Application and Evaluation of Ecological Footprint as an Environmental Education Tool[1]

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Abstract

The aim of this study is to analyze the impact of ecological footprint applications used as a tool of environmental education on changing the awareness, attitudes and behaviours of prospective science and technology teachers towards environment and sustainable life. The research was applied on 49 third grade prospective science and technology teachers studying in Gazi University Faculty of Education Science Education Program. In the research, "Environmental Education Survey" was used as data collection tool. In the analysis of statistical data, correlation method and paired samples t-Test were used. It was seen that awareness, attitude and behaviour points of the prospective science and technology teachers rose on the phase of post-test. That result shows that applying ecological footprint is an environmental education tool effective in changing the awareness, attitudes and behaviours of the prospective science and technology teachers towards environment and sustainable life.

Key Words: Ecological footprint, environmental education, sustainable life, science teaching

INTRODUCTION

In 1992, the United Nations Conference on Environment and Development, the Earth Summit took place in Rio de Janeiro, Brazil. It was the largest ever-international conference and the central aim was to identify the principles of action towards "sustainable development" in the future. Literally, sustainable development refers to maintaining development over time. However, it has been suggested that there are more than seventy definitions of sustainable development currently in circulation (Holmberg & Sandbrook, 1992). Below just a small number of such definitions and the varied interpretations of the concept which have flowed from these different ideas. Definitions

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are important, as they are the basis on which the means for achieving sustainable development in the future are built.

"In principle, such an optimal (sustainable growth) policy would seek to maintain an "acceptable" rate of growth in per-capita real incomes without depleting the national capital asset stock or the natural environmental asset stock"(Turner, 1988). "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

Sustainable development requires decreasing the consumption speed of the non-renewable sources, protecting species of plants and animals, to provide continuity of general unity of the ecosystem minimising the negative effects on the quality of air, water and other natural elements. Environmental protection is the essential of the sustainable development concept, and focused on the sources of the environmental problems, not their symptoms (Türkiye Çevre Sorunları Vakfı, 1991). Education is pre-condition of a sustainable development. It develops and strengthens the capacity of evaluating and making preference for sustainable development of individuals, groups, associations, institutions, and countries. Changing the aspects of the individuals, it makes our world safer, healthier and more comfortable and increases the quality of life (UNECE, 2003).

Education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues. To be effective, Education for Sustainability (ESD) should deal with the dynamics of both the physical/biological and socio-economic environment and human development, should be integrated in all disciplines, and should employ formal and nonformal methods and effective means of communication (Wheeler et al., 2003). Education for sustainable development is a lifelong process from early childhood to adult education. The education is of special importance for the children since the values, lifestyles and attitudes are determined in the early ages.

Environmental education (EE) and education for sustainable development (ESD) have become growing priority at the local, national and international levels in recent years. The central role of EE and ESD in fostering both the values and the skills necessary to fulfil the

broader goals of sustainable development is reinforced by the United Nations recent launch of the Decade of Education for Sustainable Development in 2005 (Globescan, 2005).

Fien (1993) asserted that the education for sustainable development improves critical thinking, reflection, and action abilities when making long-term decisions about the nature for a better world. Orr (1994) explained that education encourages the students to look from conventional box with his sentences "If the students were appropriate to the technological societies of future, they would be successful adults and achieve to constitute a sustainable future making effective decisions now". Fien and Trainer (1993) underlined that sustainable individuals can get ready in education process, judgements and attitudes can be turned to behaviours considering and broaden the subjects of sustainable development.

The concept of an "ecological footprint" is an almost intuitive measure of the impact of individuals or societies on nature. It provides a simple yet elegant accounting tool that can help us to see the impact of human consumption patterns on the earth. Today, humanity's ecological footprint is already over 30 percent larger than what the world can offer. The ecological footprint is a measure in hectares of the land used by an individual to meet the needs and absorb waste materials that is required to sustain a city, region or country. The footprint helps students to understand the concept of sustainability (Turner, 1995). Ecological footprint is an educational tool that is more effective than the knowledge that we have didactically in terms of changing our environmental attitudes and behaviours positively, because it expresses our negative effects on the world digitally. In this study, if using the ecological footprint, as an environmental education tool is effective in changing the awareness, the attitudes and the behaviors of prospective science and technology teachers directed towards sustainable life, is investigated.

Problem

Is using the ecological footprint as an environmental education tool effective in changing awareness', attitudes, and behaviours of prospective science and technology teachers towards sustainable life?

Sub-Problems

These problems were asked in this research;

1.   Before the ecological footprint application, is there a considerable relation between the awareness, attitude, and behaviour points of prospective science and technology teachers, who participated in the research, directed towards sustainable life?

2.   After the ecological footprint application, is there a considerable relation between the awareness, attitude, and behaviour points of prospective science and technology teachers, who participated in the research, towards sustainable life?

3.   Before and after the ecological footprint application, is there a considerable difference between the awareness, attitude, and behaviour points of prospective science and technology teachers, who participated in the research, directed towards sustainable life?

METHODS

Sample and Instrument

In this research a quantitative research design was used. The participants of this study consisted of 49 prospective science and technology teachers, who were enrolled in the science education program at a Gazi University Department of Education in Turkey. In the research, "Environmental Education Survey" that was developed by Meyer (2004) was used to measure awareness', attitudes, and behaviours of the prospective science and technology teachers directed towards sustainable life. The survey mentioned above applied in both pre-test and post-test. It was composed of 35 expressions and prepared using Likert-type scale. In the survey, the expressions related to sustainable life, ecological footprint, and environment were used. The expressions in the survey were prepared in three dimensions to measure awareness, attitude, and behaviour towards sustainable life. There were 20 expressions to measure awareness, 8 to measure attitude, and 7 to measure behaviour. Each expression has equivalent weight in the survey. The replies of the negative expressions in the survey were converted and considered in total evaluation. The

extent validity of Environmental Education Survey was ensured taking the views of the field experts. Cronbach α co-efficient of Environmental Education Survey was calculated 0.74.

Education Design

The prospective science and technology teachers were educated about sustainable living through active learning methods over a 5-week period. They were divided into groups via various grouping methods at each phase of instructional interventions (e.g., puzzle method). The following activities were used throughout the instructional interventions:

In the first lesson in the week of the research, "Environmental Education Survey" was applied to prospective science and technology teachers as pre-test and later, the studies, of which stages will be mentioned below, were carried out in the lessons.

In the first week of the instructional treatment, were facilitated to find answers to the following questions through group discussions: "Why are we not sustainable?" "What prevents our world and country from being sustainable?"

In the second week, the prospective science and technology teachers played a commercial game. The instructor introduced the concept of sustainable development.

In the third week, the prospective science and technology teachers in groups discussed how the sustainability of the natural ecosystem is established and drew their ideas on posters. Following the poster drawing activity the groups presented their posters to their classmates.

In the fourth week, the ecological footprints of the prospective science and technology teachers were calculated by using software ("Ecological Footprint Measurement Survey) available on the Internet. In the last week, prospective science and technology teachers were applied "Environmental Education Survey" again as post-test.

Analysis

In this research, to determine if a considerable difference between the pre-test and post-test points of prospective science and technology teachers, paired-samples t-Test analyze was used. When pre-test and post-test points belong to the same group, they form paired samples. Paired-samples t-Test is used when you have only one group of people and you collect data from them on two conditions (Pallant, 2001).

If there was a relation between awareness, attitude and behaviour points of the prospective science and technology teachers, who participated in the research, directed towards sustainable life is examined with correlation method calculating Pearson correlation co-efficient. The pre-test and post-test point distribution, measure of central tendency values (mean, median, and mode), and central distribution (standard deviation, variance, skewness, and kurtosis) values of awareness', attitudes, behaviours of prospective science and technology teachers were reported. Since correlation method and points seems continuous to find the association between two variables and explain it, calculating Pearson correlation co-efficient is convenient in terms of examining the association between these variables (Büyüköztürk, 2005).

FINDINGS

In this section, the findings, which appeared when evaluating the data that collected in the research and statistical analysis of these, were presented. The findings were interpreted regarding the order of sub-problems.

Findings Related to First Sub-problem and Commentary

With first sub-problem of the research, if there was a meaningful difference between awareness, attitude, and behaviour points of prospective science and technology teachers, was searched before and after ecological footprint application.

Before and after ecological footprint application as an environmental education tool the statistical analysis results of awareness, attitude, and behaviour values of the prospective science and technology teachers, were shown in Table 1.

Table 1. The statistical analysis results of pre-test and post-test awareness, attitude, and behaviour points associated with sustainable life

	Awareness		Attitude		Behaviour	
	pre-test	post-test	pre-test	post-test	pre-test	post-test
Mean	38.69	62.51	16.02	24.80	14.78	20.61
Median	39.00	63.00	16.00	25.00	14.00	20.00
Mode	40	65	15	24	14	20
Standard deviation	5.359	4.542	1.677	2.081	2.084	2.060
Variance	28.717	20.630	2.812	4.332	4.344	4.242
Skewness	-.315	.001	.326	.284	.082	.310
Kurtosis	.396	-.728	.081	-.131	-.482	-.359

As it is seen Table 1, the average awareness, attitude, and behaviour point of prospective science and technology teachers participated in the research towards sustainable life, which was calculated in the post-test, after ecological footprint application as an environmental education tool is higher than the average point, which was calculated in the pre-test, before the application. The skewness value provides an indication of the symmetry of the distribution. Kurtosis on the other hand provides information about the "peakedness" of the distribution. If the distribution is perfectly normal you would obtain a skewness and kurtosis value of 0 (Pallant, 2001). As it seen Table 1 skewness values were obtained respectively -.315, .001, .326, .284, .082 and .310. Kurtosis values were obtained .396, -.728, .081, -.131, -.482 and -.359 respectively. Based on these results it is possible to say that the data show a normal distribution.

t-Test analysis was used for the samples about whether there was a meaningful difference between awareness, attitude, and behaviour points of prospective science and technology teachers towards sustainable life before ecological footprint application as an

environmental education tool and their points after the application or not. The analysis results were shown in Table 2, 3, and 4 respectively.

Table 2. Pre-test and post-test dependent variable t-test results for awareness directed towards sustainable life

	N	$\bar{X}$	S	sd	t	p
Pre-test	49	38.69	5.359	48	21.414	.000
Post-test	49	62.51	4.542			

As it is seen in Table 2, there is a meaningful difference (t_{48}=21.414, p<.01) between awareness pre-test points of prospective science and technology teachers, the points of the post-test, which was applied after the application of the education process associated to ecological footprint application. While the average awareness point of prospective science and technology teachers towards sustainable life was $\bar{X}$=38.69 before the application, it increased to $\bar{X}$=62.51 after the application of education process about ecological footprint application.

This finding shows that ecological footprint application that is an environmental education has a considerable effect on increase of awareness levels of prospective science and technology teachers towards sustainable life.

Table 3. Pre-test and post-test dependent variable t-test results for attitude directed towards sustainable life

	N	$\bar{X}$	S	sd	t	p
Pre-test	49	16.02	1.677	48	19.374	.000
Post-test	49	24.80	2.081			

As it is seen in Table 3, there is a meaningful difference between attitude pre-test points and post-test points (t_{48}=19.374, p<.01) of prospective science and technology teachers, who participated in the research, towards sustainable life. While the average attitude point of

prospective science and technology teachers towards sustainable life was $\overline{X}$=16.02, before the application, it increased to $\overline{X}$=24.80 after the application. This finding shows that ecological footprint application that is an environmental education has a considerable effect on the positive change of attitudes of prospective science and technology teachers towards sustainable life.

Table 4. Pre-test and post-test dependent variable t-test results for behaviour directed towards sustainable life

	N	$\overline{X}$	S	sd	T	p
Pre-test	49	14.78	2.084	48	11.933	.000
Post-test	49	20.61	2.060			

As it is seen in Table 4, there is a meaningful difference between behaviour pre-test points and post-test points (t_{48}=11.933, *p*<.01) of prospective science and technology teachers towards sustainable life. While the average behaviour point of prospective science and technology teachers towards sustainable life was $\overline{X}$= 14.78 before the application, it increased to $\overline{X}$= 20.61 after the application of education process about ecological footprint as an environmental education. This finding shows that ecological footprint application has a considerable effect on acquiring of prospective science and technology teachers, behaviours towards sustainable life.

Findings Related to Second Sub-problem and Commentary

With second sub-problem of the research, if there was a meaningful relation between awareness, attitude, and behaviour points of prospective science and technology teachers, who participated in the research, towards sustainable life was searched before ecological footprint application.

It is examined that before ecological footprint application, whether there was an association between the awareness, attitude, and behaviour points of prospective science and technology teachers, who participated in the research, and if there was, how relation it

was, using correlation method and calculating Pearson correlation co-efficient. Data that was mentioned above was shown in Table 5.

Table 5. Awareness, attitude, and behaviour correlation before ecological footprint application

		Awareness	Attitude	Behaviour
Awareness	Pearson Correlation	1	.019	.216
	P		.896	.137
Attitude	Pearson Correlation	.019	1	.383**
	P	.896		.007
Behaviour	Pearson Correlation	.216	.383**	1
	P	.137	.007	

In respect of the data in Table 5, a high-level, positive and meaningful association ($r=0.383$, $p<.01$) was found between attitude points and behaviour points of prospective science and technology teachers wards sustainable life, before ecological footprint application. However any association could not been founded between those and awareness point. These data shows that the attitudes of prospective science and technology teachers, who participated in the research, change more positively, and their behaviours will change more positively. That finding could be interpreted as changing of the attitudes towards sustainable life positively will ensure responsible behaviour towards sustainable life. Before the application directed towards sustainable life, non-existence of a relation between awareness points and attitude and behaviour points of prospective science and technology teachers is caused by that they did not have information about sustainable life and ecological footprint subjects in the beginning.

Findings Related to Third Sub-problem and Commentary

With third sub-problem of the research, if there was a meaningful relation between awareness, attitude, and behaviour points of prospective science and technology teachers, who participated in the research, towards sustainable life was searched after ecological

footprint application. It was examined that after ecological footprint application, whether there was an association between the awareness, attitude, and behaviour points of prospective science and technology teachers, who participated in the research, and if there was, how relation it was, using correlation method and calculating Pearson correlation co-efficient. Data that was mentioned above was shown in Table 6.

Table 6. Awareness, attitude, and behaviour correlation after ecological footprint application

		Awareness	Attitude	Behaviour
Awareness	Pearson Correlation	1	.406**	.587**
	P		.004	.000
Attitude	Pearson Correlation	.406**	1	.419**
	P	.004		.003
Behaviour	Pearson Correlation	.587**	.419**	1
	P	.000	.003	

In respect of the data in Table 6, high-level, positive and meaningful associations were found between awareness and attitude (*r*=0.406, *p*<.01), awareness and behaviour (*r*=0.587, *p*<.01), and attitude and behaviour (*r*=0.419, *p*<.01) points of prospective science and technology teachers towards sustainable life, after ecological footprint application that is an environmental education tool. It is seemed that there is a meaningful increase in awareness, attitude, and behaviour correlation of prospective science and technology teachers, after ecological footprint application, which is an environmental education tool. Those findings show that the awareness of environment and sustainable life increased due to comprehension of ecological footprint during the lessons about ecological footprint and this increase effects the attitudes and behaviours of prospective science and technology teachers positively. In respect of these data, in the educational process, in which ecological footprint is used as an environmental education tool, awareness level of environment and sustainable life increases more, and the attitudes and behaviours will change more

positively; the attitude that will change positively ensures the behaviours towards sustainable life be gained a responsibility.

CONCLUSIONS

In respect of the research these results were attained;

• A meaningful difference (t_{48}=21.414, p<.01) between awareness pre-test points of prospective science and technology teachers, who participated in the research, towards sustainable life and the points of the post-test, which was applied after the application of the education process associated to ecological footprint as an environmental education tool was found.

• There is a meaningful difference between attitude points (t_{48}=19.374, p<.01) of prospective science and technology teachers towards sustainable life before and after ecological footprint application, which is an environmental education tool.

• It was seen that there is a meaningful difference between behaviour pre-test points and post-test points (t_{48}=11.933, p<.01), which were calculated after ecological footprint application, of prospective science and technology teachers towards sustainable life.

• A high-level, positive and meaningful association (r=0.383, p<.01) was found between attitude points and behaviour points of prospective science and technology teachers towards sustainable life, before ecological footprint applications which are environmental education tools. However any association could not been founded between those and awareness point.

• High-level, positive and meaningful associations were found between awareness and attitude (r=0.406, p<.01), awareness and behaviour (r=0.587, p<.01), and attitude and behaviour (r=0.419, p<.01) points of prospective science and technology teachers towards sustainable life, after ecological footprint application.

The findings in this study support some of the claims of existing literature. In Japan, a personal ecological footprint calculator that is Internet web-based was developed in a

research, which was made to assist the citizens to realise the magnitude of their ecological footprint. In respect of the results of the research, one of the necessary conditions for ecological sustainability is whether we achieve "One Planet" lifestyle and ecological footprint is an effective instrument in changing our lifestyles and providing ecological sustainability (Wada et al., 2007). Wackernagel and Rees (1996) asserted that the concept of ecological footprint should be united with the intramural and extramural education activities. They expressed that ecological footprint could be used in the games and school projects to study on energy and material flow of nature, to make experiments related to sustainable lifestyle, and to provide concrete local applications for mathematics, biology, and physics lessons, which are taught at schools simultaneously. This research supports the findings of Franson (2008), Kagawa (2007) and McMillan et al., (2004) that education on sustainability can lead students to become more sustainably oriented. Franson (2008) reported that although in her study did not use Ecological Footprint Analysis as a form of measurement, it was found to be effective as a form of treatment. Ryu and Brody (2006) found that education on sustainability produced student scores on ecological footprints that reflected a more sustainably conscious student and sustainable behaviours that can be measured with ecological footprint show positive changes and this concurs with our finding. According to Meyer (2004) although ecological footprint is not effective on altering attitudes and behaviours of the people, who learn, directly, it alters their information and alteration of information might alter attitudes and behaviours soon. Therefore ecological footprint can be used as an educational tool to increase the information about sustainable life and develop the attitudes and behaviours. The science education for sustainable education requires active participation of the students in setting the processes and the models to fill the gap between the real world and the class. Studies of the students on the sustainable life conditions in local scale, is important. The educators should encourage and motivate the schools continuously to let the environmental problems to be learned, to let them be comprehended, and let solution suggestions be presented (Herremans & Reid, 2002).

The results of this study will provide academic researchers in a variety of different disciplines with information related to education on sustainability and the effects of ecological footprint on the change in student awareness, attitudes and behaviors. This be of assistance to educators, academic researchers and environmentalists, as well as other persons involved in the sustainability movement. At the end of the study, we can suggest that get seminars and lessons about sustainable living in education faculties will be more effective. Carrying out this study for all students of the faculty of education may create a larger sample that may produce a larger perspective of views and suggestions that could contribute to the educational world.

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