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The Long-Term Impact of an Education for Sustainability Course on Israeli Science and Technology Teachers' Pro-Environment Awareness, Commitment and Behaviour

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Abstract The impact of an Education for Sustainability (EfS) course for science and technology junior high school teachers on the intentional and actual environmental behaviour of participants was studied by researching the EfS implementation of 13 science and technology teachers within their family, community, and work environment. The research was qualitative in nature, where science and technology teachers' insights on the EfS course were determined by means of an open-ended questionnaire and intensive interviews. Results indicated that the course clearly influenced the vast majority of the participants, who claimed that their environmental awareness had increased and they were capable of acting responsibly. All participants acted in favour of the environment among family, community, and at work. Yet, 2 years later, implementation seemed to be undermined by various internal and external barriers, such as the unavailability of convenient resources, or resistance on the part of family. The study suggests that course designers must include reference to potential difficulties and barriers in order to circumvent future obstacles. In addition, the implementation of post-course support would encourage overcoming the gap between willingness to act and actual practice.

Common to many other countries looking to introduce pro-environmental attitudes, the Israeli Ministry of Education has made recommendations to integrate Education for Sustainability (EfS) within the school curriculum (Ministry of Education, 2004). For this purpose, the National Teachers Center for Science & Technology in Junior High School — Weizmann Institute (NTCST) conducted a pilot course whose objectives were to highlight sustainability principles within the science curriculum and provide tools for teaching the subject to pupils.

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Teaching EfS can be a challenge for educational stakeholders because it includes not only environmental issues per se, but also aspects of social justice, culture, and politics. In other words, EfS studies should promote learners' environmental awareness and behaviour (Common & Stagl, 2005; Orr, 1992; Sauvé, 2005; Tilbury & Cooke, 2005), to inspire them to action. Thus, in addition to supplying science and technology teachers with pedagogical tools, the NTCST course aimed to develop science and technology teachers' abilities to address environmental problems and encourage them to commit to act pro-environmentally on a personal level.

The purpose of this article was to evaluate the commitment science and technology teachers had to the environment 2 years after the course, which might give some indication as to the course's effectiveness as a model for EfS.

Background

EfS aims to emphasise social justice, eradicate poverty, and develop an acceptable standard of living for the world's population (Mintz & Tal, 2013; Sauvé, 2005). EfS's goal is to educate individuals not only to be aware, but to actually cope with a changing world and deteriorating environment, and to stimulate participants to be environmentally oriented and literate, and willing to act for the benefit of the environment and society (Disinger & Roth, 1992; Gough, 2011; Yavetz, Goldman, & Pe'er, 2009). In other words, educating according to EfS principles would, hopefully, not only develop environmental awareness, but instil a moral readiness to act in favour of the environment, while teaching the power and skills to do so.

In Israel, following the Rio Declaration on Environment and Development in 1992, the government directed every government office to formulate sustainability strategies (Ministry of Environmental Protection, 2003), and the Ministry of Education (2004) subsequently recommended that all educational system divisions introduce EfS, beginning in September. Later, following a 2006 Ministry of the Environment report specifying 16 principles for environmental sustainability, the Ministry of Education mapped 11 of the principles into the science and technology curriculum and, in September 2008, called for their implementation into EfS throughout the educational system (Ministry of Education, 2008).

In order to be able to manage these curriculum changes, science and technology teachers needed preparation and training, and for this purpose, a pilot course for science and technology teachers was conducted at the NTCST. In compliance with overall EfS objectives, the goals of the course were not just to provide curriculum and teaching tools for introducing EfS principles within the science curriculum, but to give the science and technology teachers themselves the motivation and tools to act pro-environmentally. This included principles concerning pro-environmental attitudes, and promoting social justice and environmental involvement among school members and their community. Therefore, course activities focused not only on learning key principles about the environment, but dealing with real-life environmental dilemmas (addressed both theoretically and practically) concerning social and ethical issues.

Several questions can be raised concerning EfS, especially regarding its success in changing behaviour: What basic information must be taught? What is the optimum duration? How can it be ensured that science and technology teachers will embrace EfS principles and act environmentally responsible under any circumstance? For that matter, how does one evaluate 'successful' EfS training? Is only actual behaviour important, or do intentions or influence on family and community also count? How does one quantify the quality of actions? What other important issues must be addressed?

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This study focused on assessing the changes that occurred in participants' behaviour and the influence of those changes on the participants' family and community.

Analysing Environmental Behaviour

According to previous studies, knowledge is often the first step of environmental responsibility: concern about the environment and commitment to act pro-environmentally must be based on a deep understanding of the system and its complexity (Hungerford & Volk, 1990; Morrone, Manci, & Carr, 2001). However, knowledge alone does not necessarily lead to action. A pro-environmental behaviour shift demands a strong sense of responsibility (Kollmuss & Agyeman, 2002; Roth, 1992; Stern, 2000; Stern, Dietz, Abel, Guagnano, & Kalof, 1999).

The many models created for predicting pro-environmental behaviour are based on numerous variables: knowledge, attitude, and values (Stern, 2000; Stern et al., 1999; Stern, Dietz, Abel, & Kalof, 1993); normative beliefs (how others view the behaviour); evaluative beliefs (behavioural consequences; Ajzen & Fishbein, 1980); locus of control (Hines, Hungerford, & Tomera, 1986/87; Hungerford & Volk, 1990), sense of responsibility or obligation (Blake, 1999; Stern, 2000; Stern et al., 1999); and social and moral norms (Bamberg & Moser, 2007).

These variables may be categorised as either incentives or barriers, and can be further defined as *external–situational* — economic factors, infrastructure, community norms, cultural norms, and so forth (Hines et al., 1986/87; Kollmuss & Agyeman, 2002), or *internal* — motivation, sense of responsibility, sense of capability, values and beliefs (Kollmuss & Agyeman, 2002). Furthermore, not all variables are necessarily environmentally oriented. For example, saving money, not care of the environment, might be the real incentive to driving less, and the unavailability of a convenient recycling centre, and not indifference, may impede recycling. When external and internal variables act in harmony, environmental action is almost inevitable; when they conflict, environmental action may be restricted (Berenguer, Corraliza, & Martin, 2005; Corraliza & Berenguer, 2000).

Blake (1999) mentions three types of barriers that can inhibit environmental action: *individual barriers* (laziness, indifference, strong desire for some environmentally unsound activities such as flying abroad even though it affects global warming), *responsibility barriers* (feeling inept in influencing specific environmental issues or lacking trust in institutions), and *practicality barriers* (lack of money, time, or information). In order for action to occur, personal values and commitment must overcome the barriers.

One model that predicts environmentally responsible behaviour is the value-belief-norm (VBN) theory developed by Stern and colleagues (Stern, 2000; Stern et al., 1999), which examines which values, beliefs, and personal norms will evolve into positive environmental behaviour. According to this theory, if one's values mature into an ecological worldview, they will evolve into beliefs — awareness of consequences (AC) and ascription of responsibility (AR) — that will lead to developing pro-environmental personal norms (a sense of obligation to take pro-environmental actions) and culminate in environmentally responsible behaviour. Stern and colleagues identified several behavioural options in the private (purchase, use, and disposal of personal and household products) and public spheres (active involvement in environmental organisations, influence at work). The theory suggests a causal chain of variables, while a variable can affect not only the adjacent one but one further down the chain as well.

The VBN model was used to classify participants' behaviour level as it evolved from values into beliefs and on to personal norms prompting responsible behaviour, and it formed the basis for classifying different behaviours in the private (at home, among

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friends, and in the community) and public (in the classroom, among school colleagues, and in the school) spheres.

Education for Sustainability Courses and Environmental Awareness and Behaviour

Studies have shown that EfS courses do indeed contribute to the development of responsible pro-environmental behaviour (Hungerford & Volk, 1990; Erdoğan & Tuncer, 2009; Hsu, 2004; Mintz & Tal, 2013). Mintz and Tal (2013) examined three environmental courses offered in a leading science and engineering university in Israel, all of which focused on the natural environment and taught about ecological systems from various perspectives. One course that combined field trips and field studies with the usual classroom work and lectures produced the greatest learning outcomes concerning environmental awareness and motivation to promote sustainability.

Other studies have indicated that teachers most likely to include pro-environmental concepts in their teaching were those who had had a positive experience in an EfS course and those who were specifically asked to commit to teaching the concepts to their students. Teachers who had been highly affected by a course had a greater propensity to teach the concepts to their classes (Meichtry & Smith, 2007; Heimlich & Ardoin, 2008). A similar result was obtained when preservice science teachers participated in an 'Outdoor Inquiry Unit' that studied different environments (natural and man-made systems) both within and outside of the school (Abramovich & Tal, 2009). Findings showed that when specifically asked for a commitment, 42% of preservice teachers expressed agreement to do so. The preservice teachers who specifically committed to teach about the environment were the same individuals who expressed higher levels of environmental awareness and behaviour (Abramovich & Tal, 2009).

This present study examined science teachers' intentional and actual environmental behaviour 2 years after they completed a professional development EfS course, in order to ascertain, by means of questionnaires and direct interviews, the success the EfS course had on affecting their commitment to the environment.

Research Goal

In order to ascertain the influence that the EfS course had on science and technology teachers' intentional and actual behaviour, the study was set up to focus on two specific areas: (1) science and technology teachers' environmental intentions and their reasons for it; and (2) the longevity and extent of the science and technology teachers' EfS implementation.

Methodology

The Research Environment: The EfS Course

The EfS course was designed and implemented as a pilot program that aimed to change EfS from an abstract idea into practical principles, and to encourage science and technology teachers to implement EfS processes in their schools. Three course planners designed a course that spanned two academic years (October 2007 to May 2009) and comprised 140 hours: sixteen 7-hour workshops every 2 weeks during the first year (112 hours), and four 7-hour workshops every month in the second. The course planners were experts in their field; one was the second author of this report. The preservice science and technology teachers chosen for the course had been previously trained at the science teachers' centre in subjects related to science, technology, and leadership, to ensure success in spreading and implementing sustainability principles.

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The course aimed not only to develop the science and technology teachers' environmental awareness, but to encourage an increase in environmental and social activism and inspire ecological practice as a lifestyle, ultimately influencing students, colleagues, families, and friends. The course was intentionally designed to run for 2 years, as long-term training had been shown to lead to the expected change (Chawla & Cushing, 2007; Rickinson, 2001; Tal & Abramovitch, 2013).

The course was based on the 11 sustainability principles mapped out by the Ministry of Education (2008). Content included sustainability perceptions, principles, policies, and initiatives; environmental problems and methods to prevent those problems (e.g., water and air pollution, resources depletion); and current environmental dilemmas (analysing problems, and proposing and discussing appropriate solutions). The course included lectures, field trips, and workshops dealing with environmental dilemmas. Field trips included a group activity in the north of the country to investigate coastal concerns and the influence of a power plant on a nearby river, and individual activities initiated by participants in their own area of residence (e.g., sanitary landfill, polluted river, nature reserve). The participants presented their findings to the class and received feedback and guidance with respect to their topic.

Participants were also taught how to introduce the topic of sustainability into their curriculum and were familiarised with governmental organisations and current environmental fieldwork. They were trained to apply higher-order cognitive skills in order to educate and empower their students to be environmentally literate.

Since participants were expected to inspire their students to act, environmentally speaking, they were asked to set an example and to start with a personal (or family-level) goal by choosing one aspect (e.g., saving water), building a suitable program with incentives and rewards, acting according to the plan, and maintaining this behaviour.

The Study

In order to obtain a comprehensive, reliable picture that would allow identifying and understanding the phenomena related to the field, the research was qualitative in nature (Lincoln & Guba, 2000). Science and technology teachers' insights on the EfS course were determined by means of an open-ended questionnaire and intensive interviews (details in the data-collection section). The statements were compiled and analysed through inductive content analysis followed by alignment to categories based on the VBN theory. The two authors, who are environmental education experts, validated the final classification. Inter-judgmental agreement was 90%.

Participants

Of the 28 junior high school science and technology teachers who had participated in the pilot EfS course, 13 volunteered, 2 years after its termination, to respond to the requested feedback. Of the other 15, some could not be located, and some, while expressing a favourable recollection of the course and claiming that it had made a difference to their teaching, were unable to participate in the study.

The participating science and technology teachers, 11 female and 2 male, were in their thirties and forties, and each had more than 10 years' teaching experience in the educational system. They all held at least a BSc in biology and/or chemistry. Ten held masters degrees: seven in biology, two in science education, and one in educational systems. Alongside their duties teaching science and technology, all had some additional role in the educational system, such as science coordinator or research work coordinator.

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Research Tools and Data Collection

An initial email with an open-ended questionnaire ('First Questionnaire') was sent to all 28 science and technology teachers who had participated in the course. On the basis of the answers of the 13 who expressed willingness to participate, another questionnaire ('Second Questionnaire') was constructed and sent by email. The Second Questionnaire became the basis for in-depth interviews.

First Questionnaire

The first questionnaire comprised 19 questions concerning participants' professional development; opinions on the influence the course had on their environmental knowledge, awareness, and behaviour; and feelings of responsibility regarding implementing EfS at home and at school.

Second Questionnaire

The second questionnaire comprised VBN statements gathered from responses to the first questionnaire. Some examples are 'Today, I "think green" for *almost* everything I do' (values); 'I think that sustainability is a lifestyle that must be expressed by everything one does, whether at home, at work, or in the community' (beliefs); 'I believe that the sustainability education I give my students will produce adults who make environmental responsibility a part of their decision-making' (awareness of consequences); 'My family and I are aware of how environmental problems affect the earth and *do our best* to act responsibly by conserving water and energy, making wise purchasing decisions, etc' (actual intent/implementation). The science and technology teachers were asked to rate to what extent they agreed with each statement (from 1: *always true*, to 4: *never true*) and give specific examples of behaviour. This became the basis for in-depth interviews.

Constructed in-depth interviews

The second author (who had conducted the EfS course) interviewed all 13 participants in depth for 60–90 minutes each, using the second questionnaire as the basis. According to Patton (1990), in-depth interviews help comprehend perceptions, feelings, and knowledge. The interviews were recorded and transcribed.

Data Analysis

Behaviour was categorised as one of two types: intentional and implemented. Intentional environmental behaviour encompasses motives and willingness to act in a pro-environmental manner; implemented behaviour includes actual application of actions.

Statements of intent were compiled and analysed by inductive content analysis, and then aligned to the theoretical source — the VBN theory (Stern, 2000; Stern et al., 1999) — and to previous research regarding changes in environmental awareness and behaviour among students (Abramovich & Tal, 2009, 2011). They were categorised as (1) habit-dependent behaviour (unexplained behaviour); (2) behaviour exhibiting general care for the environment; and (3) behaviour specifically for the benefit of the environment for which cognisant arguments regarding the complexity of the problem and required solutions were given.

Statements of implementation were divided into 'home behaviour' (effected among family and community), and 'workplace behaviour' (effected in the classroom and among peers and colleagues).

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Results

Intent Behaviour

All science and technology teachers but one (F.H.) exhibited deep understanding, personal values, and explicit willingness to act in favour of the environment.

F.H. felt that her environmental awareness had risen, professed to being environmentally responsible, and expressed pride in being involved in colleagues' science projects concerning environmental issues (according to the first questionnaire), yet her interview actually revealed a lower level of environmental awareness and behaviour. For example, she stated about her lifestyle: 'The change should start as a personal change, and then one can influence others at home and at work.... I teach my own children and my students to keep the environment clean.' F.H.'s words express 'general care' for the environment without values or signs of environmental beliefs. Regarding environmental behaviour statements, F.H. said: 'Used bottles are being used to store food, we save water and energy, yet we still use plastic bags that we gathered.' F.H. continued by stating that she and her family take these actions because they are aware that the environment is in danger and they need to do whatever one can to protect it. Her words, however, as encouraging as they may seem, really expressed only general care for the environment rather than explicit willingness to act for its benefit. Her low grade may be because she participated in the EfS course for the first year only and/or she comes from a village without environmental facilities. Thus, to F.H., simple environmental actions were perceived as significant steps for meaningful environmental behaviour.

H.H. is an example of a teacher with excellent environmental values and beliefs, a deep understanding of environmental problems, and a profound willingness to act. H.H. wrote:

> *I began my change when I progressed from simply knowing about environmental issues and their consequences to the recognition that I must take concrete actions for the benefit of the environment (environmental obligation). This is so strong that when I face a sustainability principle — for example, protecting natural resources — I will act even when it is less convenient for me; for example, gathering waste for recycling; thinking twice before driving the family car; avoiding disposables, even on a picnic; buying 'second-hand items'; using ecological cleaning materials (even though more expensive); and so forth (environmental obligation). At school I teach my students about environmental problems, people–environmental relationships, and interpersonal relationships, and encourage them to become involved in caring for the environment and each other (ascription of responsibility). The change I experienced hasn't bypassed my family. Unfortunately, I fear these efforts will be largely ineffective if they are restricted solely to my family and are not adopted universally (awareness of consequences). Yet, if I don't act in a way in which I believe, I will be acting against my values (values and beliefs).*

H.H.'s environmental behaviour is based on solid values and a deep concern for the environment. In addition, her developed awareness triggers her actions in favour of the environment.

Implementation Behaviour

The study examined how the science and technology teachers implemented their knowledge and beliefs among students, peers and colleagues, and among family and community.

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All the science and technology teachers expressed a strong commitment to implementing sustainability principles in school, yet they wavered somewhat concerning their home environment, expressing 'conditional behaviour' despite a deep understanding of environmental needs. Reasons included both internal (e.g., convenience) and external (e.g., infrastructure) barriers. Science and technology teachers cited external barriers that included: the economic situation; lack of infrastructure; moving to another school in which the staff, including the school's principal, were not cooperative in environmental issues; and having to follow a science curriculum that removed any focus from sustainability implementation. Internal barriers included inconvenience, lack of motivation, and community moral norms not in line with sustainability implementation. For example, G.H. stated:

> *I do more with my students than at home. My students are full partners in recycling waste at school: since there isn't any recycling infrastructure in their villages, I ask my students to bring in bottles, paper, batteries, etc. to be disposed at the school.*

G.H. continued:

> *At home, I am willing to act environmentally if I have the right facilities. I am aware of the importance, yet I try to find the balance between environment and quality of life. According to my agenda, I save energy and water, don't use disposable dishes, and don't throw batteries into the garbage. Still, I don't separate garbage because of a lack of facilities and I don't collect water from the bathroom during the winter because there is enough water.*

In other words, the same teacher who asks her students to bring their waste to school because of a lack of facilities in their villages, does not do so herself, and while she *could* bring her own separated waste to school or to a nearby town, she only acts 'environmentally' when it is not an inconvenience. Here, one can identify an external barrier (lack of facilities) and an internal barrier (lack of motivation, not willing to make any extraordinary effort).

Figure 1 illustrates science and technology teachers' implementation during the course and 2 years later.

	During EfS course					**After two years**				
Teachers' Name	At home		At work			At home		At work		
	Family	Community	Class	Colleagues	Entire school	Family	Community	Class	Colleagues	Entire school
E.O.	■	■	■	■	■	■		■		
F.H.	■		■	■		■		■		
G.H.	■		■	■	■	■		■		
G.O.	■	■	■	■	■	■		■	■	■
H.H.	■	■	■	■	■	■	■	■	■	■
N.K.	■	■	■	■	■	■	■	■	■	■
R.S.	■	■	■			■	■	■	■	■
S.B.	■	■	■		■	■	■	■		■
S.N.	■	■	■	■	■	■	■	■		
S.R.	■	■	■	■	■	■	■	■	■	■
T.G.	■		■	■	■	■		■		■
T.Y.	■		■	■		■		■	■	■
Y.K.	■		■		■	■	■	■		■

FIGURE 1: Science and technology teachers' implementation at home and at school during the EfS course, and 2 years later.

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Figure 1 shows that six science and technology teachers already began implementing sustainability principles at home and at work during the EfS course, and four were still applying them 2 years later. E.O.'s level of implementation diminished due to both internal and external barriers: she initially worked in a public school where students were mostly from a low socio-economic level. During the course, her environmental awareness was strengthened at every meeting and, as a result, even her husband and children became environmentally oriented — recycling, using fewer plastic bags, and conserving water and energy. At school, E.O. initiated lunch-box recycling. Thanks to her efforts, students also started recycling paper, involving their families in this project. Her enthusiasm persuaded the principal and other teachers to join this project and involve other students. Two years later, E.O. was reassigned to a new school. She felt she had to find her place among her colleagues before introducing and promoting sustainability principles.

Three science and technology teachers mentioned an additional incentive for sustainability implementation at school: funding offered by the Ministry of Environment's 'Green Schools Project' in which a grant is given to schools where environmental issues are taught and evidence of water and energy savings and waste management is shown.

Community Involvement

Eight science and technology teachers stated that they had begun to implement sustainability principles among the community during the EfS course and seven did so in the 2 years since. Three types of community implementation were identified: (1) activities that influenced students' families, (2) class activities that influenced the community, and (3) direct action within the community (see Figure 2).

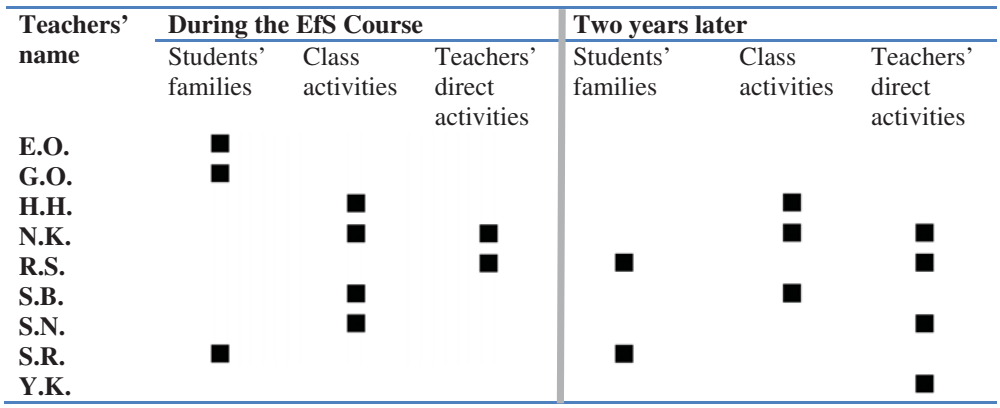

FIGURE 2: (Colour online) Ways that science and technology teachers implemented sustainability principles in the community during the EfS course and 2 years later.

Two science and technology teachers involved students' families with environmental activities during the EfS course but not 2 years later: E.O. had moved to another school and had not yet had the chance to act among her new students and families. During the course, G.O. had organised a parent–student project that 'adopted' a nearby, neglected site (parents, children and teachers cleaned the site, planted trees and flowers, and built ecological benches), yet it was a single act.

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The other four science and technology teachers did expand their class activities into the community. H.H., for example, recruited her excellence-class students to initiate waste separation and present environmental issues to other classes. They visited the local shopping centre to explain to passersby about Israel's water problems and to sell water-saving devices. She encouraged her students to discuss the issues with their families. H.H. is convinced that her students have absorbed the information and their future decisions will consider environmental impact: 'In fact, they already do it. . . . Being aware of air pollution and the scarcity of energy resources, they organise car pools.' Figure 2 shows that H.H. continued likewise 2 years later.

N.K. became a sustainability instructor, advising colleagues and students, introducing field trips and films, leading discussions concerning environmental dilemmas, and combining environmental issues with science subjects. As a result, her students and fellow teachers became more involved in the community by organising second-hand sales, adopting a site, teaching after-school programs about the environment and environmental issues, and arranging various activities for the benefit of the environment and community.

S.B.'s science-and-technology students influenced their community in an inspirational way. After learning about excess waste, they decided to replace their plastic lunchbags with reusable containers or fabric bags. The student–parent council, acting under S.B.'s supervision, were so successful in encouraging others to do likewise that almost 70% of the student population began bringing their lunch in recyclable containers. This council also placed special garbage bins to separate trash in the classrooms, and adopted a nearby monument site and cleaned it up. During lunch breaks, S.B. and his students educate other students on environmental issues. On Earth Day, S.B. gives his colleagues relevant reading material with suggestions on how to teach their students about environmental issues. Every month, his class cleans a nearby neighbourhood. S.B.'s actions are remarkable. Unfortunately, this is a 'one-man show'. As S.B. stated:

> *There is a lot of environmental activity in school . . . about the environment and for the environment. We print on both sides of paper and use scrap paper for drafts and notes. All this would not have happened if I didn't care about these things. Even the council I established is under my supervision, and I really don't know if there is anybody that can replace me.*

It seems that the day S.B. retires, all environmental action will stop.

Discussion

Evaluation of Science and Technology Teachers' Intentional Environmental Behaviour

Pre-course self-assessment

All science and technology teachers claimed some understanding of environmental issues and their impact before the EfS course. But while three had been actively involved in environmental projects, the answers of others led us to conclude that they did not fully understand the issues, especially those who 'couldn't let go of old habits', which does not conform to being environmentally aware and responsible. This is disconcerting, as the participants are science and technology teachers who are supposed to teach about environmental issues in their classes (Ministry of Education, 2012).

Post-course self-assessment

All science and technology teachers declared that both during the EfS course and 2 years later they were qualified to deal with environmental issues. Twelve science and

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technology teachers claimed that their environmental awareness had increased and they were capable of acting responsibly (F.H. was the only exception). This change — from values, to beliefs, to environmental awareness, and to the capability for action — has been indicated by researchers as conditions that might lead to environmentally responsible behaviour (Bamberg & Moser, 2007; Stern, 2000; Stern et al., 1999).

To make a real change, there must be constant, substantial and appropriate guidance, extensive training, course relevance, and active learning inside and outside the classroom (Blake, 1999; Chawla & Cushing, 2007; Rickinson, 2001). The EfS course seems to have met these demands: it lasted 2 years and it included varied activities to enrich knowledge, develop skills and environmental awareness, and stimulate new behaviour. Yet, some science and technology teachers only acted when certain conditions were met, and comfort requirements, absence of infrastructure, lack of motivation or 'old habits' often hindered environmentally responsible action. According to Kollmuss and Agyeman (2002) 'old habits' can be difficult to change even when new behaviour has an advantage over old. Adults, though highly aware of environmental problems and the need for action, might have difficulty changing ingrained behaviours. Perhaps the course was not relevant, active, or long enough to increase *adults'* environmental awareness and their willingness to act (Brody & Ryu, 2006; DiEnno & Hilton, 2005; Hsu, 2004), or perhaps environmental action on their part is more dependent on circumstances (Blake, 1999; Heimlich & Ardoin, 2008). Hsu (2009) found that the most relevant stimuli for responsible environmental behaviour during adulthood were participation in environmental organisations, the loss of beloved natural places, and friends who are environmentally concerned; only 13% of respondents stated that adult environmental activism was fostered by education.

Hsu's (2009) finding might discourage the designers and educators of courses on the subject of the environment who hope that proper training can change the participants' environmental awareness and their willingness to act in an informed, pro-environmental manner. In spite of that, the findings in the current study, as well as others (Chawla & Cushing, 2007; Hsu, 2004; Rickinson, 2001) show that while a positive change in environmental awareness and willingness to act does in fact occur, in order for the change to be more significant, a post-course support system is required.

Evaluation of Science and Technology Teachers' Actual Environmental Behaviour

Besides assessing the presence of environmental *awareness*, the study also examined its implementation at and away from school, expecting that science and technology teachers with a deep understanding of environmental problems and awareness of the need for immediate environmental action would exhibit action. Yet, of the 12 participants who were determined to fit these criteria, only 6 took positive action immediately after the course, and only 4 maintained this level 2 years later (Figure 1). We determined that the reasons for this gap between potential and actual practice were internal and external barriers (inconvenience, lack of infrastructure, or other constraints).

Several of these barriers — economic situation, lack of infrastructures, moral norms, comfort, and lack of motivation — have been mentioned in previous studies (Bamberg & Moser, 2007; Blake, 1999; Corraliza & Berenguer, 2000; Kollmuss & Agyeman, 2002). In the present study, the barriers most cited were the teacher's transfer to another school where they were focused on integrating into the system, uncooperative colleagues or administrators, or a new science curriculum that interfered with implementing sustainability principles. The principal's cooperation is crucial for any school program's

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success: as school leaders, principals have a direct effect on teachers' attitudes, professional development, and implementation of educational reform (Leithwood et al., 2007).

This gap between potential involvement and actual behaviour was illustrated by one participant, E.O. Even though her environmental awareness had not changed, she stopped acting environmentally at the school to which she was transferred, yet continued to do so at home. This is congruent with findings that show that when external and internal variables are in accord, action happens (her desire to act and the conditions at home allow this), yet a conflict between variables restricts environmental action (as at school); Berenguer et al., 2005; Corraliza & Berenguer, 2000). It matches Blake's (1999) theory that even though a person overcomes his individual barriers, the social context might hinder action.

These findings also help one understand why G.H., to overcome the lack of infrastructure in her students' village, encouraged them to bring trash from home to be separated at school, yet avoided recycling herself by the same method. In her case, her comfort (an internal variable) was not matched by the non-existence of convenient recycling facilities (external variable). Thus, for some science and technology teachers, despite undertaking 2 years of part-time study in the EfS course, implementation levels decreased due to external and internal barriers. Others did maintain their environmental activity (even if sometimes partially), perhaps due to the course's effect on their values and beliefs or because these values had been assimilated even before the course. Heimlich and Ardoin (2008) expressed this in different words: '… people act in ways that are usually consistent with how they express their values, beliefs, understandings, culture, socialization, enculturation, upbringing and training' (p. 230).

In general, internal variables seemed to remain highly stable, resulting in environmentally responsible action in areas that were under the teacher's control. Yet, external variables became barriers that hindered willingness for pro-environmental action and encouragement of friends, the community, and colleagues to undertake similar actions.

In order to increase environmental action, perhaps the EfS course should seek to define each teacher's unique motivation and then encourage those teachers to make pro-environmental behaviours routine and relevant.

In summary, a change seemed apparent. Is it enough to justify investing funds in similar continuing education programs? In our view, the answer is a resounding 'yes', if only because these teachers are educating the next generation. It is imperative that the decision-makers of tomorrow have a thorough understanding of environmental issues, and the knowledge to make and carry out informed decisions.

Conclusions and Implications

The present study demonstrated that the EfS course is, indeed, an appropriate instrument to increase science and technology teachers' environmental awareness, and has the potential to promote responsible, pro-environmental behaviour even 2 years hence. Concurrently, a gap between 'potential' and 'actual' environmental action often exists due to internal and external barriers that can hinder transformation of theoretical understanding into real deeds, due to each individual's motivations. These should be taken into consideration when planning similar courses to ensure their success in disseminating sustainability principles.

It is recommended that course designers also take into account the participants' background, environmental awareness and motivation to act so that barriers can be foreseen and methods to overcome those barriers addressed. Future course designers might also consider providing post-course support to participants. These actions —

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foresight and future support — may lead to successfully implementing the routine, environmentally favourable actions that the course intends to foster.

It is also suggested that the principles of the EfS course should be a basis for other courses that could be implemented among two sectors. One sector would be stakeholders (e.g. school principals and their teachers, not just science and technology teachers), and the second sector would be primary, junior high, and high school students. On the one hand, principals could support environmental dedicated teachers and transform school policy by embracing environmental education principles into the school curriculum, while on the other hand, students could be trained during school hours (not only during science and technology lessons) and become, with the right guidance, environmentally responsible citizens. If consistent action is done in two directions — 'top down' (principals and teachers) and 'bottom up' (students) — in years to come, the gap between 'knowing what to do' and 'actual acting in favour of the environment' will be hopefully reduced to a minimum. To conclude, environmental EfS is a crucial subject, especially when dealing with a deteriorating environment and quality of life, for everyone, everywhere. The EfS course, could be the tool to accomplish the environmental EfS mission.

Keywords: education for sustainability, environmental awareness and behaviour, internal and external barriers, environmental commitment, science and technology teachers

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