes and skills that enable knowledge to be converted into effective action. In order that these EE goals be realized in science education and other environment-oriented disciplines, it is necessary that they be explicitly stated in the teaching goals (Anderson et al., 2007), and addressed in the planning and conductance of the courses by the faculty. In this manner, these subjects can provide a platform for meaningful EE.

CONCLUSIONS – IMPLICATIONS FOR TEACHER PREPARATION

The findings of this study have implications for all teacher education programs - the environment-affiliated disciplines and non-environment affiliated disciplines. With regards to the 'environmental' programs, results point to the necessity (without compromising the disciplinary goals of these programs) to reorient the curriculum from the traditional scientific approach to include: a) A comprehensive perspective that addresses the complexity and inter-relationships among the biophysical, economic, social and political dimensions of sustainability issues; and b) Provides learning experiences, beyond science context, that foster the knowhow (knowledge, skills and commitment), as well as environmental citizenship skills, so that these will be reflected in the graduates' competence as environmental educators. Such reorientation requires that the wider goals of EE, those that go beyond the cognitive knowledge level, be explicitly incorporated within the curricular goals of the programs, infiltrating down to the courses and academic staff. It cannot be assumed that such reorientation towards education for sustainability will occur on its own.

With respect to all other programs, principles of EE need to be incorporated in at least one component, disciplinary or teaching and pedagogy, of all training programs. Following are some suggestions. One approach is a mandatory course on EE for all students as part of their basic education courses. Alternatively, would be a component within the pedagogical framework. The latter approach has a number of advantages: a) It takes advantage of a component common all programs; b) In view of the interdisciplinary nature of EE, it can both contribute and benefit from the integrative nature of pedagogy studies; c) The pedagogical component provides a built-in framework for addressing practical aspects of the pedagogies for teaching environmental dilemmas in the

classroom as well as the internship for hands-on experience. A joint initiative of The Ministry for Environmental Protection and Ministry of Education, reflecting these ideas, was commenced in the academic year of 2012.

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