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The Awareness Levels of Science and Technology Teacher Candidates towards Ecological Footprint

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ABSTRACT

The aim of this study was to investigate and evaluate the ecological footprint awareness levels of science and technology teacher candidates. This research was performed in 361 science and technology teacher candidates, who were in Science Education Department of Gazi Education Faculty of Gazi University in the spring semester of 2013-2014. The research was carried out using a cross-sectional survey model. The variables of this research were gender and grade levels. The data were collected using the Ecological Footprint Awareness Scale. Descriptive statistic techniques, independent samples t-test, and one-way ANOVA were used for data analysis. The results obtained from this study showed that science and technology teacher candidates have the largest footprint in food subscale, and the smallest footprint in energy subscale. The ecological footprint awareness levels of female science and technology teacher candidates were found significantly higher than those of male science and technology teacher candidates. The ecological footprint awareness of science and technology teacher candidates was observed significantly higher than that of freshmen science and technology teacher candidates.

Keywords: Ecological Footprint; Environmental Education; Science and Technology Education; Sustainable Life.

INTRODUCTION

In the universe's perfectly running system, each and every piece forming the universe are connected to each other in an excellent balance. The most important element in humans' lives, one of the elements forming the universe, is the balance element. The strongest step of this balance is the natural balance formed spontaneously between human and the environment (Yıldız, 2014). Since the systems forming the natural balance as a whole are connected to each other with the long connection links, a damage which may occur in one of the links on the chain disturbs this balance by affecting the whole chain, which causes environmental problems. Humans' efforts to regulate the nature by disturbing the natural balance have caused the environment to get into a deterioration process by causing breaks in the links on the chain (Doğan, 1997).

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Environmental problems appearing in different forms during the production and the consumption process disturb the nature's balance, which have become a threat to both environment, and thereby the existence of all species (Gökmen, 2011). These problems faced by the humanity and environment are related to many factors and the processes, such as population increase, insensible use of the natural sources, destruction of the wild life habitat, extinction of many plants and animals, natural disasters, urbanization, and the wealth difference within a country and between countries.

Although the environment can renovate itself in spite of the problems caused by people, its self-renovating limit has also been exceeded especially with the realization of the industrial revolution (Aydoğdu and Gezer, 2006). With the industrialization process, local productions in agricultural societies have been replaced with factories and growing industrialization has increased the rural-urban migration. Developing industrialization, rapidly growing population, urbanization, and people's wish to have better life conditions have caused the insensible overuse of natural resources and consumption. Consequently, the earth has become unable to restore the natural resources, i.e. it has become unable to renovate itself (Yıldız, Sipahioğlu and Yılmaz, 2008).

Human beings concerned for the future because of the problems they have caused have started to look for a solution to the environmental problems. Within this context, firstly the sustainable development concept has been suggested as a solution for the environmental problems. With the concept of "sustainability", leaving a livable environment to the next generations is meant. The other important concept accompanying the concept of "sustainability" is "ecological footprint".

Ecological footprint is a sustainability indicator measuring how much the products are is consumed at the end of human activities and at which point the consumption has exceeded the national and global limits The Ecological Footprint is a resource accounting tool that measures how much bioproductive land and sea is available on Earth, and how much of this area is appropriated for human use. The Ecological Footprint, human demand, and biocapacity, ecosystem supply, are both measured in units of global hectares, a hectare normalized to the average productivity of all bioproductive hectares on Earth. (Kitzes and Wackernagel 2009; Lenzen and Murray 2001).

Actually ecological footprint means more than an indicator with regards to sustainability owing to the benefits of being an educational approach for sustainability and getting over the physiological perspectives of especially some current global environment problems In this context, we think that the ecological footprint is more than an indicator for sustainability. It has the merits of being an educational approach to sustainability, especially concerning overcoming some of the physiological perspectives of current global environmental problems. (Gottlieb, Vigoda-Gadot and Haim, 2013). With this point of view, it can be said that, the basic emphasis on ecological footprint is on the sustainability concept, which stipulates the increase in the bio-productive areas that have the capacity to renovate themselves and to maintain their renovation abilities, including the idea of leaving a preserved environment to next generations.

Within this context, for the sustainability of life, it is imperative for individuals to adapt their life conditions and economic activities with regards to the bearing capacity of the Earth (Young, 2009).

By learning our ecological footprint, we can see the size of the damage that we give to the environment and we can identify the measures that need to be taken against them. Therefore, the importance of involving the concept of ecological footprint in environment education curricula becomes clear. We can raise individuals who are sensitive to the environment and have high awareness levels with the integration of the ecological footprint applications to the education setting (O'Gorman and Davis, 2013). Teachers who are the most

important elements of education in raising individuals who have environmental sensitivity and are aware of the environment problems have an enormous responsibility.

It is natural that teachers, who are sensitive about and interested in environmental issues, and with positive attitudes and behaviors regarding environment would be expected have a positive impact on student regarding these concepts. Within this context, it is necessary for teachers to complete their education equipped with required knowledge and skills. Therefore, pre-service teachers should be introduced to the concept of ecological footprint before they begin practicing. That's why ecological footprint concept absolutely should be included in the current teacher training programs. Determining the teacher candidates' current status in ecological footprint awareness issue will be beneficial in the reconstruction of education programs.

An analysis of the contents of the subjects shows that that especially science and technology teachers have more duties and responsibilities. Therefore, science and technology teachers should be equipped with necessary knowledge and skills regarding the issue before they graduate and start practicing. Therefore, in this study, science and technology teachers' ecological footprint awareness levels were aimed to be evaluated.

To this end, the question "What are science and technology teacher candidates' awareness levels about ecological footprint subject?" was investigated through the following research questions:

1. Which field contributes most to the ecological footprint awareness levels of science and technology teacher candidates?
2. Do the ecological footprint awareness levels of science and technology teacher candidates show any significant differences according to their genders?
3. Do the ecological footprint awareness levels of science and technology teacher candidates show any significant differences according to their grade levels?

METHODOLOGY

This part includes the model of the research, research population and sample, and the data collection tool subtopics

a) Model of the research

The present research is a quantitative study, and a descriptive research model was used. Since the survey method is one the most commonly used methods, descriptive studies are generally known as survey studies (Tanrıöğen et. al., 2012). Survey studies are the ones in which researchers provide detailed information about the current situation (Fraenkel and Wallen; 2006). In this research, the cross-sectional survey model, in the descriptive research model, was used in the determination process of the ecological footprint awareness levels of science and technology teacher candidates.

b) Research Population and Sample

Science and Technology Teacher Candidates studying at the Science Education Department of Gazi Education Faculty of Gazi University in the spring semester in 2013-2014 were the research population.

To determine the sample of the research, the stratified purposive sampling method was applied. Individuals in the population were divided into 4 groups according to their grade levels. To determine the population features and to be able to compare between the units, stratified purposive sampling method was chosen. The number of participants in each grade level is given in Table 1.

Table 1. *The Number of Participants in Each Grade Level*

Grade level	N	%
1	62	17.2
2	63	17.5
3	126	34.9
4	110	30.5
Total	361	100

Table 1 shows that 17.2% of the participants were in the 1st grade (N=62), 17. 5% in the 2nd grade (N=63), 34. 9% in the 3rd grade (N=126), and 30.5% in the 4th grade (N=110). In total, 361 teacher candidates participated in the present research (N_T=361).

c) Data Collection Tool

The Ecological Footprint Awareness Scale, developed by Coşkun (2013) to determine the primary school teacher candidates' awareness levels about ecological footprint subject, was used for data collection in the present research.

The first part of the Ecological Footprint Awareness Scale includes 6 items regarding individuals' demographic features, namely gender, grade, longest living unit, economical income, and parents' educational status. In the second part of the Ecological Footprint Awareness Scale, there are 46 items to determine the individuals' ecological footprint awareness levels.

During the preparation of the Ecological Footprint Awareness Scale, firstly related literature was reviewed, and the 83-item scale that was drafted was presented to 1 field expert, 1 education expert, 1 language expert, and 1 evaluation and assessment expert for their critical review. The scale was reduced to 71 items after the first round of review, which was reviewed again by 2 field and 1 language expert. The final version of the scale included 46 items with 5 sub-dimensions.

The Ecological Footprint Awareness Scale includes 5 sub-dimensions, namely food, transportation and accommodation, energy, wastes, and water consumption. There are 8 items in the food sub-dimension, 9 items in the transportation and accommodation sub-dimension, 15 items in the energy sub-dimension, 9 items in the wastes sub-dimension, and 5 items in the water consumption sub-dimension. The reliability coefficient for each sub-dimension was found as 0.65 for food, 0.71 for transportation and accommodation, 0.89 for energy, 0.80 for wastes, and 0.73 for water consumption.

Five-point Likert scale was used for all items. Decreasing points were given as 5 points to "Definitely agree", 4 points to "Agree" statements, and so on. The items left blank by participants were considered as 0 point.

To determine the ecological footprint awareness levels of teacher candidates and which sub-dimension contributes most to the ecological footprints, descriptive statistics was used. Independent samples t-test was used to determine the effect of the gender on the ecological footprint. Finally, to examine the effect of the grade variable to the ecological footprint, one-way ANOVA analysis was performed. SPSS 18 (Statistical Package for Social Sciences Program, Version 18.0) was used for statistical analyses.

d) Data Analysis

We used various descriptive and inferential analyses in the present study. Descriptive statistics were used to understand the psychometric factors of GM foods and the teaching of this topic. We used structural equation modelling (SEM) as an inferential analysis to test the

relationships between CBs and teaching efficacy beliefs. We controlled the assumptions of SEM such as normality, random missing data and model specification. To find the predictors of beliefs about teachers' roles in teaching SSI, we used Multinomial Logistic Regression (MLR). In addition, we tried to understand the potential use of a teaching method in SSI education with a scatter gram, which was plotted using the mean scores of the responses to questionnaire items in the first part (efficacy beliefs) against the mean scores of the responses to the items in the second part (effectiveness beliefs). To measure the relations between CBs and beliefs about teaching methods, we used Pearson Moments Correlations and correlated the CBs with the effectiveness beliefs about teaching methods in SSI education.

FINDINGS

In the first question, to find out the participants' distribution among the sub-dimensions of the scale and to identify which sub-dimension contributed most to the ecological footprints, descriptive statistics was used and the results are presented in Table 2.

Table 2. *Descriptive Statistic Results Belonging to Sub-dimensions*

Sub-dimension	N	Min	Max	X	SS
Food	361	1.75	4.75	3.20	0.47
Transportation and accommodation		1.22	4.78	3.26	0.57
Energy		1.73	5.00	4.08	0.57
Wastes		1.78	5.00	3.72	0.60
Water Consumption		1.80	5.00	3.87	0.71
Ecological Footprint		2.24	4.76	3.68	0.45

Table 2 shows the average ecological footprint awareness level of the participants as X=3.68, and the highest vale was observed in the energy sub-dimension (X=4.08) with the lowest value in the food sub-dimension (X=3.20). The other sub-dimension in which the ecological footprint awareness level was the second most was the water consumption sub-dimension (X=3.87). Wastes (X=3.72) and transportation and accommodation (X=3.26) sub-dimensions followed. Since the ecological footprint in any sub-dimension reduces as the awareness level increases, the high level of awareness in a sub-dimension means that this sub-dimension contributes less to the ecological footprint. Based on this, it was found that the least contributing sub-dimension to the ecological footprint was energy sub-dimension. Water consumption, wastes, and transportation and accommodation followed it. Again the highest ecological footprint level was determined in the food sub-dimension.

Second research question inquires if the ecological footprint awareness levels of the participants show any significant differences according to the gender.

Descriptive statistics results of the participants regarding the gender variable, and independent samples t-test results of ecological footprint awareness levels in all sub-dimensions are given in Table 3.

Table 3. *Independent Samples T-test Results of Ecological Footprint Awareness Levels in All Sub-dimensions According to the Gender*

Sub-dimensions	Gender	N	%	X	SS	sd	r^2	t	p
Food	Female	309	85.6	3.24	0.46	359	0.027	3.20	.001
	Male	52	14.4	3.01	0.47				
Transportation and Accommodation	Female	309	85.6	3.28	0.55	359	-	1.53	.126
	Male	52	14.4	3.15	0.67				
Energy	Female	309	85.6	4.12	0.55	359	0.015	2.35	.019
	Male	52	14.4	3.92	0.62				
Wastes	Female	309	85.6	3.76	0.57	359	0.030	3.33	.001
	Male	52	14.4	3.47	0.68				
Water Consumption	Female	309	85.6	3.91	0.69	359	0.019	2.66	.008
	Male	52	14.4	3.63	0.77				
Total	Female	309	85.6	3.71	0.43	359	0.028	3.24	.001
	Male	52	14.4	3.49	0.51				

Table 3 shows that the ecological footprint awareness levels of the female participants in the food sub-dimension (X=3.24, s=0.46) is significantly higher than those of the male participants (X=3.01, s=0.47) ($t_{(359)}$=3.20, p<.05 and r^2=0.027). It was observed that 2.7% of the variance in the awareness level according to the effect size is explained with the gender variable. To Cohen (1988), this value is described as small effect.

No significant difference was observed between the ecological footprint awareness levels of female (X=3.28, s=0.55) and male participants (X=3.15, s=0.67) in the transportation and accommodation sub-dimension ($t_{(359)}$=1.53, p>.05).

It was observed that the ecological footprint awareness levels of female participants in the energy sub-dimension (X=4.12, s=0.55) were significantly higher than those of the male participants (X=3.92, s=0.62) ($t_{(359)}$=2.35, p<.05 and r^2=0.015). In terms of the effect size, 1.5% of the variance in the awareness level is explained by gender variable. To Cohen (1988), this value is described within the small effect range.

It was observed that the ecological footprint awareness levels of female participants (X=3.76, s=0.57) in the wastes sub-dimension were significantly higher than those of the male participants (X=3.47, s=0.68) ($t_{(359)}$=3.33, p<.05 and r^2=0.030). According to the calculated the effect size, 3.0% of the variance in the awareness level is explained by the gender variable. To Cohen (1988), this value is identified as small effect.

It was observed that the ecological footprint awareness levels of female participants (X=3.91, s=0.69) in the water consumption sub-dimension were significantly higher than those of the male participants (X=3.63, s=0.77) ($t_{(359)}$=2.66, p<.05 and r^2=0.019). In terms of the effect size, 1.9% of the variance in the awareness level is explained by the gender variable. To Cohen (1988), this value is identified as small effect.

According to the general data analysis results of the Ecological Footprint Scale, it was observed that the ecological footprint awareness levels of female participants (X=3.71, s=0.43) were significantly higher than those of the male participants (X=3.49, s=0.51) ($t_{(359)}$=3.24, p<.05 and r^2=0.028). In terms of the effect size, 2.8% of the variance in the awareness level is explained by gender variable. To Cohen (1988), this value is in the small effect categorization.

Third research question inquires if the ecological footprint awareness levels of the participants show any significant differences according to the grade level.

Descriptive statistic results of participants in terms of the grade level variable are given in Table 4.

Table 4. *Descriptive Statistic Analysis Results of Ecological Footprint Awareness Levels in All Sub-dimensions According to the Grade Levels*

Sub-dimensions	Grade Level	N	%	X	SS
Food	1	62	17.2	3.19	0.41
	2	63	17.5	3.24	0.51
	3	126	34.9	3.16	0.42
	4	110	30.5	3.25	0.53
	Total	361	100	3.20	0.47
Transportation and Accommodation	1	62	17.2	3.26	0.50
	2	63	17.5	3.29	0.59
	3	126	34.9	3.25	0.59
	4	110	30.5	3.25	0.57
	Total	361	100	3.26	0.57
Energy	1	62	17.2	3.92	0.55
	2	63	17.5	4.23	0.50
	3	126	34.9	4.07	0.57
	4	110	30.5	4.12	0.59
	Total	361	100	4.09	0.57
Wastes	1	62	17.2	3.66	0.61
	2	63	17.5	3.80	0.60
	3	126	34.9	3.66	0.57
	4	110	30.5	3.77	0.61
	Total	361	100	3.72	0.59
Water Consumption	1	62	17.2	3.77	0.76
	2	63	17.5	3.93	0.65
	3	126	34.9	3.91	0.75
	4	110	30.5	3.85	0.67
	Total	361	100	3.87	0.71
Total	1	62	17.2	3.60	0.40
	2	63	17.5	3.76	0.44
	3	126	34.9	3.65	0.46
	4	110	30.5	3.70	0.47
	Total	361	100	3.68	0.45

In Table 4, it is seen that 4ht grade participants with higher ecological footprint awareness levels in the food sub-dimension (X=3.25; s=0.53) had higher point averages than the other students. In the transportation and accommodation, energy, and water consumption sub-dimensions, the 2nd grade participants with higher ecological footprint awareness levels had higher point averages than the other students. To determine if the differences in these point averages are statistically significant in terms of grade levels and sub-dimensions, one-way ANOVA analysis was performed and the results are given in Table 5.

Table 5. *ANOVA Results of Ecological Footprint Awareness Levels in Different Grade Levels*

Sub-dimensions	Resource	SS	df	MS	F	p
Food	Inter groups	0.541	3	0.180	0.816	0.486
	In groups	78.892	357	0.221		
	Total	79.432	360			
Transportation and Accommodation	Inter groups	0.89	3	0.30	0.091	0.965
	In groups	116.626	357	0.327		
	Total	116.715	360			
Energy	Inter groups	3.263	3	1.088	3.436	0.01
	In groups	113.007	357	0.317		
	Total	116.270	360			
Wastes	Inter groups	1.454	3	0.485	1.372	0.251
	In groups	126.122	357	0.353		
	Total	127.575	360			
Water Consumption	Inter groups	1.036	3	0.345	0.683	0.563
	In groups	180.481	357	0.506		
	Total	181.516	360			
Total	Inter groups	0.972	3	0.324	1.589	0.192
	In groups	72.844	357	0.204		
	Total	73.816	360			

Table 5 shows that there is no statistically significant differences between the ecological footprint awareness levels in food, transportation and accommodation, wastes, water consumption sub-dimensions and the general ecological footprint awareness levels in terms of grade levels. Only in the energy sub-dimension, it was observed that there is a significant difference in terms of grade levels ($F_{(3,357)}$=3.436; p<.05). To determine in which groups there is a significant difference, Scheffe test was performed. According to the Scheffe

test result, between the ecological footprint awareness levels of the 1st and 2nd grade participants in energy sub-dimension, a significant difference in favor of the 2nd grade participants ($X_{2.grade}$=4.23, $X_{1.grade}$=3.92) was found. For this research, the effect size was found as (eta square) .028. According to Cohen (1988), this value is in the small effect size category and also 2.8% of the variance in the awareness level of the science and technology teacher candidates in energy sub-dimension is caused by the grade level variable.

CONCLUSION and DISCUSSION

Analyses showed that the highest awareness level of the participants was in the energy sub-dimension, and it was followed by water consumption, wastes, and transportation and accommodation, and the least awareness level was with the food sub-dimension (Table 2). The reason for the highest awareness level of the participants was with the energy sub-dimension may be that individuals are conscious about energy consumption and that they have limited economic conditions. The reason for having the second highest ecological awareness level in the water consumption sub-dimension can be explained with the factors that individuals attending to the research have comprehended the importance and necessity of using water resources carefully, and thus they have behaved cautiously about water consumption. As the reason of ecological awareness level in wastes sub-dimension, the effect of the public service advertisements prepared to raise public awareness and the activities about recycling conducted in many agencies and institutions can be shown. The fact that the lower awareness level of the teacher candidates in food and transportation and accommodation sub-dimensions than the other sub-dimensions may have resulted from the fact that the participants were students; therefore, they may be prone to consume convenience food, including frozen foods and foods originated from animals, and they may have limited options in terms of transportation means. Moreover, it can be said that the factors like most of the teacher candidates' accommodating in dormitories and some of them sharing the same house have contributed to reduce the ecological footprint. These results are in line with the results expressing the fact that teacher candidates have the smallest ecological footprint in energy sub-dimension and the result found in the previous reports performed to determine the awareness level of the teacher candidates, the most contributing sub-dimension to the ecological footprint is the food sub-dimension (Coşkun, 2013; Keleş, 2007; Keleş et. al., 2008). Also, the result that the most contributing field to the ecological footprint is the food sub-dimension shows similarity with some reports in the literature (Simpson, Petroeschesky and Lowe, 2013).

In terms of all sub-dimensions, except for the transportation and accommodation sub-dimension, there was a statistically significant difference between genders favor of females (Table 3). According to this result, it has been determined that females are more aware with regards to food, energy, wastes, water consumption, and the awareness of ecological footprint in general than males. Compared to males, females are usually more active in social life, especially in house or family environment, during the process of providing food for the house, and they are more conscious in terms of energy use and saving, waste disposal at home, and water use. These factors may be listed among the reasons for females' higher ecological footprint awareness levels. These results are in parallel with the fact that the ecological footprint awareness levels of the individuals show significant differences according to the gender as reported by Keleş's (2011) and Ek et. al. (2009), namely female students are more sensitive to the environmental problems compared to males. Moreover the research results showing that there is no statistically significant difference in transportation and accommodation sub-dimensions according to the gender is in a line with the results of some previous reports in the literature (Akıllı et. al., 2008; Keleş et. al., 2008; Coşkun, 2013).

In terms of the relationship between grade levels and the awareness level, the results showed that there is a statistically significant difference between grade levels and the energy sub-dimension in favor of the 2nd graders (Table 4 and Table 5), and there is no significant difference in the other sub-dimensions and in total scores. The fact that students in the 1st grade generally accommodate in dormitories in their first years and then later they stay at homes, and they shoulder some various responsibilities as a result of some chores they do, such as consumption of the electricity and gas, paying the bills can be shown as a reason for their higher awareness in energy sub-dimension. Coşkun (2013) reports that that there is no significant difference between the awareness level of the primary school teacher candidates studying in the 2nd grade and the awareness level of the primary school teacher candidates studying in the 3rd grade in the study is in line with this results of the present study.

As a result, it is determined that the education received at the university does not increase the ecological footprint awareness levels. Especially an improvement should have been observed in the ecological footprint awareness levels of the candidates after the subjects are taught about the environment in the 3rd grade. Based on this outcome, it can be concluded that the environmental education given at the university is insufficient.

SUGGESTIONS

In the light of the results and the findings obtained within this research, the following points are suggested:

The environmental education given at the university does not contribute to the ecological footprint awareness of the individuals in a positive way. Therefore the required education activities should be arranged appropriately in order for the teacher candidates to start the profession with the sufficient knowledge and skills about the sustainability and ecological footprint.

Similar studies should be performed in in-service teachers and their ecological footprint awareness levels should be determined. In the light of the studies to be performed, they should be provided with the opportunities to raise their awareness about the sustainability and the ecological footprint through in-service trainings and other means.

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