Volume 1 - Issue 2 - January 2011

International Electronic Journal of Environmental Education

ISSN: 2146-0329

RESEARCH PAPERS:

INSTRUCTIONAL PRACTICE:

IEJEE Green

www.iejeegreen.com

INTERNATIONAL ELECTRONIC JOURNAL OF ENVIRONMENTAL EDUCATION

Vol. 1, Issue 2, January 2011

ISSN: 2146-0329
www.iejeegreen.com

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Dear Readers,

Welcome to the second issue of the first volume of International Electronic Journal of Environmental Education (IEJEE-Green). Although IEJEE-Green is a new journal, I am very happy to say that we received many manuscripts for the second issue from various countries such as United States, Turkey, Spain, Korea, Thailand etc. This is evidence that IEJEE-Green is becoming a well known journal by researchers from various countries. I believe that the number of submitted manuscripts will increase in the coming days. Several researchers wonder whether IEJEE-Green is listed in any index for scientific journals. We are working on this issue and with the publication of the third issue of the first volume I hope we'll be listed in some of them.

This issue contains 4 research papers and an instructional practice. The first research paper is presented by Sacit Kose, Ayse Savran Gencer, Kudret Gezer, Gul Hanım Erol and Kadir Bilen. In their paper, the authors represented Turkish undergraduate students' environmental attitudes. In the second research paper, Alexandar Ramadoss and Gopalsamy Poyya Moli introduced active learning modules for an effective biodiversity education. Besides, the authors tested the effectiveness of modules to increase students' knowledge, interest and skills towards biology conservation, local issues pertaining to protection and conservation of biological resources. In the third research paper, Danielle Dani, from United States used sustainability triad; social, economic and environmental aspects of sustainability, to explore preservice teachers' analyses and decision-making about socioscientific issues. The last research paper of the second issue is about factors that influence student's satisfaction in an environmental field day experiences. In this research paper Hui-Hui Wang and Stephan Carlson argue student's satisfaction in a field day experience was mainly composed by three important factors, presenter, social content, and learning related conditions. In their papers Ayse Oguz Unver, Kemal Yurumezoglu and Songul Sever shared an instructional practice with us which is mainly focusing on photosynthesis.

I believe that all the papers published in IEJEE-Green have a valuable contribution to the field. I hope that readers of this issue also will find the papers exciting and inspiring. The Editorial Board of IEJEE-Green thanks all the authors for their kind contribution to the journal and the reviewers for dealing with the manuscripts quickly and diligently.

Sibel OZSOY
Editor

ISSN: 2146-0329
www.iejeegreen.com

International Electronic Journal of Environmental Education
Vol. 1, Issue 2, January 2011

Investigation of Undergraduate Students' Environmental Attitudes*

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Abstract

Environmental education has been viewed as an important way to educate students about environmental issues beginning from pre-school to higher education. This study is a part of this field- namely, undergraduate environmental education. The purpose of the study is to explore undergraduate students' attitudes towards environment at the end of the course "Environment, Human, and Society". In direction of this basic aim, environmental attitudes of university students were examined according to the gender and faculty type factors. The research was applied at Pamukkale University in School of Foreign Languages during the spring term of 2008-2009 education years. A questionnaire consisting of 2 parts titled "personal information" and "measuring attitude towards environment" was utilized as the means of collecting data. As a result of the study, it could be concluded that undergraduate students had positive attitudes toward the environment as regard to their gender and faculty types. It was emphasized that female students were more sensitive toward environment than male students. At the end, some advices were given in relation with environmental researches.

Keywords: environment, environmental education, environmental attitudes, undergraduate students, gender

Introduction

The environmental problems may increase in a huge amount mainly due to some global negative activities or environmental policies of counties rather than an individual activity. But, as an individual there are a lot of things that can be done to prevent the environmental pollution and the rapid destruction of environment. Only individuals who have environmental

* The manuscript is presented at a conference (International Workshop on Urbanization, Land Use, Land Degradation and Environment, 28th September – 1st October, 2009, Denizli-Turkey).

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ISSN: 2146-0329
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literacy, awareness, and sensibility would contribute the diminishing the environmental problems. Therefore, environmental education has been viewed as an important way to educate students about environmental issues in identifying and challenging environmental problems in all educational levels including university (Fernandez-Manzanal, Rodriguez-Barreiro & Carrasquer, 2007; Tuncer et al., 2009; Uzun & Sağlam, 2006). In attaining this goal, one of the important outcomes of an effective environmental education is to lead positive changes in students' attitudes and behaviors toward environment. Fernandez-Manzanal et al. (2007) point out that "environmental attitudes provide a good understanding of the set of beliefs, interests, or rules that influence environmentalism or pro-environmental action" (p.990).

In this sense, it is important to explore the attitudes of students toward environment in understanding the environmental behaviors of students and providing need analysis for reconstructing environmental education starting from the pre-school to higher education. But, for Turkish context there are a few studies for measuring and analyzing environmental attitudes of pre-school, primary and secondary school students as regard to some independent variables (Gezer, Çokadar, Köse & Bilen, 2006a; Gezer, Köse & Erol, 2006b; Tuncer, Sungur, Tekkaya, & Ertepınar, 2005a; Tuncer, Ertepınar, Tekkaya, & Sungur, 2005b; Uluçınar-Sağır, Aslan & Cansaran 2008; Yılmaz, Boone & Anderson, 2004), especially the studies about higher education is solely restricted by pre-service teacher education students (Erol & Gezer, 2006; Şama 2003; Tuncer, Sungur, Tekkaya & Ertepınar, 2007).

Among the university students from quite different programs, Ek, Kılıç, Öğdüm, Düzgün and Şeker (2009) investigated first year and senior students' attitudes and sensibilities toward environmental problems by considering additional socio-demographic characteristics. They found that students' attitudes toward environment displayed significant differences in terms of the program they enrolled, grade level, gender, age, fathers' job, and the city they lived longest. As regard to gender, they found that girls had a higher mean score on the Environmental Attitude Scale than boys. They also reached a mean difference among the academic programs in which students enrolled mainly due to vocational school of automotive and health school of nursery.

In order to get a wider point of differences between boys' and girls' environmental attitudes at the higher education level, Tuncer (2008) emphasized gender as a significant factor in determining students' perception towards sustainable development. She found that girls became more sensitive toward sustainable development. Another study from Turkish context, with the sample of students from medicine and health programs, similar results were revealed in environmental attitudes of students as regard to gender, age and for some other demographic

characteristics (Özdemir, Yıldız, Ocaktan, & Sarışen, 2004; Özmen, Çetinkaya, & Nehir, 2005).

From a more global perspective, gender differences in environmental attitudes at higher education level have converged on females that are more sensitive toward environmental issues. For example, Fernandez-Manzanal et al. (2007) revealed that female students have higher scores than male students on the attitudes scale, especially in the factors of the need for conservation and environmentally favorable behavior. The differences between males and females' attitudes were elaborated in the meta analysis study by Zelezny, Chua, and Aldrich (2000). In their study, the consistent result of woman who "reports stronger environmental attitudes and behaviors than man" were supported by cross age and across countries studies (p.443).

Purpose and Rationale

Given the importance of a strong sense of positive attitudes toward environment are related to desirable behaviors of sensibility, awareness and consciousness about environmental problems, it seems particularly important to examine university students' environmental attitudes. Therefore, the purpose of this study is to explore preparatory class undergraduate students' attitudes toward environment. More specifically, based on the main problem, the research questions to be addressed in this study are as follows:

R.Q.1: What are undergraduate students' attitudes toward environment?

R.Q.2: Are there any differences in undergraduate students' attitudes toward environment in terms of their gender?

R.Q.3: Are there any differences in undergraduate students' attitudes toward environment in terms of their faculties?

Method

This quantitative study employs a causal-comparative method to measure students' environmental attitudes. A causal-comparative method "determine the cause or consequences that already exist between or among groups of individuals" (Fraenkel & Wallen, 1996; p.341). In this study gender and different faculty types in which students would be enrolled were described as predefined groups in exploring consequences of an environmental course offered in preparatory class.

Sample

The target population of this study is preparatory class students in School of Foreign Languages before starting their programs at Pamukkale University in Denizli, Turkey. The sample was convenient students who enrolled in the course of Environment, Human and Society during

preparatory class. Data in this study were collected from a total number of 376 students. The sample consisted of 203 (54%) females and 173 (46%) males. The sample included 139 (37%) Engineering Faculty, 49 (13%) Medicine Faculty, and 188 (50%) Economics and Administrative Sciences Faculty.

Context

In Turkey there are many universities. Some of them require English Preparatory Class consisting of mainly English courses. Among them, Pamukkale University has recently required a preparatory class for some faculties. Engineering, Economic and Administrative Sciences, and Medicine are the preliminary faculties that require students completed preparatory class before starting their programs. But, the School of Foreign Languages at Pamukkale University has different curriculum or application. The students in the preparatory class additional to English courses must take some courses in Turkish content such as "Environment, Human and Society". The course basically aims to initiate awareness about environmental issues. The students are expected to identify and challenge environmental problems in relation with the society.

Data Collection

The participants completed the questionnaire of the Attitude Scale towards Environment was developed by (Özkan, 2001). The questionnaire consists of 22 items in a five- point Likert type scale and response categories were accomplished by assigning a score of 5 to "strongly agree", 4 to "agree", 3 to "uncertain", 2 to "disagree", and 1 to "strongly disagree. The questionnaire includes four negatively worded items. Negatively written items that were shown with asterisks in Table 1 were reversed at their scores at the beginning of the statistical analysis to provide consistent values between negatively and positively worded items. For one dimensional scale, Cronbach's alpha reliability coeffient was stated as .79 (Özkan, 2001).

A questionnaire consisting of 2 parts titled "Personal Information" and "Measuring Attitude towards Environment" was utilized as the means of collecting data. The questionnaire was applied to students who enrolled in the course of "Environment, Human, and Society" within the context of School of Foreign Languages in the spring semester of 2008-2009 academic years. The data were collected at the end of the course from the voluntary students.

Data Analysis

Data of the present study were analyzed utilizing descriptive statistics (i.e., percentages, means and standard deviations) and inferential statistics by using a statistical analysis package SPSS 17. In the analysis of first research question of the study, descriptive statistics were utilized to determine students' environmental attitudes. Based on the respondents' scores on the scale, individual item means and standard deviations as well

as mean scores and standard deviations for the whole scale were computed. A mean score of was evaluated as medium level around one point standard deviation according to the average level of the scale that someone would get from the scale. Because of the environmental scale consisting of 22 items with a five category response scale, the possible minimum score that someone would gets from the scale is 22 (lowest attitudes) and the maximum score is 110 (highest attitudes) then the average score is around 66 points.

In the analysis of second and third research question, two-way ANOVA was used to determine whether students' environmental attitudes changed in terms of gender and faculty types. In the further analysis of third research question, the Scheffe post hoc tests one-way ANOVA test was used to determine whether students' attitudes changed in terms of their faculties.

Results

The problem under investigation is to explore undergraduate students' environmental attitudes. Further, some independent variables were considered to determine the differences between the perceptions of the undergraduate students' environmental attitudes. The respondents' scores on the environmental scale were analyzed by utilizing descriptive statistics. For this study, raw scores ranged from 24 to 105 with a mean score of 67.44 and a standard deviation of 22.65. It was a very close value to the average level that someone would get from the scale. Therefore, we can conclude that university students in this context indicated positive attitudes toward environment at the medium level. This was supported by other studies utilizing the Scale of Attitude towards Environment for different samples (Gezer, et al., 2006a; Çetin, 2003) in which they obtained higher scores on the scale.

They also indicated an average mean score of "3" according to the respondents' mean scores on the scale for all the items as it can be seen in Table 1. According to the descriptive result of this study, the undergraduate students indicated positive environmental attitudes. However, the total scale score and item scores were clustered just above the mid-point.

Table 1

Total scale and item means and standard deviations of respondents' scores on the attitudes scale towards environment, (n = 376)

Item Number		*M*	*SD*
Item 1	I like to learn something about the environment.	3.15	1.58
Item 2	I would like to contribute to the solution of problems related to the environment.	3.18	1.57
*Item 3	I'm sick of hearing the word "Environmental protection".	3.37	1.57
Item 4	I believe that the most important factor on environmental pollution is human.	2.94	1.52
Item 5	I read articles published about the environment.	3.12	1.15
Item 6	I prefer to buy products that do not harmful for the environment.	2.94	1.27
Item 7	I believe that environmental problems are the most priorities to solve	3.02	1.30
Item 8	I do not prefer to use products which are sold in plastic bottles	2.88	1.15
Item 9	I'm always very sad about forest fires.	3.00	1.76
*Item 10	I don't draw attention about "ozone layer".	3.12	1.62
*Item 11	I believe that garbage thrown by people doesn't damage the world.	3.15	1.68
Item 12	I believe that air pollution damage to the environment.	3.11	1.72
Item 13	I believe that hunting is an activity needed to be banned.	3.11	1.20
Item 14	I believe that environmental pollution is the most important problem in nature.	2.90	1.23
Item 15	I always take care of throwing a used newspaper and paper to recycling bins.	2.99	1.48
Item 16	I would like to have more environment-related courses at school to be more environmentally conscious.	3.16	1.19
Item 17	I would like to work as a volunteer in the environment-related projects.	3.06	1.14
*Item 18	It doesn't bother me whether there is a nuclear power plant where I live in.	2.96	1.61
Item 19	I believe that reduction of forests and destruction of plants doesn't mean only cutting trees. It means also destroying animals and the environment.	2.99	1.65
Item 20	I believe that population growth is an environmental problem.	3.48	1.38
Item 21	I believe that environmental pollution is the most important factor for the nature.	3.11	1.44
Item 22	I'm especially interested in environmental and ecological issues in biology course.	3.02	1.15
Total Scale (Min 22-Max 110)		67.44	22.65

In order to investigate the research question 2 and 3, undergraduate students' attitudes toward environment were evaluated by means of gender and faculty types. A two-way Analysis of Variance (ANOVA) was conducted on the Attitude Scale toward Environment to evaluate the main and interaction effects of gender and faculty type at the significance level .05, as seen in Table 2. Results revealed statistically significant main effects of gender, faculty types, and their interaction effects.

Table 2
Results of two-way ANOVA on the attitude scale towards environment

Source	*SS*	*df*	*MS*	*F*	*p*
Gender	26470.116	1	26470.116	147.309	.000
Faculty types	18583.209	2	9291.605	51.709	.000
Faculty*Gender	20640.071	2	10320.036	57.432	.000
Error	66306.091	369			
Corrected total	191095.024	374			

A statistically significant mean difference was found between boys' and girls' attitudes toward environment [F (1,369) = 147.09; p = .000]. When the mean scores given in Table 3 were examined, it was found that girls hold higher attitudes toward environment than boys.

Table 3
Descriptive statistics of university students by means of gender and faculty types

		N	*M*	*SD*
Gender	Girls	203	81.92	17.22
	Boys	172	50.58	15.24
Faculty types	Engineering	139	54.05	17.94
	Medicine	49	83.20	8.38
	Economics	188	73.30	23.18

As regard to main effect of faculty types, a statistically significant mean differences were found amongst Engineering Faculty, Medicine Faculty, and Economic and Administrative Sciences Faculty on the Attitude Scale toward Environment [F (2, 369) = 51.709, p = .000]. The Scheffe post-hoc tests were conducted to determine the mean score differences between groups. The comparison of mean scores according to the faculty type indicated that Medicine Faculty students expressed more positive environmental attitudes than both Engineering and Economic and Administrative Sciences Faculties. In addition, Economic and Administrative Sciences Faculty students displayed more positive environmental attitudes than Engineering students.

As regard to interaction effects of gender and faculty types there were significant differences [F (2, 369) = 57.432, p = .000]. Figure 1 indicates that environmental attitudes of girls have highest score with the faculty of Economic and Administrative Sciences while boys with the faculty of Medicine have the highest score.

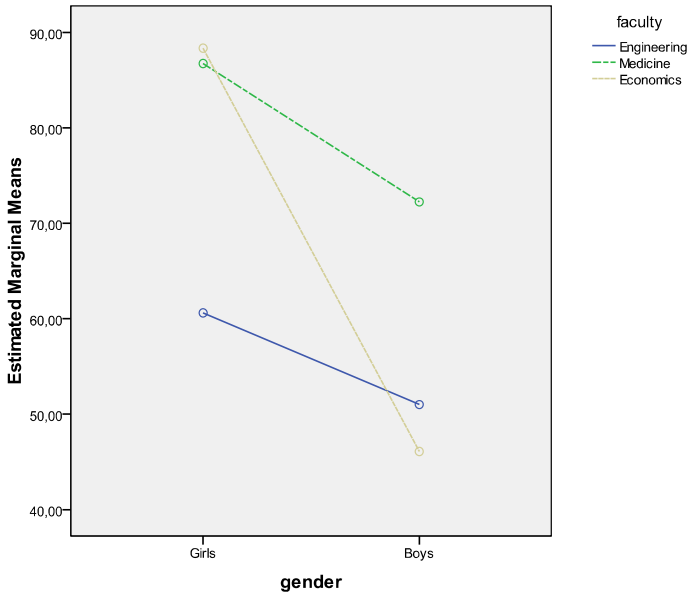

Figure 1. The interactions effects of gender and faculty types on the attitude scale toward environment

Discussion and Conclusion

According to the descriptive result of this study, the undergraduate students indicated positive environmental attitudes. However, the total scale score and item scores were clustered just above the mid-point. It would be expected near to the higher points after they enrolled in the environmental course. Otherwise, consistent with the previous literature university students were found at a low level of awareness and sensibility to environmental problems (Kahraman, Yalçın, Özkan, & Aggül, 2008; Özdemir et al., 2004). It was the limitation of the study to relate the effect of the course on the environmental attitudes of students; therefore an experimental design would be suggested to see the relations more clearly.

In our education system, beginning from the pre-school to secondary school in some extent to which the curriculum may cover environmental science education as a main subject or integrated in a related domain. In higher education, only a few departments include environmental science courses or environmental education courses such as biology, science education, environmental engineering etc. On the other hand, many departments of social sciences, medicine and economics do not include

environmental issues in any way. Therefore, it is a good sign for Pamukkale University to integrate a course related to environment during preparatory class before starting an academic education. From the point of the university students' views, Ek et al., (2009) and Özmen et al., (2005) indicated that an environmental course should be included at university education as well as primary and secondary education. For the future implications, the content and delivering of the environmental course would be restructured to get obtain more interests of university students from a wide range faculties and different backgrounds in handling environmental issues and improving their environmental attitudes. In addition, it should be investigated for the most suitable place of the environmental course whether in the School of Foreign Languages or departmental course.

A two-way ANOVA was revealed main and interaction effects of gender and faculty types. The results revealed significant differences in the perceptions of male and female students' environmental attitudes. This finding is consistent with the literature that many other studies found female students had more positive attitudes toward environments (Ek et al., 2009; Fernandez-Manzanal et al. 2007; Jenkins and Pell, 2006; Özmen et al., 2005; Tuncer et al., 2005a). In the same line for Turkish context, Tuncer et al., (2005b) obtained girls being more aware of environmental problems and individual responsibilities as well as having more positive attitudes than boys. The consistent attitude differences between boys and girls also have been supported by across country studies (Zelezny et al., 2000). Also, girls seem to be socially responsible and make a significant contribution to environmental protection (Jenkins and Pell, 2006; Zelezny et al., 2000). For future implications, environmental education activities or courses at any level of education system would be adjusted to account for boys' and girls' different interests.

The Scheffe post-hoc tests revealed differences among the mean scores of students in terms of their faculties on the Attitude Scale toward Environment. The comparison of mean scores according to the faculties indicated that Medicine Faculty students expressed more positive environmental attitudes than both Engineering and Economic and Administrative Sciences Faculties. In addition, Economic and Administrative Sciences Faculty students displayed more positive environmental attitudes than Engineering Faculty students. This finding is consistent with the literature that many other studies found differences among to the different academic programs (Ek et al., 2009; Özmen et al., 2005). For this study, it would be expected medicine and engineering students to have more positive attitudes than economics when their secondary school science background is considered because of medicine and engineering students coming from secondary schools' science branch including more biology and environmental science subjects. Conversely, for the students who will enroll economics and administrative departments this would be the first time to take a course related with environment.

Therefore, they might be more interested with environmental issues resulting more positive attitudes than engineering students.

Nowadays, environmental problems have increased rapidly. Then, educating people is the main way to reduce environmental problems by creating consciousness and sensibility toward environment. Education is a long-life process, so it is crucial to teach subjects about environment beginning from pre-school and continue to the university education and so on. Within the context of higher education it seems to be more important because students at the universities today will drive our life in the future. Some of them may be engineers in large factories or administrative staff in private and public places in the future as directly policy makers or applying pressure on policy makers in diminishing the environmental problems. Therefore, universities for all programs should provide an education program covering environmental science to nurture conscious and sensitive graduate students toward environment.

♦ ♦ ♦

Biographical statements

Dr. Sacit Köse is currently an Associate Professor of Biology Education at Pamukkale University. He was born in Edirne, Turkey. He has BSc and MSc degree in Biology Education from Dokuz Eylül University and PhD degree from Karadeniz Technical University in the same field in 2004. His research interests including determination and overcoming students' misconception, to challenge students' conceptions and students' use of conceptual change text, computer-assisted material, concept mapping, cooperative learning and POE as an aid to their conceptual understanding of science concepts, students' attitude toward science/biology/computer/environment and perceptions of science. He is on editorial/review boards for Computers & Education, Scientific Research and Essays, Eurasian Journal of Educational Research, Essays in Education, and World Applied Sciences Journal.

Dr. Ayse Savran Gencer was born in Turkey at 1975. She has BSc degree in Biology Education from Middle East Technical University and MSc - PhD degree from Middle East Technical University University in the field of Biology Education. She is working as an assistant professor in the Faculty of Education of Pamukkale University in Turkey. As a senior lecturer she gives courses at undergraduate and graduate levels. Her research includes mainly elementary and secondary science teacher education with interests of their teacher efficacy beliefs, classroom management beliefs, reflective thoughts, and learning approaches. As regard to science education and environmental education, her research examines constructivist ways of learning such as cooperative learning, concept mapping and currently Vee diyagrams and learning journals. She is in the editorial board of some peer-reviewed journals such as Teaching and Teacher Education.

Dr. Kudret Gezer is currently an Associate Professor of Biology at Pamukkale University. He was born in Mugla, Turkey. He has BSc and PhD degree in Biology from Dokuz Eylül University and MSc degree from Anadolu University in the same field. His research interests including wild mushrooms, antimicrobial and antioxidant activities of wild *mushroom* species, culture mushrooms production and environmental education.

Gül Hanım Erol is currently a Research Assistant of Elementary Science Education at Pamukkale University. She was born in Isparta, Turkey. She has BSc and MSc degree in Elementary Science Education from Pamukkale University and still PhD student in Pamukkale University in the same field. Her research areas are Environmental Education, Teacher Education, Nature of Science and Scientific Argumentation.

Dr. Kadir Bilen was born in Nigde, Turkey at 1980. He has BSc and MSc degrees in Science Education from Pamukkale University and PhD degree from Gazi University in the field of Science Education. He is working as a research assistant in the Faculty of Education of Pamukkale University in Turkey. His major interests are teacher education as a means of effetive teaching of science and effective science teacher. As regard to science education, his research includes understanding pre-service science teachers' science process skills, attitudes and *nature* of *science through* constructivist ways of learning including "Predict-Observation-Explain" (POE). As a research assistant, he is conducting science laboratory studies.

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International Electronic Journal of Environmental Education
Vol. 1, Issue 2, January 2011

Lisans Öğrencilerinin Çevre Tutumlarına Yönelik Araştırma*

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Kadir BİLEN

Özet

Çevre eğitimi okul öncesi itibaren yüksek öğretime kadar çevre sorunları hakkında öğrencileri eğitmek için önemli bir yoldur. Bu çalışma bu alanda lisans çevre eğitiminin bir parçasıdır. Çalışmanın amacı, "Çevre, İnsan ve Toplum" dersi sonunda çevreye karşı lisans öğrencilerinin tutumlarını araştırmaktır. Bu temel amaç doğrultusunda, üniversite öğrencilerinin çevre tutumları cinsiyet ve fakülte değişkenlerine göre incelenmiştir. Araştırma 2008-2009 bahar yarı yılında Pamukkale Üniversitesi Yabancı Diller Fakültesinde gerçekleştirilmiştir. Veri toplama aracı olarak "kişisel bilgi" ve "çevreye karşı tutum" başlıklı 2 bölümden oluşan bir anket kullanılmıştır. Çalışmanın sonucunda, lisans öğrencilerinin cinsiyet ve fakülte türlerine ilişkin olarak çevreye karşı olumlu tutumlara sahip oldukları söylenebilir. Kız öğrencilerin erkek öğrencilere göre çevreye karşı daha duyarlı olduğu belirlendi. Son olarak çevre araştırmaları ile ilgili olarak bazı önerilerde bulunulmuştur.

Anahtar Kelimeler: Çevre, çevre eğitimi, çevreye yönelik tutumlar, lisans öğrencileri, cinsiyet

* Bu çalışma, "International Workshop on Urbanization, Land Use, Land Degradation and Environment" isimli konferansta bildiri olarak sunulmuştur (28 Eylül-1 Ekim 2009, Denizli, Türkiye).

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ISSN: 2146-0329
www.iejeegreen.com

International Electronic Journal of Environmental Education
Vol. 1, Issue 2, January 2011

Biodiversity Conservation through Environmental Education for Sustainable Development - A Case Study from Puducherry, India

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Abstract

Promoting students commitment to protect local biodiversity is an important goal of education for sustainable development in India and elsewhere. The main focus of the biodiversity education was to create knowledge, interest and necessary skills to solve various biodiversity problems with reference to the local context. In order to develop the biodiversity consciousness among students, the action oriented biodiversity education methods were identified in this study such as active classroom sessions, hands-on-activities, experiential education, and field exposures that are vital to achieve sustainable biodiversity knowledge and motivate to protect and conserve local biodiversity. We developed a comprehensive framework to assess the efficacy of biodiversity education modules in enhancing teaching and training in biodiversity conservation at high school level. Since the pre-test indicated little lesser than average interest in the relevance of biodiversity, the observed increase in post-test phase could be attributed to our education for sustainable development efforts.

Keywords: Biodiversity conservation, environmental education for sustainable development, skills, knowledge, confidence, high school

Introduction

Sustainable development is seeking to meet the needs of the present without compromising those of future generations. We have to learn our way out of current social and environmental problems and learn to live sustainably, if we desire to survive as a species. Sustainable development is a vision of development that encompasses populations, animal and plant

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ISSN: 2146-0329
www.iejeegreen.com

species, ecosystems, natural resources and that integrates concerns such as the fight against poverty, gender equality, human rights, education for all, health, human security, intercultural dialogue. Education for sustainable development aims to help students to develop the attitudes, skills and knowledge to make informed decisions for the benefit of themselves and others, now and in the future, and to act upon these decisions (United Nations Decade of Education for Sustainable Development 2005-2014 http://www.unesco.org/en/esd/).

Education for sustainable development addresses biodiversity by focusing on the interlinking issues of biodiversity and livelihoods, agriculture, livestock, forestry, fisheries, and more. The Decade of Education for Sustainable Development (DESD) offers an opportunity to better understand how consumption impacts biodiversity at local and global levels, to sensitize young people to their roles and responsibility in this process and to advance progress in human resource development, education and training to prevent habitat loss and degradation, species loss, and pollution (United Nations Decade of Education for Sustainable Development 2005-2014 http://www.unesco.org/en/esd/).

Everyone in the world depends on natural ecosystems to provide the resources for a healthy and secured life [Millennium Development Goal (MDG), 2010]. Humans have made unprecedented changes in ecosystems in recent decades to meet their expanding populations and booming economy. Human activities have taken the planet to the edge of a substantial wave of species extinctions, further threatening our own well-being. The pressures on water, air, and natural ecosystems will increase globally in coming decades unless human attitudes and actions change (MDG, 2010).

World Environment Day (WED) is one of the principal vehicles through which the United Nations stimulates worldwide awareness of the environment and enhances political attention and action. The agenda is to give a human face to environmental issues; empower people to become active agents of sustainable and equitable development; promote an understanding that communities are pivotal to changing attitudes towards environmental issues; and advocate partnership which will ensure all nations and peoples enjoy a safer and more prosperous future (World Environment Day http://www.un.org/depts/dhl/environment/).

The world is facing a biodiversity crisis (Wilson 2002). In response, schools, teachers and parents are being urged to prepare students to face the real life issues they will routinely encounter in efforts to sustainably manage the biosphere and integrate biodiversity conservation with other societal goals (Colker 2004, European Platform for Biodiversity Research Strategy, 2006, Noss 1997).

The evolution from nature conservation education to environmental education to education for sustainable development is one that can be

characterized by an increasing awareness of the need for self determination, democratic processes, a sense of ownership and empowerment, and, finally, of the intricate linkages between environmental and social equity (Hesselink, van Kampen & Wals, 2000; Jensen & Schnack, 1994; 1997).

Several authors have shown that academic coverage of environmental topics and ecological principles increases student awareness, and positively affects attitudes, behaviors, and values regarding conservation issues (Humston & Ortiz-Barney, 2005; 2007; Leeming, Dwyer, Porter & Cobern, 1993; Rickinson, 2001; Zelezny, 1999). It has been more difficult to create reliable instruments that correlate specific course teaching methods and learning objectives with changes in attitudes and values (Humston &Ortiz-Barney, 2005).

Teaching biodiversity has been practiced some hundred years ago, but due to low baseline level knowledge (Leather & Quicke, 2009), it had become a challenging educational task at least since the conference of Rio in 1992 (Gaston & Spicer, 2004; Weelie & Wals, 2002), and it has been emphasized again at the Conference of Bonn in 2008 . From an educational point of view, however, biodiversity is a rather ill-defined abstract and complex construct (van Weelie & Wals, 2002) which has to be transformed into small entities to enhance a sustained learning and understanding, especially in the context of high schools. The most common entity used by conservation groups are species (van Weelie & Wals, 2002). Therefore, basic knowledge about animal species, their identification and life history has been targeted as a fundamental aspect for learning and understanding biodiversity (Gaston & Spicer, 2004; Lindemann &Matthies, 2005; Randler & Bogner, 2002). This is true for plant species identifications skills too (Tessier, 2003), but baseline knowledge seemed to have declined significantly in recent decades (Leather & Quicke, 2009; Randler, 2008).

Teaching about animals and about biodiversity in general should give a preference to outdoor ecological settings (Killermann, 1998; Lock, 1998; Prokop, Tilling, 2004; Tuncer, & Kvasničák, 2007a,). Previously, a lot of outdoor educational lessons often dealt with more or less immobile taxonomic groups such as plants or some invertebrates (Killermann, 1998). Within the context of ecology, many educational researchers emphasized measuring psycho-logical constructs such as attitude, perception and other personality factors rather than knowledge (Bogner, 2002; Randler & Bogner, 2002). But assessing cognitive learning outcome should support the possible benefits of outdoor ecology education. Outdoor education must be enhanced and should be supported by previous learning within the classroom. This prepares the students for issues and tasks during outdoor field work and prevents them from novelty effects (Falk, Martin, & Balling, 1978; Falk, 1983 & 2005).

Statement of the problem

Concerned by the continued loss of biological diversity, the United Nations General Assembly declared 2010 the International Year of Biodiversity. The year coincides with the target adopted by governments in 2002 to achieve, by 2010, significant reduction in the current rate of loss of biodiversity (Convention on Biological Diversity 2009).

The most important threats to biodiversity have long been habitat loss, due to large scale conversion of land to agriculture and urban centers, introduction of invasive alien species, overexploitation of natural resources, and pollution. Climate change is now adding its effects to the cumulative pressures (Convention on Biological Diversity 2009).

In considering these issues, the objectives of study are to assess the student's knowledge, interest and skills towards biodiversity conservation, local issues pertaining to protection and conservation of biological resources and to investigate the changes before and after implementing the biodiversity education programme/curriculum implementation with middle school students.

We report on the results of developing and piloting an active biodiversity education for sustainable development that measures and assesses learning gains in biodiversity education. We use this framework to evaluate the effectiveness of content learning gains, along with changes in students' interest in biodiversity, student perceptions of changes in process skills, and shifts in ecological worldview.

Methodology

Population and Sample

The study was conducted during July 2009 to April 2010 with Chevalier Sellane Government Higher Secondary School (CSS), Kalapet, Puducherry and Javagar Navodya Vidyalaya School (JNV), Kalapet, Puducherry region, India. The selected schools, located 15-18 km North of Puducherry town on the East coast road (ECR), have sufficient and diverse vegetative cover to conduct field exposure and hands-on-training to investigate biodiversity. In addition, the schools represented a diverse student population with urban and suburban settings. The experiment with control group design was used for this study. The participants in this study were chosen from age group between 13 to 15 middle school standards as these students are much free from regular curriculum and more time available for extracurricular activities than the high and higher secondary level. A total of 140 students, 70 from CSS School and 70 students from JNV School were randomly selected based on their interest, motivation and commitment. Each school had 35 students each in experimental and control groups. Experimental group with 35 students were exposed to active biodiversity education program. The students participating in the program

were then compared with control group in order to assess the student's confidence in biodiversity knowledge, interest in biodiversity and skills in biodiversity conservation.

Biodiversity module

Basic constructs of the active biodiversity education model for the successful study of ecology and biodiversity conservation, an innovative model of environmental education, is composed of three constructs – didactic, conceptual and technological. It was developed using the conceptual models provided by Kostova (2003 and 2004). The main objectives of the environmental education module are to foster the acquisition and transfer of knowledge, skills and affective attributes concerning the environment and its problems (UNESCO-UNEP International Environmental Educational Program, 1985). The didactic construct ensures contemporary educational process in which all achievements of pedagogy and psychology are put into practice. The conceptual construct comprises the biodiversity conservation concepts and reveals them from different aspects: cognitive, value and action. These three constructs of the innovative model of EE proposed by Kostova (2003) taken together provide the possibilities for close interaction of psychology and pedagogy with ecology and conservation on the basis of continuous research and improvement. Through the innovative model of biodiversity education (Figure 1), the systems of approaches are put into practice.

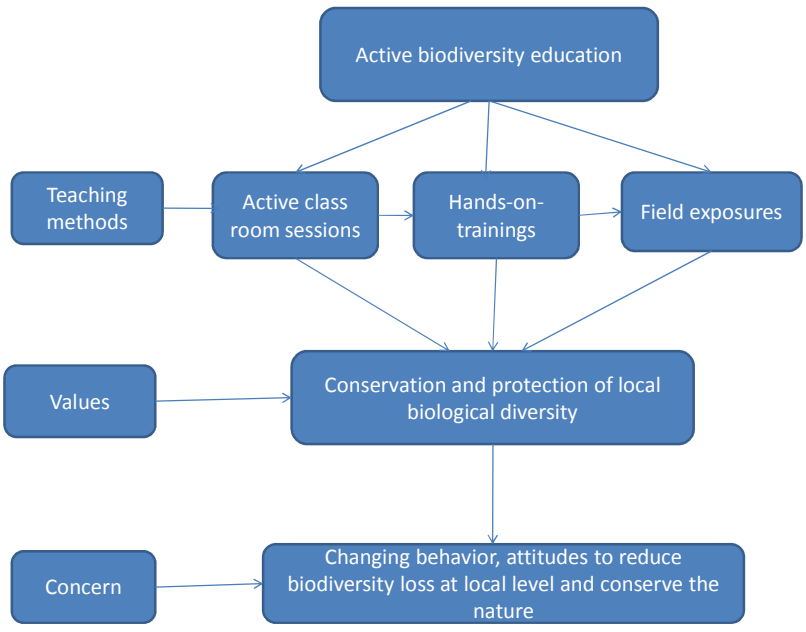

Figure 1. Conceptual diagram of the teaching methods and concerns in biodiversity education for school students used in the present study (modified and adopted from Lee & Tong Ma, 2009)

Instruments

A self administered questionnaire was used to determine students' understanding, knowledge, and skills assessment of various issues on biodiversity and its conservation. Questionnaires are quantitative measurement instruments. For example, a Likert scale (in which respondents circle a number between one and five) was used to measure agreement with certain statements regarding biodiversity. Both in pre and post tests with control groups questions were grouped into three categories to compare overall reported changes in learning: biodiversity knowledge confidence, biodiversity interest, and biodiversity process skills as suggested by Hagenbuch et al (2009) (Table 2).

Table 1

Questions used in the present study grouped into three categories (modified and adopted from Hagenbuch et al 2009)

Biodiversity Knowledge Confidence- assessed the student's confidence in:
1. Defining biodiversity
2. Identifying threats to biodiversity
3. Providing examples of the importance of biodiversity
4. Describing methods and strategies used in conservation
5. Identifying issues in a conservation controversy
6. Analyzing/synthesizing information on an issue
Biodiversity Interest- assessed the student's interest in:
1. Understanding the relevance of biodiversity to real world issues
2. Taking additional courses related to biodiversity and conservation
3. Majoring in a related subject
4. Exploring career opportunities
5. Considering changes in lifestyle choices
Biodiversity Process Skills- assessed the student's confidence in:
1. Oral communication
2. Written communication
3. Identifying underlying conservation problems
4. Gathering credible information to support a thesis
5. Sorting and filtering diverse sources of information
6. Predicting potential outcomes
7. Applying critical thinking
8. Collecting data and managing information
9. Working collaboratively with and in a group

Assessment Framework

We evolved a comprehensive outcomes framework (modified and adopted from Hagenbuch et al 2009) to assess the efficacy of biodiversity education modules in enhancing teaching and training in biodiversity conservation. The framework measured changes in conceptual understanding,

improvements in self-perceptions of process skills, confidence in biodiversity knowledge, interest in biodiversity topics, and changes in environmental orientation. The methodology adapted and integrated three types of evaluation instruments in a pre-module exposure test/post-module exposure test format: To assess student learning outcomes; A self-reporting instrument measures changes in student confidence, interests, and process skills.

Biodiversity modules have been prepared to expose the definition, importance of biodiversity and threats to Biodiversity. Each module includes an interactive PowerPoint lecture slides with notes and discussion questions, a detailed topical synthesis paper, and a series of hands-on exercises and field exposures in which students collect, in order to analyze, and synthesize biodiversity data from multiple sources. Each module component contains specific learning objectives to assist faculty teaching the material.

We have used power point presentations to introduce and discuss topics and applied the exercises as complements to lectures. We introduced the activity and answered questions at the end of the lecture, allowed students to work on the problems and then discussed the results in the following class. Based on the feed back received /identified problems, a series of activities were planed and executed and this was continued for the whole year. Variability in use and adaptation was allowed in this study since we were testing the proposed assessment framework rather than applying a quasi-experimental design.

Content Knowledge Tests

Content knowledge assessments measure student learning from the module component used. These assessments include true/false questions, multiple choice, matching, short answer, problem sets, and short essays (Hagenbuch *et al,* 2009). In addition to measuring knowledge recall, assessments focus on higher-order learning, including comprehension and application of material and problem solving in new situations. The biodiversity module used a written content knowledge test, consisting of twenty multiple-choice, true/false, and matching questions that were selected from the three modules, to measure changes in students' knowledge of biodiversity. Pre-tests were given prior to classroom use of the modules. The post-test was administered immediately after teaching the modules.

Student Assessment of Learning

The Student Assessment of Learning is a self-reporting survey instrument that measures students' perceptions of their knowledge, attitudes, and skills The questionnaire was created to assess changes in students' confidence, interest and involvement in scientific modes of inquiry (Seymour & Hewitt, 1997). The specific questions covering the following

areas were developed and implemented 1) confidence in knowledge and understanding of biodiversity conservation; 2) interest in the field of conservation biology; 3) confidence in process skills; and 4) preferred learning styles. Questions used a standard five-point Likert scale ranging from 1 (not at all confident) to 5 (extremely confident).

With regard to confidence in process skills, biodiversity module identified thirteen skills that are important within the conservation biology profession, including: professional oral and written communication; public communication and outreach; problem and question definition; information gathering, critical inquiry, and research skills; sorting and filtering diverse sources of information; predicting potential outcomes and consequences; critical thinking for decision-making; data collection and management; data analysis and interpretation; graphical expression and interpretation; collaborative working skills; and project coordination and management skills. Biodiversity module exercise emphasizes at least one of these process skills. Because the module emphasizes active-learning approaches, we developed the questionnaire to allow students to rank their preferred learning styles. Choices ranged from traditional lectures to hands-on activities and outdoor field experiences. The standard Likert scale ratings ranged from strongly disagree to strongly agree. demographic information, including gender, ethnicity, class standing and major, as well as reasons for enrolling in the course were also collected.

Analysis of the Data

Paired-sample two-tailed t-tests compared pre- test and post- test means for each question on the content knowledge test for all respondents. Questions were grouped into three categories to compare overall reported changes in learning: confidence in biodiversity knowledge, interest in biodiversity, and skills in biodiversity. Paired-sample t-tests assessed differences across pre- and post- tests for each of these measures.

Reliability and Validity of Instruments

The questionnaire we followed was the student's assessment of learning gains prepared and tested by Hagenbuch et al (2009). This questionnaire was used to measure the perceptions of students in five areas: 1) confidence in knowledge and understanding of biodiversity conservation; 2*)* interest in the field of conservation biology; 3) confidence in process skills. Questions used a standard five-point Likert scale ranging from 1 (not at all confident) to 5 (extremely confident).

Results and Discussion

A comparative assessment of student's preference in teaching learning methods in active biodiversity education was done. The results obtained from the experiment on teaching and learning exercises are presented in (Figure 2).

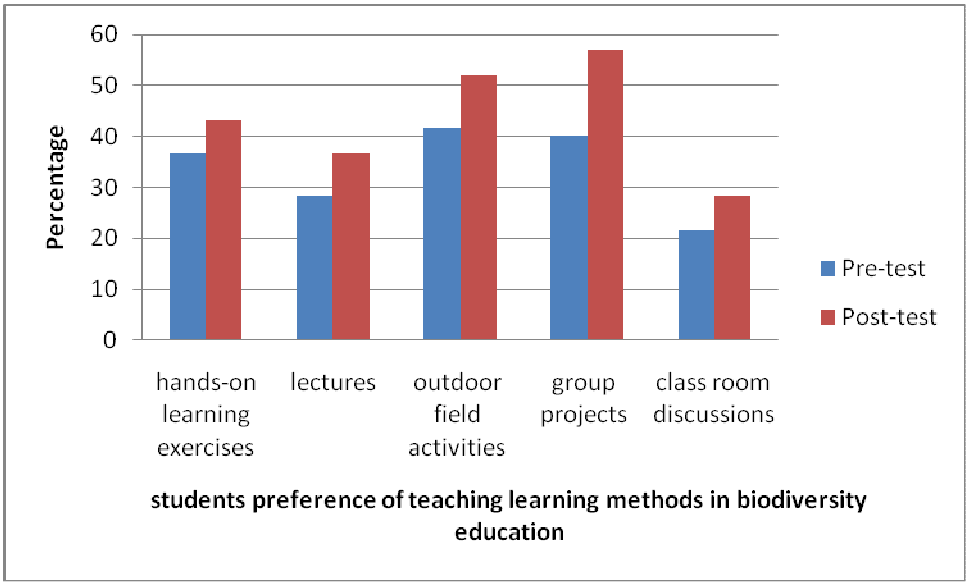

Figure 2. Students preference of teaching learning methods in biodiversity education
Students learning gains in biodiversity knowledge, interest and skills

Students in the post test phase significantly increased their confidence in biodiversity knowledge: defining biodiversity between pre- and post- testing, identifying principal threats, providing examples of how biodiversity is important to human society, describing methods and strategies used in conservation, identifying underlying issues in a conservation controversy, analyzing/synthesizing information on an issue (CSS $t = 0.122$, $p < .005$) (Figure 3) (JNV $t = 2.481$, $p < .005$) (Figure 4).

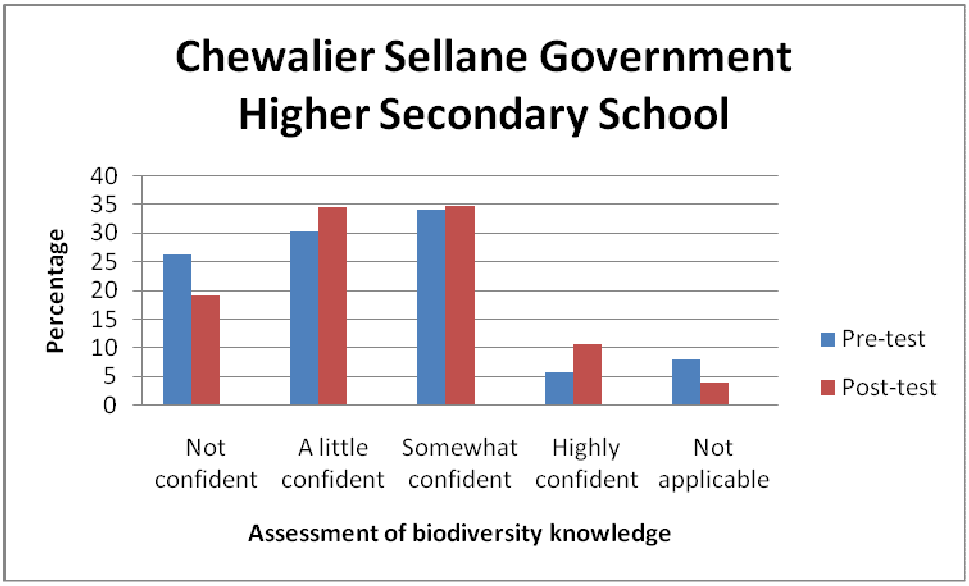

Figure 3. Assessment of biodiversity knowledge before and after with CSS School students

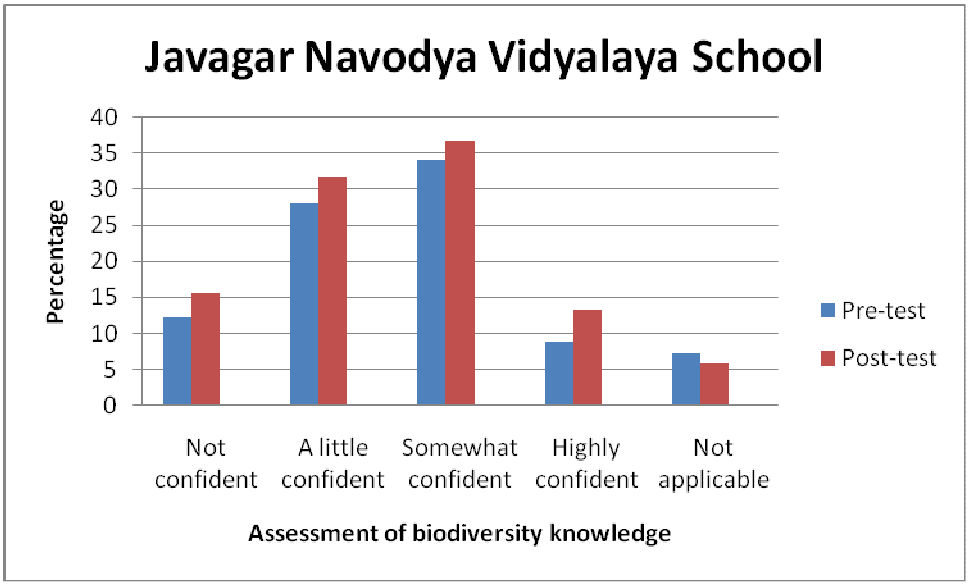

Figure 4. Assessment of biodiversity knowledge before and after with JNV School students

Students showed their interest in biodiversity conservation between pre- and post- testing phases: the questionnaire in order to test the students understanding and the relevance of biodiversity to real world issues explore their interest in taking additional courses related to biodiversity and conservation, majoring in a related subject, exploring career opportunities, onsidering changes in lifestyle choices. (CSS t = 4.768, $p < 0.005$) (Figure 5) (JNV $t = 3.677$, $p < .005$) (Figure 6).

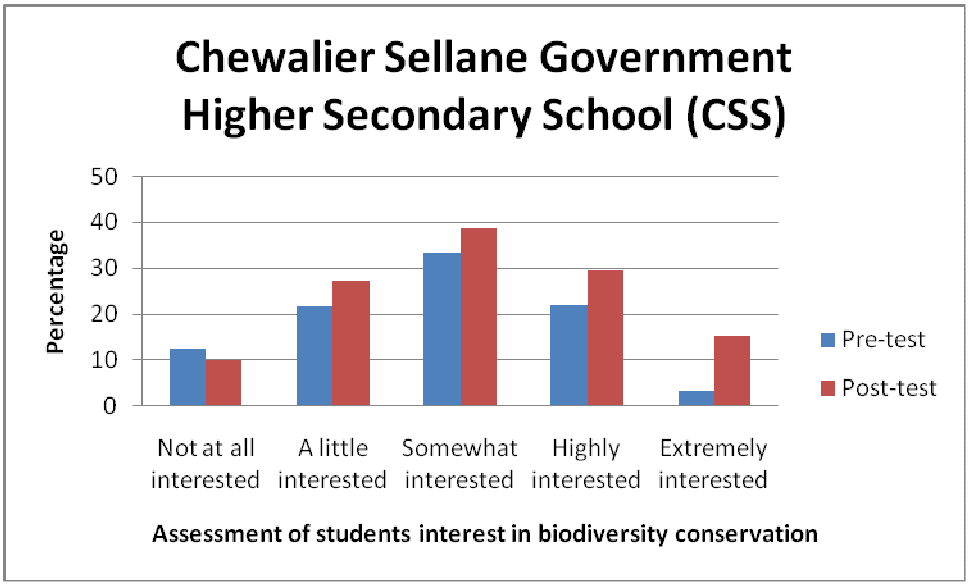

Figure 5. Assessment of student's interest in biodiversity conservation with CSS School students

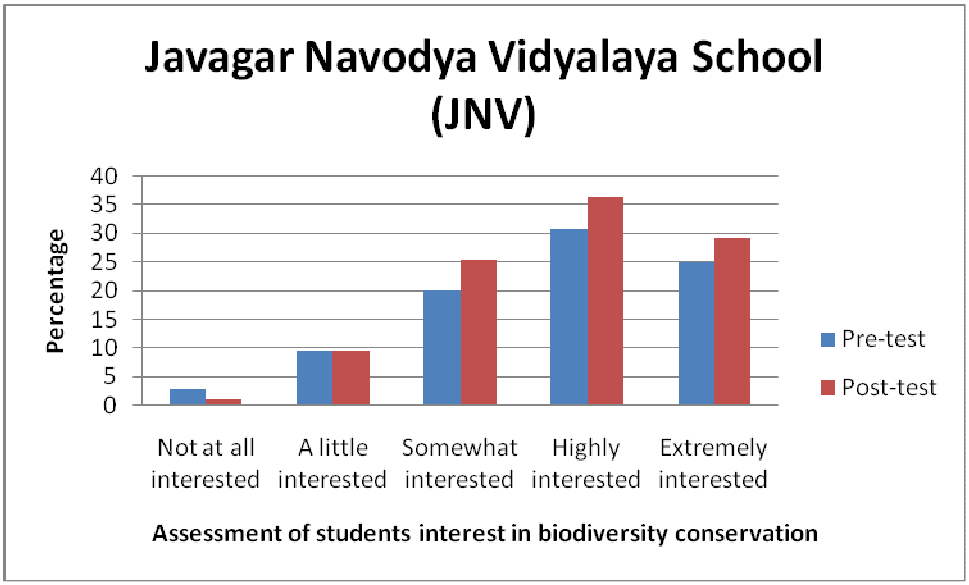

Figure 6. Assessment of student's interest in biodiversity conservation with JNV school students

In terms of biodiversity process skills, students reported significant gains between pre- and post- testing phase in confidence in their skills in identifying conservation issues such as oral communication, written communication, identifying underlying conservation problems, gathering credible information to support a thesis, sorting and filtering diverse sources of information, predicting potential outcomes, applying critical thinking. (CSS t = 0.949, p < .005) (Figure 7) (JNV t = 1.796, p < .005) (Figure 8).

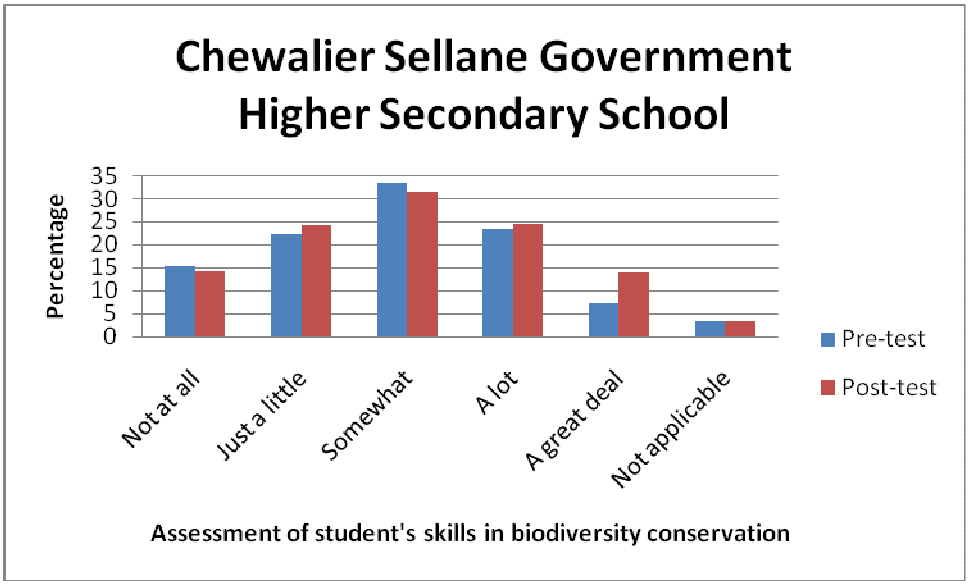

Figure 7. Assessment of students biodiversity process skills in confidence with CSS school students

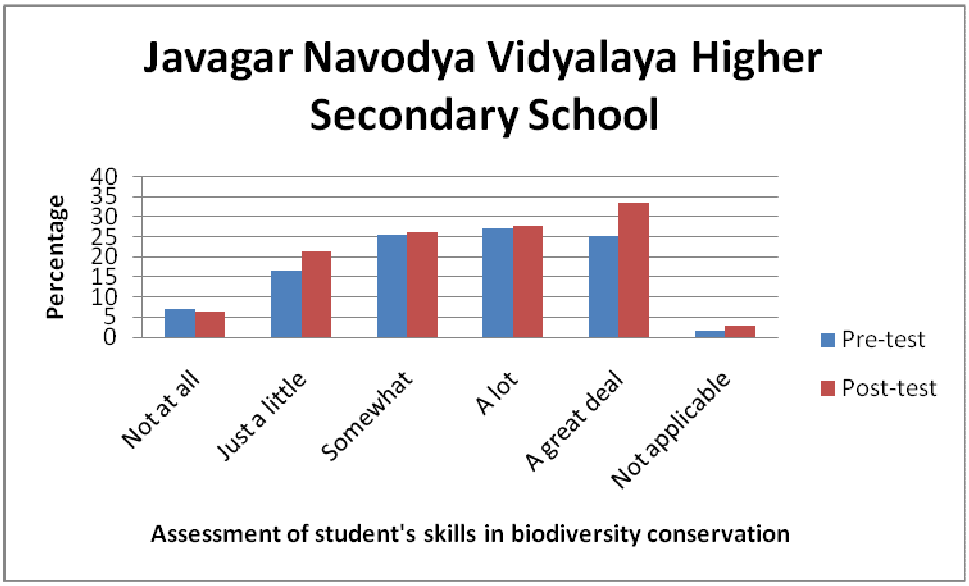

Figure 8. Assessment of students biodiversity process skills in confidence with JNV school students

The reported gains in the knowledge/skills are related to understanding the relevance of biodiversity to real world issues, taking additional courses related to biodiversity and conservation, majoring in a related subject exploring career opportunities, considering changes in lifestyle choices to conserve and protect the biological diversity. There are no significant changes in any of the learning: knowledge, interest and skills on biodiversity conservation issues with control group students between pre and post test analysis since they have no exposure to active based biodiversity education.

Statistical analysis revealed there are significant differences with respect to overall changes in content knowledge tests and the students learning - reflecting changes in confidence in biodiversity knowledge, interest in biodiversity conservation, and confidence in biodiversity skills in compared with control group (non exposure group). There are no significant differences in control group between pre-test and in post-test ($t = 0.637$ $p <$ .005).

Conclusion

The proposed active learning participatory methods for biodiversity education for sustainable development encompasses comprehensive aspects of students cognitive, affective-and behavioral-development related to the perception and understanding of local biodiversity conservation. These types of experiments can make learning about their local biodiversity practical and meaningful potentially having long term impacts on student's attitudes towards local biodiversity and also in shaping their future life. The results obtained from these experiments reflects the student's experiences and actions in their homes, school and community as this will

get them pondering about everyday habits and happenings in biodiversity dimension. These biodiversity education programs help students to acquaint with the local biodiversity problems, and create an interest, motivation, commitment and action.

From the analysis it is apparent that active biodiversity education program increases the student's knowledge, interest and skills in order to protect and conserve local natural resources and biodiversity. This study therefore, stresses the need to extend teaching and learning activities into the immediate environment (natural/built) of the students beyond the classroom for inculcating a culture of biodiversity conservation.

♦ ♦ ♦

Acknowledgement

We sincerely thank the Department of Educational Research and Policy Perspective (DERPP) and the National Council of Educational Research and Training (NCERT), New Delhi, India. The latter has provided a research fellowship to one of us (Alexander). We acknowledge the valuable suggestions from DERPP and NCERT for which we remain grateful. We are grateful thanks Brian E. Hagenbuch for granting permission to use his study framework and instruments. We are also benefitted from the helpful suggestions offered by Prof T. Vasanthakumaran, Retired Prof & Head, Department of Geography, Madras University. We thank the officials from Directorate of School Education, Govt of Puducherry for their permission to conduct our action Research in CSS school. Vinayathan, Principal JNV School granted permission and encouraged us to conduct our Research in the school and to interact with students for which we are grateful. Last, but not in the least, we whole heartedly thank the student volunteers, who helped us in carrying out this study.

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International Electronic Journal of Environmental Education
Vol. 1, Issue 2, January 2011

Sürdürülebilir Kalkınma için Çevre Eğitimi ile Biyoçeşitliliğin Korunması- Pondicherry, Hindistan'da Bir Durum Çalışması

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Özet

Hindistan ve diğer yerlerdeki sürdürülebilir kalkınma için eğitim, öğrencilerin yerel biyoçeşitliliği korumak için teşvik edilmesinde önemli bir hedeftir. Biyoçeşitliliğe yönelik eğitimin ana odağı yerel bağlamda referans ve çeşitli biyolojik çeşitlilik sorunlarını çözmek için bilgi, ilgi ve gerekli becerileri oluşturmaktır. Bu çalışmada öğrenciler arasında biyoçeşitlilik bilincini geliştirmek amacıyla yapılan eylem odaklı biyoçeşitlilik eğitim yöntemleri, aktif sınıf oturumları, deneyimsel eğitim ve alan deneyimleri gibi hayati önem taşıyan sürdürülebilir biyoçeşitlilik bilgisine ulaşmak ve yerel biyoçeşitliliği korumak, muhafaza etmek ve öğrencileri motive etmek için kullanılmıştır. Araştırmacılar, lise düzeyinde biyolojik çeşitliliğin korunmasına yönelik eğitim ve öğretimi artırmada biyoçeşitlilik eğitim modüllerinin etkinliğini değerlendirmek için kapsamlı bir çerçeve geliştirmiştir. Ön-testte biyoçeşitliliğe yönelik ilgi düşük çıksada, son-test aşamasında gözlenen artışın sürdürülebilir kalkınma çabaları için uygulanan eğitim sayesinde olduğu düşünülebilir.

Anahtar Kelimeler: Biyoçeşitliliğin korunması, sürdürülebilir kalkınma için çevre eğitimi, beceriler, bilgi, güven, lise

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ISSN: 2146-0329
www.iejeegreen.com

International Electronic Journal of Environmental Education
Vol. 1, Issue 2, January 2011

Sustainability as a Framework for Analyzing Socioscientific Issues

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Abstract
Scientific and environmental literacy are cornerstones of science education reform and twenty first century citizenry. The ability to make decisions about socioscientific issues is a characteristic of scientific and environmental literacy. This study uses the Sustainability Triad to explore preservice science teachers' analyses and decision-making about socioscientific issues. Results indicate that preservice science teachers do not consistently use the dimensions of the Sustainability Triad as they analyze socioscientific issues, and make decisions that are not sustainable. Recommendations for science teacher preparation programs that emphasize sustainability considerations are provided.

Keywords: socioscientific issues, scientific literacy, environmental education, sustainability, science teacher preparation

Introduction

Much of the socio-political rhetoric of the 21st century is centered on socioscientific issues and sustainable development. The need for citizens who use knowledge of scientific concepts to participate in social conversations and make decisions about socioscientific issues is epitomized in the science education community's calls for scientific literacy (American Association for the Advancement of Science, 1993; Bybee, 1997; National Research Council, 1996). Socioscientific issues are complex social dilemmas that (a) impact economic, civic and cultural affairs, (b) lack clear-cut solutions, and (c) have conceptual or technological ties to science (Sadler, 2004). Some examples of socioscientific issues include genetic screening, diet, medical treatment, and biological and chemical weapons.

Scientific literacy also entails decision-making that leads to sustainable development. Sustainable development results in practices, processes, activities, or regions that meet the needs of the present without compromising future generations' ability to meet their needs. For sustainable decision-

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ISSN: 2146-0329
www.iejeegreen.com

making to occur, the principles, values, and concepts of sustainable development must be integrated into all aspects of education and learning (Bybee, 2008; United Nations Educational Scientific and Cultural Organization [UNESCO], 2010). The outcomes of such an education are citizens with the "attitudes, skills and knowledge to make informed decisions that would benefit themselves and others, now and in the future, and to act upon these decisions" (UNESCO, 2010).

Sustainability and sustainable development naturally fit in the science curriculum. Currently, sustainability in the form of environmental literacy is apparent in new and revised K-12 science curricula across the globe (Organization for Economic Cooperation and Development, 2005; Partnership for 21st Century Skills, 2009). Considerations of sustainability are also at the center of the curriculum of several institutions of higher education (Morrone, Mancl, & Carr, 2001). While the need to prepare sustainability-literate teachers is slowly gaining momentum (McLean, 2009; Nolet, 2009), research that examines science teachers' knowledge and actions relating to sustainable development is non-existent. Yet teachers are the most influential factor affecting the development of learners' attitudes, skills, and knowledge. The purpose of this study is to investigate the following research questions:

1. Do preservice science teachers intuitively use sustainability as a criterion for analyzing socioscientific issues?
2. What considerations do preservice teachers mostly use to inform their decisions about socioscientific issues?
3. What factors characterize preservice teachers' analysis of socioscientific issues?
4. How sustainable are preservice teachers' stances respective to selected socioscientific issues?

The Sustainability Triad

This study uses the Sustainability Triad, Sadler's (1990) conception of the social, economic and environmental aspects of sustainability, as a conceptual framework. The triad visually represents sustainability in three overlapping circles representing the social, economic, and environmental dimensions. The economic dimension of the sustainability triad is concerned with satisfying the material wealth of people through money, property, or other possessions that have an economic value measurable in price. The social dimension of the triad is concerned with maintaining and improving human living standards, shifting "the emphasis from individual right and economic wealth to community rights and social welfare of all human beings" (Herremans & Reid, 2002, p. 18). The environmental dimension is concerned with systems that preserve the integrity and continued productivity and functioning of ecosystems. Any activity, process, region, or project can be considered sustainable if it (a) lies in the sustainability domain, which is the intersection of the three circles, and (b) is characterized by congruence and lack of conflict

among the three dimensions, and (c) maintains, supports, or carries the weight or burden of all three dimensions of the Sustainability Triad over the long term (Fien & Trainer, 1993).

Herremans and Reid (2002) propose the sustainability triad as a classroom tool for the development of understanding, recognition, and implementation of the concept of sustainability. These researchers posit that using the triad as a framework for case analysis offers several advantages:

1. It helps students to conceptualize the relationships between the three dimensions of sustainability and begin to understand the dimensions more deeply by identifying activities that fit into each of the areas of overlap (conflicts or congruencies);
2. It can help students understand that the diversity of stakeholders' values may constitute a barrier to achieving sustainability; and
3. It contributes to the development of higher levels of learning including analysis, synthesis, and evaluation.

The Sustainability Triad provides students with a concrete process for identifying practices that are not sustainable (conflicts) and ones that are more so (congruencies). Identification of conflicts and congruencies between the economic, social, and environmental dimensions leads to determinations of why practices are not sustainable, followed by a discussion of the steps needed to seek a solution and move from an unsustainable position to a more sustainable position (Herremans & Reid, 2002).

Methods

The study relied on a mixed-methods approach (Creswell, 2009) to guide the collection, organization and analysis of data. Data collection occurred in the context of two sections of a middle school science methods course at a US Midwestern university. Participants consisted of 40 preservice teachers enrolled in the course. Twenty-seven of the participants were female. The preservice teachers were in the final stages of completing the science content requirements for their license. Science requirements consisted of courses in chemistry, physics, geology, astronomy, and plant structure and development. Requirements additionally included the Plants and People course and a choice between the Environmental Geology and Water and Pollution courses.

Data for this study consisted of the *Does it Matter* methods course assignment. The Does it Matter assignment requires groups of preservice science teachers to:

a) Select a socioscientific issue based on interest in general or by choosing from *Thinking scientifically about controversial issues: Clones, cats, and chemicals* (Slesnick, 2004),

b) Identify the science and technology concepts tied to the issue, and relating them to relevant state and national standards,

c) Assemble relevant media resources to deepen understanding of the issue,

d) Summarize the merits, disadvantages, and implications of the beliefs and practices of stakeholders, and

e) Take a stance on the issue and supporting it with references to prepared summary.

Eleven Does it Matter assignments were used as a data source. The title of the socioscientific issues that were the focus of these assignments are described in Table 1. Table 1 also describes the stance that each group of preservice teachers took with respect to their selected issue. Data analysis began after the course was completed and grades were submitted. Qualitative and descriptive statistical data analysis of the eleven Does it Matter assignments followed the interactive process described in Creswell (2009).

Table 1
Participants' decisions about socioscientific issues.

Issue	Stance	Number of participants
No Weapons I	No to the use of biological and chemical warfare	4
No Weapons II	No to the use of biological and chemical warfare	3
Yes Weapons	Yes to the use of biological and chemical warfare	3
E-coal	Yes to the use of energy from coal	3
E-biofuel	Yes to the use of energy from biofuel	4
E-nuclear	Yes to the use of nuclear energy	4
Allow Cats	Allow free roaming cats	3
Ban Cats	Ban free roaming cats	4
Allow Hunting	Modern humans should hunt	4
Allow GMP	Genetically modified plants should be used	4
Allow Logging	Deforestation/logging should be allowed	4

To answer the first research question, the rationales proposed in the eleven assignments were identified and categorized into one of the triad's three dimensions. An example of a rationale that was categorized as economic consists of, "Our use of biofuel will result in less gasoline import and more economic independence." An example of a rationale that was categorized as social consists of, "A downside is that radiation exposure may lead to cancer and birth defects." An example of a rationale that was categorized as environmental consists of, "Some engineered plants, like poplar, clean heavy

metal pollution from ground water." Furthermore, the frequency of rationales consistent with each dimension was calculated for each assignment and in total (Table 2). Using the data presented in Table 2, the percentage of assignments that used rationales consistent with all three dimensions of the Sustainability Triad was calculated. Similarly, the percentage of assignments using rationales consistent with only two dimensions or only one dimension was calculated respectively. These percentages are presented in the Results section. Finally, the total number of rationales proposed was calculated by assignment and overall (Table 2).

Table 2
Total number of rationales by assignment, dimension, and pro and con.

Assignment	Economic	Social	Environmental	Total	Total Pro	Total Con
Allow Hunting	4	6	2	12	10	2
No Weapons I	6	6	3	15	9	6
Yes Weapons	4	2	0	6	5	1
No Weapons II	4	4	0	8	5	3
E-Coal	6	3	0	9	8	1
E-Biofuel	13	0	6	19	13	6
E-Nuclear	5	2	5	12	7	5
Allow Logging	9	6	4	19	13	6
Allow GMP	7	7	9	23	15	8
Allow Cats	0	0	4	4	2	2
Ban Cats	4	2	3	9	5	4
Total	62	38	36	136	92	44

To answer the second research question, the rationales grouped within each dimension of the sustainability triad were subjected to an open coding process to determine the type of considerations preservice teachers use to inform their decisions about socioscientific issues. Three economic, four social, and four environmental subcategories emerged and are listed in Table 3. Frequencies and percentages were calculated for the number of rationales per subcategory (Table 3).

To answer the third research question, the rationales proposed in each assignment were categorized as pro or con, and the total number of each was calculated (Table 2). The pro category represented preservice teachers' supportive arguments, benefits or other positive consequences. The con category represented preservice teachers' counter arguments, disadvantages or other negative consequences. Next, the pro and con rationales for each of the assignments were analyzed for congruencies and conflicts between dimensions (Herremans & Reid, 2002), and the types of values apparent in

the analysis. Kluckhohn & Strodtbeck's (1961) continuum of values in the following three areas was used:

a) Only humans have value – all life has value;
b) Self-interest – community interest; and
c) Short-term vision – long-term vision

Table 3
Rationales and considerations by dimension of the sustainability triad

Dimension	Subcategory	Total	Percentage
Economic	Personal Wealth	30	22%
	Corporate Wealth	24	18%
	National Wealth	8	6%
Social	Health Care	13	10%
	Food Standards	7	5%
	Happy Life	7	5%
	Welfare and Rights	11	8%
Environmental	Pollution	18	13%
	Populations	12	9%
	Resources	3	2%
	Species	3	2%
	Total	136	100%

To answer the fourth research question, the dimensions of the sustainability triad, emerging subcategories, conflicts, congruencies, and values were used to construct descriptive cases for each of the Does it Matter assignments (samples provided in the Appendix). The eleven cases were subjected to cross case analysis. Several patterns emerged regarding the relationship between the characteristics of preservice teachers' analysis of socioscientific issues and the extent to which their stances were sustainable. The patterns are summarized in the next section.

Results

This section begins with a report of the number of rationales preservice teachers used from each of the dimensions of the sustainability triad in their analysis of the selected socioscientific issues. This report is followed by a description of the types of considerations used to inform the preservice teachers' decisions. Then, an account of the congruencies, conflicts, and values that characterized the preservice teachers' analysis is provided. The section ends with a description of the extent to which the preservice teachers' stances were sustainable.

Dimensions of the Sustainability Triad

An average of 12.36 rationales were used to support each of the stances taken in the eleven Does it Matter assignments. The majority of the rationales,

46%, were aligned with the economic dimension of the sustainability triad. Of the remaining, 28% were aligned with the social dimension and another 26% were aligned with the environmental dimension.

The majority (55%) of the Does it Matter assignments reflected rationales from the three dimensions of the Sustainability Triad. Five assignments (36%) reflected rationales from two of the triad's dimensions: economic and social. One assignment, Allow Cats, presented rationales from the environmental dimension only. While all but one assignment contained rationales consistent with the economic dimension, three assignments (E-Coal, No to Weapons II, and Yes to Weapons) did not contain rationales consistent with the environmental dimension (Table 2). Only one assignment, E-Biofuel, did not contain rationales consistent with the social dimension.

Economic Considerations

The rationales within the economic dimension were grouped into three subcategories of considerations (Table 3). The subcategories represented considerations of growth or reduction in national wealth, corporate wealth, and/or personal wealth in the form of money, property, and jobs. National wealth was affected by revenue and expenditures resulting from taxes, military spending, research and development, imports, and/or exports. Corporate wealth was affected by revenue and expenditures from start-up businesses, corporate research and development, technological innovations, patents, sales, production costs, and/or materials production and sales. Personal wealth was affected by the loss and gain of money, property, and/or jobs.

Growth in personal wealth emerged as the most frequently used consideration, followed by growth in corporate wealth. Reduction in national wealth was used least frequently within the economic dimension. Table 3 presents the number of considerations used from each of the subcategories of the economic dimension of the sustainability triad.

Social Considerations

The rationales within the social dimension were grouped into four subcategories of considerations (Table 3). The subcategories represented considerations of the quality and availability of health care and food, a happy life, and/or welfare and rights of individuals and societies. Quality and availability of health care were affected by increased possibilities of injury, disease, birth defects, allergies, and/or overall well-being. Availability of food was influenced by the increase or lack of opportunities to procure more, and/or nutritious food. Leading a happy life was affected by the availability of stable social interactions and/or availability of recreational opportunities. The welfare and rights subcategory encompassed attention to human exploitation, community rights and activism, and/or social welfare and health.

Threats to the quality and availability of health care emerged as the most frequently used consideration in the social dimension (Table 3).

Considerations of the welfare and rights of societies and groups came next. Threats to a happy life were used least frequently.

Environmental Considerations

The rationales within the environmental dimension were grouped into four subcategories of considerations (Table 3). The subcategories represented considerations of populations, diversity of species, pollution, and/or resources. Considerations about populations were concerned with impacts on population growth, control, maintenance, and overpopulation. Considerations about diversity of species were concerned with the discovery or creation of new species, and/or extinction threats to existing species. Considerations about pollution were concerned with the impact of emissions and other factors that restore, maintain, disrupt, or destroy ecosystems. Considerations about resources focused on the availability and use of renewable and non-renewable resources.

Pollution emerged as the most frequently used consideration in the environmental dimension (Table 3). Considerations about population management came next. Considerations about species were used least frequently.

Characteristics of Socioscientific Issue Analysis

The preservice science teachers' analysis of socioscientific issues was characterized by conflicts, congruencies, and values to various extents.

C*onflicts.* Conflicts between dimensions of the Sustainability Triad were apparent in the preservice teachers' analysis as follows (see Table 4):

- None (n = 4)
- Economic/Social (n = 3)
- Economic/Environmental (n = 1)
- Social/Environmental (n = 1)
- All (n = 1)

An example of a conflict between the social and environmental dimensions is apparent in the Allow GMP assignment, where the preservice teachers concluded that the availability and improved quality of food and health at a national and international level might come at the cost of biodiversity. An example of a conflict between the economic and social dimensions is apparent in the No Weapons I assignment, where the preservice teachers cited a reduction in corporate and national wealth as one consequence of their decision and more global harmony as another. An example of a conflict between the economic and environmental dimensions is illustrated in the Allow Logging assignment, where an increase in personal and corporate wealth occurs as habitats continue to be destroyed.

Congruencies. Congruencies between dimensions of the Sustainability Triad were also apparent in the preservice teachers' analysis as follows (see Table 4):

- None (n = 4)
- Economic/Social (n = 5)
- Economic/Environmental (n = 1)
- Social/Environmental (n = 1)
- All (n = 1)

Table 4
Conflicts Congruence and Values

Assignment	Conflict	Congruence	Values
Allow Hunting	None	All	Only humans vs. All life has value Self-interest vs. Community interest Short-term vs. Long-term vision
No Weapons I	Eco / Social Eco / Envi	Social / Envi	Self-interest vs. Community interest Only humans vs. All life has value
Yes Weapons	Eco / Social	None	Self-interest vs. Community interest Short-term vs. Long-term vision
No Weapons II	Eco / Social	None	Self-interest vs. Community interest Short-term vs. Long-term vision
E-Coal	Eco / Social	Eco / Social	Short-term vs. Long-term vision Self-interest vs. Community interest
E-Biofuel	None	Eco / Envi	Self-interest vs. Community interest Short-term vs. Long-term vision
E-Nuclear	None	Eco / Envi	Short-term vs. Long-term vision Self-interest vs. Community interest
Allow Logging	All	None	Only humans vs. All life has value
Allow GMP	Social / Envi	Eco / Social	Self-interest vs. Community interest
Allow Cats	None	None	Only humans vs. All life has value
Ban Cats	Eco / Social	Eco / Envi	Only humans vs. All life has value Short-term vs. Long-term vision

An example of an attempt at congruency between the economic and social dimensions is apparent in the E-Coal assignment, where the use of coal continued to support personal and corporate wealth as it maintained the quality of life of individuals and communities. An example of a an attempt at congruency between the economic and environmental dimensions is illustrated in the E-Nuclear assignment, where cheaper energy and additional jobs to reprocess fuel contribute to personal, corporate and national wealth and independence while at the same time decreasing pollution. An example of a congruency between the social and environmental dimensions is apparent in the No Weapons I assignment, where social interests and global welfare go hand in hand with decreased pollution.

Values. A variety of values were apparent in the preservice teachers' analysis of socioscientific issues as follows (Table 3):

- Self-interest vs. Community interest (n = 8)
- Short-term vision vs. Long-term vision (n = 7)
- Only humans have value vs. All life has value (n = 5)

An example of a statement reflecting one end of the "Only humans have value vs. All life has value" continuum from the Allow Hunting assignment is, "Hunting results in the murder of innocent animals or the violent and inhumane treatment of animals like hounds." Another example from the Ban Cats assignment states, "Cats need exercise and space." Examples closer to the other end of the continuum include the Allow GMP assignment statement "GMPs result in healthier animals that produce more nutritious eggs, milk, and meat" and the Allow Logging assignment's "We may end up losing plants and animals with potential medicinal benefits."

Examples of statements reflecting one end of the "Short-term vision vs. Long-term vision" continuum are, "There are enough fossil fuels to maintain quality of life for next 200-300 years" (E-Coal) and "Future generations need to monitor waste storage" (E-Nuclear). An example of a statement that reflects the values of the "Self-interest vs. Community interest" continuum is, "It is important to keep harmony between nations" (No Weapons II).

Sustainability of Stance

Few of the preservice teachers' adopted stances reflected an attempt at sustainability. Most of the preservice teachers' adopted stances in the Does it Matter assignments were supported by a majority of pro rationales. The only exception, the Allow Cats stance, was supported by an equal number of pro and con rationales. Considerations of all dimensions of the Sustainability Triad, conflicts, congruencies, and values emerged as indicators of sustainability.

One assignment, Allow Hunting, reflected a stance in the sustainability domain characterized by (a) rationales from all dimensions of the triad, (b) congruence between all dimensions of the Sustainability Triad, (c) an absence of conflicts, and (d) harmony in values. Corporate and national interests were not in conflict with the interests of the individual and community, or the belief that all life has value.

Four assignments (No Weapons I, E-Nuclear, Allow GMP, and Ban Cats) reflected an attempt at sustainability characterized by (a) rationales from all dimensions of the sustainability triad, (b) congruence between some of the dimensions of the sustainability triad, and (c) conflicts between some of the dimensions of the triad.

Five assignments reflected stances that were not sustainable. These assignments were characterized by rationales from only one or two dimensions of the Sustainability Triad. These assignments were E-Coal, E-Biofuel, Yes Weapons, No Weapons II, and Allow Cats. A sixth assignment, Allow Logging, also reflected an unsustainable stance that was characterized by conflicts and a lack of congruence between all dimensions of the Sustainability Triad.

Discussion

The findings of this study indicate that more than half of the preservice teachers used rationales aligned with all three dimensions of the Sustainability Triad. This finding implies that these preservice teachers were intuitively oriented to consider sustainability as they analyzed and made decisions about socioscientific issues. The majority of the remaining preservice teachers either considered rationales from the economic and social, or the economic and environmental dimensions of the triad as they analyzed and made decisions about socioscientific issues. These preservice teachers seemed to be less oriented to consider sustainability in their analysis. Only one group of preservice teachers did not seem to be oriented to reason from a sustainability perspective at all. This third group of teachers only considered rationales from the environmental dimension.

The findings of this study also indicate that the economic dimension constituted the largest source of rationales for the preservice teachers. This finding implies that as a group, the preservice teachers in this study were oriented to think of economic considerations to a large extent. The preservice teachers seemed to be oriented to think of social and environmental considerations to a lesser degree.

Finally, except for one, the preservice teachers' adopted stances in this study were not sustainable for two reasons: not all dimensions of the Sustainability Triad were considered, and the relationship between the conflicts, congruencies, and values characterizing the preservice teachers' analyses was not considered. As mentioned previously, many of the preservice teachers did not intuitively consider all the dimensions of the sustainability triad. Instruction about sustainability using the Sustainability Triad may help address this issue. Furthermore, the preservice teachers did not seem to be aware of the conflicts and/or congruencies that characterized their analysis. Without being aware of the conflicts and congruencies among the social, environmental, and economic dimensions, the preservice teachers did not have the opportunity to discuss whether their decisions met Fien and Trainer's (1993) criterion of maintaining, supporting, or carrying the weight or burden of all three dimensions of the sustainability triad over the long term.

Additionally, the preservice teachers did not seem to explicitly consider the values they, as stakeholders, and the stakeholders they cite bring to the analysis and the decision. This lack of awareness of values seems to have made it harder for the preservice teachers to, as Herremans and Reid (2002) state, find common ground for reaching a sustainable decision. One other possibility for why the preservice teachers' decisions were not sustainable may be that they do not value sustainability as a goal for policy and practices. A lack of understanding of the concept of sustainability may be an underlying cause for this possibility.

Recommendations

The findings of this study support several recommendations for the teaching of sustainability in the context of science teacher education. A first recommendation calls for science teacher education programs that incorporate explicit instruction about sustainability, the Sustainability Triad, and related constructs in content courses. Content courses may emphasize the relationship between sustainability, science, technology, and ecology by giving examples of sustainable practices, unsustainable practices, and consequences of both. Content courses may also engage preservice teachers in analyzing community-based cases using the Sustainability Triad. Herremans and Reid (2002) provide an example of such a case and its analysis based on a Canadian park.

A second recommendation calls for science teacher education programs that incorporate explicit instruction about sustainability, the Sustainability Triad, and related constructs in science education courses. One way of addressing the concept of sustainability in a science methods course consists of explicit instruction about the Sustainability Triad in the context of socioscientific issues. The Sustainability Triad can serve as an advance organizer (Ausubel, 1978) to be shared with preservice teachers prior to discussions of socioscientific issues. As an advance organizer and framework for analyzing socioscientific issues, the sustainability triad has the potential to help scaffold the types of higher order learning necessary to promote understanding, recognition, and action for sustainable development.

Conclusion

Preservice teachers may intuitively draw on the dimensions of the Sustainability Triad as they analyze and make decisions about socioscientific issues. However, a large number of preservice teachers may not consider one or more of the dimensions of the triad due to inadequate understanding of the concept of sustainability or orientations to reason from a limited number of perspectives. Failure to consider the economic, social, *and* environmental domains to analyze socioscientific issues and concomitant projects, activities, regions, or processes will undoubtedly result in less sustainable decisions and actions. The use of the Sustainability Triad as an advance organizer for the discussion of socioscientific issues is recommended.

♦ ♦ ♦

Biographical statement

Dr. Danielle Dani holds a B.S. in Biology and a M.S. in Biology. She received her Ed.D. in Curriculum and Instruction from the University of Cincinnati. Dr. Dani teaches graduate and undergraduate courses in science education and teacher education. Her research examines the knowledge, beliefs and practices necessary for teaching science as inquiry, promoting environmental and scientific literacy in the 21st century, and engaging in reflective, high-quality, student-centered teaching.

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Appendix

Allowing Hunting

	Economic	Social	Environmental
Pro	• Provides tax revenue • Provides revenue from hunting licenses • More income from ammunition sales • More income from camouflage attire sales	• More sources of food • Stronger sense of family • More bonding time with friends • Availability of recreational activity	• Provides funds to manage parks • Hunting seasons and regulations protect wildlife populations
Con		• More hunting related accidents • More hunting related deaths	
Conflict and/or Congruence	No Conflict	Economic, social, and environmental congruence.	
Values	Only humans vs. All life has value		

Allow Logging/Deforestation

	Economic	Social	Environmental
Pro	• Provides jobs. • Provides homes. • Provides usable land for individual farmers growing crops. • Provides usable land for companies growing crops. • Provides usable land for animal pasture. • Provides a source of income for many individuals • Supports a variety of industries • Results in the establishment of recycling companies.	• More sources of food. • Provides schools. • Provides tools. • Rallies and unionizes community members.	
Con		• Results in political activism. • Results in the loss of plants and animals with potential medicinal benefits.	• Destroys habitats. • Causes soil erosion. • Causes flash flooding. • Results in the loss of plants and animals (extinction).
Conflict and/or Congruence	Economic / Environmental / Social conflict	Economic / Social congruence	
Values	Only humans vs. All life has value		

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International Electronic Journal of Environmental Education
Vol. 1, Issue 2, January 2011

Sosyobilimsel Sorunların Analizi İçin Bir Çerçeve Olarak Sürdürülebilirlik

Danielle DANİ*

Özet

Bilimsel ve çevre okuryazarlığı yirmi birinci yüzyılda yaşayan tüm insanlar ve fen eğitimi için önemli bir köşe taşıdır. Sosyobilimsel konular hakkında karar alabilme yeteneği, bilimsel ve çevre okuryazarlığının bir özelliğidir. Bu çalışmada öğretmen adaylarının sosyobilimsel konular hakkında analiz ve karar verme becerilerini keşfetmek için Sürdürülebilirliğin üç öğesi kullanılmıştır. Sonuçlar öğretmenlerin sürdürülebilirliğin üç öğesini sosyobilimsel analizlerde çok sık kullanmadıklarını bu nedenle de verdikleri kararların sürdürülebilir olmadığını göstermiştir. Fen öğretmeni yetiştirme programları için Sürdürülebilirlik hususları vurgulamaları yönünde önerilerde bulunulmuştur.

Anahtar Kelimeler: Sosyobilimsel konular, bilimsel okur-yazarlık, çevre eğitimi, sürdürülebilirlik, fen öğretmeni hazırlama

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ISSN: 2146-0329
www.iejeegreen.com

International Electronic Journal of Environmental Education
Vol. 1, Issue 2, January 2011

Factors that Influence Student's Satisfaction in an Environmental Field Day Experience*

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Stephan P. CARLSON**

Abstract
A field trip is a common strategy used by educators to bring out-of-school learning experience into schools. Many research studies suggest a field trip will not only bring an individual close to the real-world, but may also increase an individual's environmental knowledge and responsible behaviors. Program evaluations usually focus on the predetermined outcomes, such as increasing environmental knowledge and responsible behaviors, which were decided by environmental educators and programmer planners. It is known that positive emotions help promote creativity and attention for learners. This paper suggests that increased satisfaction on student field trip experiences, leads to the achievement of programs predetermined goals and outcomes. This study focuses on investigating the factors that influence students' satisfaction in a field day experience. In this study, we found that presenters, social content, and learning related condition are critical criteria to improve students' satisfaction in a field day experiences.

Keywords: Environmental education, field trip, out-of-school, satisfaction, confirmatory factor analysis.

Introduction

Environmental educators are aware of the importance of bringing real-world experiences to their teaching. Also, a lot of research studies suggest that students must integrate in-school environmental literacy with out-of-school natural world experiences (Dori, 2000; National Research Council, 1996; Tonye, 1993). A field trip becomes the most common strategies, which is used

* This study was funded in part with NSF REESE project #635559, 'Developing an Evaluation Tool for Environmental Field Days".
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ISSN: 2146-0329
www.iejeegreen.com

by most school teachers, to bridge student's environmental knowledge with real-world experience. For example, over 10,000 4th- to 6th-grade students participate in Environmental Field Day in each academic year in Minnesota (Carlson, 2008). Environmental field day not only provides various learning opportunities in different subjects, such as biology, chemistry, and wildlife and natural resource conservation, but also is a place that can bring students close to the natural world. Normally, these field day events require significant investments, such as time, people, and money. Therefore, having program evaluations to improve effectiveness of a field day is necessary. Educators and politicians are often concern that program planners will waste money (Benninga, Berkowitz, Kuehn & Smith, 2006) and not be able to achieve predetermined learning outcomes, such as increasing knowledge and promoting environmental friendly attitudes and behavior (Barney, Mintzes, & Yen, 2005; DiEnno & Hilton, 2005; Farmer, Knapp, & Benton, 2007; Goth & Hall, 2004; Knapp & Barrie, 2001;). Therefore, in most existing environmental education studies, program evaluation primarily focuses on educational intervention (Rickinson, 2001). Students play a less active role in terms of expressing their experience in a field trip.

Rickinson (2001) suggests when applied to students' learning in a field trip, program evaluations should consider what students want to say. However, the research studies that explore student's feelings and experience in a field trip are limited. In other words, most field trip evaluations rarely consider what students' are 'feelings' in a field trip program. In the field of educational physiology, a lot of research studies support that emotions change people's thoughts, actions, and physiological responses (Bolte, Goschke & Kuhl, 2003; Fredrickson, 1998; Isen, Rosenzweig & Young, 1991; Park, 2008). The research study from Seligman, Ernst, Gillham, Reivich and Linkins (2009) suggests that positive moods help facilitate students' engagement in learning and achievement. In other words, if students have positive feelings on a field trip, such as joy, interests, love, and satisfaction, the field trip is more likely to achieve its predetermined learning goals.

In this study, we investigated the factors that influence students' satisfaction in a field day experience. Field day and field trip are used synonymous in this paper.

Literature Review

There has been an increase interest in schools to use field trip as part of environmental education programs (Knapp & Benton, 2006; Storksdieck, 2006, Stern, Powell & Ardoin, 2008). Field trip helps students enhance their learning experience and knowledge. Hmelo-Silver, Marathe and Liu (2007) pointed out that rigorous school textbooks, cannot provide a dynamic and interactive learning experience to students when teaching students about what a natural system is and an ecological phenomena. A quality field trip program, which includes pre-visit activities, a field trip, and post-visit activities, can also enhance students' scientific literacy and communication skills in a very young age, such as kindergarten and first grade students

(Gostev & Michaelides Weiss, 2007). However, few research studies with older students have focused on how student evaluate their field trip experiences.

Some literature suggested that a meaningful field trip should address student's educational need, or be base on school curriculum, or state standards (Carlson, 2008; Nabors, Edwards, & Murray, 2009; Orion & Hofstein, 1994). However, when James and Bixler (2008) asked 4th- and 5th-grade gifted students what makes a meaningful field trip, the answer was either addressing student's educational need, or the state standards and school curriculum. They found that students think a meaningful field trip should connect to their personal experience suggesting that students hold the key to meaningful field trips. Orion and Hofstein (1994) suggested high quality and novelty are two important factors that influence student's learning on field trips. In order to have a high quality field trip, environmental educators and program planners should consider the quality of learning materials, structure, and teaching and learning strategies (Orion & Hofstein, 1994).

On the other hand, it is a common belief that certainly moments in people's lives characterized by experiences of positive emotions, such as joy, interests, love, and satisfaction (Fredrickson, 1998; 2001), have the ability to broaden people's momentary thoughts-action repertoires. Fredrickson suggested "joy, for instance, broadens by creating the urge to play, push the limits to be creative" (Fredrickson, 2001). Research focused on student's field trip learning experiences suggested that affective perception and social interaction with others has a strong influence in creating a meaningful field trip experience. For example, Cline's (1996) study suggested that students emphasized the importance of social interactions with others on a field trip. Jones and his colleagues (1994) also suggested that the most memorable things for students were related to social and environmental factors, such as friends, night hikes, black flies, and campfires. These studies pointed out the salient things that students remembered the most, such as a party, hiking and campfires, were not only the things that they did with others, but also involved their affective perception, such as happy, afraid, likes and dislikes. These research studies suggest that affective perception and social interaction are important factors to consider in providing a meaningful field trip experience for students.

Method

This study was conducted at the eleventh annual Metro Children's Water Festival (MCWF). The MCWF was held at the Minnesota State Fairground on September, 2008. The setting included both indoor and outdoor activities where thirty one learning stations were set up. Each station had a theme that was relevant to water. All the learning stations were designed to provide students with hands-on, mind-on learning experiences. Most of the volunteer instructors in MCWF were scientists who work for State or Federal agencies, nonprofit organizations, or the University Extension. Each instructor had

approximately thirty minutes to deliver his or her programs to twenty-five to thirty students. After thirty minutes, classes rotated from stations to stations. The sequence of the rotation for the learning stations and classes were assigned by the MCWF planning crews. During the days, one class visited five to six learning stations, and a one hour large group presentation. Although there were thirty learning stations at the MCWF, a class visited less than 25% of them.

Participants:
There were close to 1,200 fifth grade students, sixteen schools, 44 different classes from each of the seven Metropolitan counties in Minnesota attended MCWF. Although MCWF had approximately 1,200 participants, 841 valid surveys (89%) were returned within a week of the field day.

Instrument and Analysis:
The student's instrument was originally designed for another purpose, to test the validity of a field day observation tool. This was done by triangulating the data from the student survey with the observation tool (Carlson, Storksdieck & Heimlich, accepted 2011). The observation tool looked at 7 components of a field day that were supported in both the literature and through a Modified Delphi method with a team of 40 experts (Heimlich, Carlson, Tanner & Storksdieck, accepted 2010). The student survey questions were developed from the Instructor/Presentation and Audience Engagement components of the Delphi. Each item on the student survey had at least 2 questions that try to answer the construct. The tool was approved by IRB and appropriate forms were sent to principals, teachers and parents. The secondary use of the student's tool was to identity factors and model learning in field day programs. This secondary data from the student's survey was used to validate the relationship of the satisfaction constructs found in informal learning environments.

The survey contained forty-three multiple choice items and four open-ended essay questions. The student survey intended to measure three different dimensions, 1) MCWF learning objective, 2) overall field day experience, and 3) student content knowledge. The survey had twelve multiple choice items that measured learning objectives for MCWF, and had thirty-one multiple choice items that assessed the overall field day experience. The last part of survey had four open-ended essay questions to evaluate students' content knowledge. For the purpose of this study, only the second part of the student's survey, overall field day experience, was analyzed. After students filled out the MCWF student survey, school teachers mailed the surveys back to the researcher.

Instrument Design and Analysis

Thirty-one multiple choice items were designed to measure the overall field day experience. These survey items were on a five point Likert scales. Based on the purpose of the items, there were three sets of scales on a one to five

rating for students' level of agreement or disagreement. The three sets of coding were 1) 1= strongly disagree, and 5=strongly agree; 2) 1= never, and 5= all of the time; and 3) 1= no way, and 5= oh yeah. However, there were six items that were reversed or using negative expressions that were randomly inserted in the survey. These items seemed to have cause confusions for fifth grade students. For example, the question, I felt there was nothing for me to do at the station, had a crying face to represent the scale of all of the time and a big smiley face to represent the scale of never. This seemed to confuse the students and the data bore this out so we exclude the reverse items.

We conducted reliability coefficient for the rest of the twenty-five items. However, there were four items that had less than 0.2 corrected item-correlation with other items and were excluded. These four items were 'At the learning stations, I knew what would happen', 'I got to do, hear or see things that I already knew', 'the Water Festival felt like being in school', and 'I enjoyed being away from school'. The item that had the highest correlation is 'I will recommend the Water Festival to a friend (0.767)' and the item had the lowest correlation is 'I had a chance to ask my questions (0.258)'. (Appendix A)

Based on our hypothesis, we categorized the rest of the twenty-one items into four subscales, satisfaction, presenter, social content, and learning related conduction (Appendix A). We ran a reliability coefficient for these four subscales. After we acquired the internal consistency of each subscale, we conducted confirmatory factor analysis to identify if these factors exist independently.

Finally, we use multiple regression to learn more about the relationship between the four subscales. Both SPSS 1.60 and R, sem package were used to analyze our data.

Result

Subscales Internal Consistency:

The internal consistency of the four subscales was estimated by the Cronbach's α Reliability coefficient. The items measuring satisfaction had the best internal consistency (α = .917). However, the rest of subscales displayed moderate reliability (Social content, α = .676; Learning-related condition, α = .661; Presenter, α = .626).

Confirmatory Factor Analysis (CFA):

We conducted confirmatory factor analysis (CFA) to test the proposed factor structure. The four categories (subscales) to be measured through CFA were satisfaction, presenter, social content, and learning related condition. Based on our research question, the factors influence on student's satisfaction, we hypothesized that the presenter, social content, and learning related condition are independent variables and highly correlated with student's satisfaction. First, CFA was performed with four-factor model (satisfaction, presenter, social content and learning related condition scales). The result showed that four-factor model was not a goodness-of-fit (χ^2 (210) = 8055.1, RMSEA = .066,

Goodness-of-fit index = .90, NFI = .892, NNFI = .90, SRMR = .053, CFI = .913). However, the three-factor model (presenter, social content and learning related condition scales) was examined through CFA and showed a goodness-of-fit model (χ^2 (78) = 2518.1, RMSEA = .046, Goodness-of-fit index = .969, NFI = .932, NFFI = .942, SRMR = .036, CFI = .955). Table 1 presented the factor loadings and error for the three subscales. The corresponding items are positively and substantially loaded on presenter, social content and learning related condition. The CFA result suggests that presenter, social content and learning related condition independently exist in the survey. The item, "the presenters at the Water Festival were nice to me", had the highest factor loading in factor one. The item, 'kids in my class had fun at the stations", had highest factor loading in factor two. The highest factor loading item in the factor three was "I found the stations interesting". (Table 1)

Table 1.
Completely factor loadings and errors for overall field day experience

Subscale	Factor loading	Std Error
Factor 1: Presenter		
Presenter told us who they were	0.403	0.038
Presenter asked us questions that I could understand, even though I did not know the answer	0.404	0.039
I could hear and see the presenters at the stations	0.489	0.037
The presenters at the Water Festival knew a lot	0.597	0.037
The presenters at the Water Festival were nice to me	0.616	0.037
Factor 2: Social Content		
Kids in my class listened when they were supposed to	0.406	0.037
Kids in my class really got into the activities at the stations	0.749	0.033
Kids in my class had fun at the stations	0.764	0.033
Factor 3: Learning-Related Condition		
I had a chance to ask my questions	0.348	0.036
I learned something new at the stations	0.596	0.034
I paid attention at the stations	0.559	0.034
I found the stations interesting	0.715	0.033
I got to do, hear or see new things	0.614	0.034

Multiple Regression:
A multiple regression was conducted to examine the relationship between satisfaction and the other three predictors. Table 2 summarized the statistics and the analysis results. The result showed all of the factors are positively and significantly correlated with satisfaction. The standardized coefficients result suggested that learning related condition may be a more important predictor (ß = 0.45, p <.001) than either social content (ß = 0.27, p < .001) or presenter (ß = 0.13, p <.001) to predict student's satisfaction in a field trip experience. Overall, the three factor model was able to account for 54% of the variance in student's satisfaction at the Children Water Festival,[$F(3, 837) = 328.69$, $p < .001$].

Table 2.
The relationship between satisfaction and presenter, social content and learning related condition in correlation and multiple regression

Variable	Mean	Std	Correlations with Satisfaction	b	ß
Satisfaction	3.34	0.84			
Presenter	4.23	0.60	0.528*	0.188*	0.134
Social Content	3.86	0.73	0.582*	0.308*	0.271
Learning Related	3.96	0.69	0.687*	0.548*	0.455

*$p < .001$

Discussion
One of the common indicators to evaluate a successful educational program is satisfaction. Student's satisfaction is often study in other field, such as on-line learning (So & Brush, 2008) and higher education course evaluation (Endres, Chowdhury, Frye & Hurtubs, 2009), but rarely can be found in a field trip's evaluation. So and Brush (2008) suggest that course structure and emotional support are two important factors that will lead to a successful on-line learning. In this study, over 50% of student's satisfaction in a field day experience was composed by three important factors, presenter, social content, and learning related conditions.

The finding suggests the presenter factor has positive correlation with student's satisfaction in a field trip. We suggest a high quality field trip should not only be concerned with learning materials, structure, and teaching and learning strategies (Orion & Hofstein, 1994), but also need to have presenters who are knowledgeable and friendly to implement educational programs to students.

On the other hand, the Contextual Model of Learning can be considered as a key theoretical framework to investigate learning within an informal setting (Falk & Dierking, 2000; Falk, & Storksdieck, 2005), such as a field trip. In the Contextual Model of learning, the sociocultural context is considered as one of the substantial components that engage learners to lean.

Our finding suggests that a fun learning environment may intrigue learning behaviors between students with their peers. In other words, a positive learning environment where one arouses learner's positive emotions, such as a fun and interesting learning station in a field day, may be part of a fundamental cornerstone to building the sociocultural context. This finding of a fun or an interesting learning environment is also a critical factor to promote students' social interaction with their peers corresponds to Cline's (1996) and Jones and his colleagues' (1994) findings. As Fredrickson's "broaden-and-build" theory (1998, 2001) asserts that positive emotions not only build people's momentary experiences in social and physical behavior, but also support intellectual, cognitive and artistic behavior (Fredrickson, 2001; Isen, Daubman, & Nowicki, 1987, Isen, Rosenzweig, & Young , 1991), such as broadening student's attention (Bolt, Goschke, & Kuhl, 2003; Fredrickson & Branigan, 2005).

One of the critical criticisms that out-of-school educational program, such as a field trips face, is that some educators believe students only have fun, but learn nothing from the out-of-school experiences (Shortland, 1987; Wymer 1991). However, based on our findings and the literature, a meaningful field trip experience will occur when social interactions and positive environmental factors, such as a friendly and knowledgeable presenter, and an interesting learning station, are fulfilled. This paper argues that an interesting and fun learning station, well taught, is one of the most important factors which contribute to student's satisfaction. High satisfaction, leads to learning related behaviors, such as attention, engagement and creative student/presenter interactions. In other words, it results in field trip program planners and educators achieving their educational goals. From a student's perspective, the antecedent for learning is that students need to have fun and enjoy the field trip experience. So, in order to create a quality field trip experience, instructors and program planners should design a fun and interesting learning environment, and provide various opportunities for students to interact with both instructors and other students.

Conclusion

This study provides concrete evidence to support a fun or an interesting field trip experience relate to high satisfaction of students. Many research studies support that high satisfaction leads to positive motions which can promote predetermined learning outcomes, such as increasing learning interests, broadening attentions, and stimulating positive social interactions. This has been studied in on-line learning environments but this environment has limited connections to field trips. Therefore, in a informal learning environment, when a student has fun on a field day, he or she is more likely to transfer the field trip experience into a meaningful learning experience. This study also suggests that satisfaction plays a role in strengthening the dimensions of environmental citizenship and should be a key outcome for engaging young people.

Because of the limits of this secondary data, we suggest further studies in order to explore additional factors that influence student's field trip experiences. We suggest first, more studies to investigate other variables that influence students' field day experience. For example, other than a knowledgeable, skillful and friendly instructor, social interactions and do and see new and interesting things, what other factors will increase student's attention during a field trip? In addition, what do students think a fun and interesting learning environment should look like? Last but not least, additional studies should verify the ways these factors interact with each other as reported on in this study.

♦ ♦ ♦

Biographical statements

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Appendix A. Categories of Survey Items and Correlation

Subscale	Item Correlation
Satisfaction Items	
1a. I enjoyed the presenters	0.580
1b. I love the things we did at the stations	0.651
1c. I enjoyed at the Water Festival	0.753
1d. I would recommend the Water Festival to a friend	0.767
1e. I would like to come back next year	0.731
1f. Other kids who did not come to the Water Festival would like the Water Festival	0.700
1g. The Water Festival was what I was hoping it to be	0.649
1h. I liked the water Festival	0.743
Presenter Items	
2a. Presenter told us who they were	0.286
2b. Presenters asked us questions that I could understand, even though I did not know the answer	0.296
2c. I could hear and see the presenters at the stations	0.271
2d. The presenters at the Water Festival knew a lot	0.450
2e. The presenters at the Water Festival were nice to me	0.489
Social Content Items	
3a. Kids in my class listened when they were supposed to	0.261
3b. Kids in my class really got into the activities at the stations	0.586
3c. Kids in my class had fun at the stations	0.628
Learning-Related Condition Items	
4a. I had a chance to ask my questions	0.258
4b. I learned something new at the stations	0.495
4c. I paid attention at the stations	0.427
4d. I found the stations interesting	0.718
4e. I got to do, hear or see new things	0.565

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International Electronic Journal of Environmental Education
Vol. 1, Issue 2, January 2011

Çevresel Tatbikat Gününde Öğrenci Memnuniyetini Etkileyen Faktörler*

Hui-Hui WANG

Stephan P. CARLSON**

Özet

Alan gezisi okullarda okul dışı öğrenme deneyimi sağlamak için eğitimciler tarafından kullanılan ortak bir stratejidir. Birçok çalışmaya göre alan gezileri bireyi gerçek dünya ile yaklaştırır aynı zamanda bireyin çevre bilgisini ve sorumlu davranışlarını da arttırır. Programın değerlendirilmesinde genellikle program planlamacıları tarafından karar verilen çevre bilgisi ve sorumlu davranışlar gibi önceden belirlenmiş sonuçlara odaklanır. Bu olumlu duyguların öğrenenlerin yaratıcılık ve dikkatini toplamasına yardımcı olduğu bilinmektedir. Bu çalışmada önceden belirlenmiş amaç ve hedeflerin alan gezisinde öğrencilerin memnuniyetinin artmasını sağladığı sonucuna ulaşılmıştır. Bu çalışma bir alan günü deneyiminde öğrencilerin memnuniyetini etkileyen faktörleri belirlemeye odaklanmıştır. Bu çalışmada, sosyal içerik ve ilgili durumları öğrenmenin bir alan günü deneyiminde öğrenci memnuniyetini artırmak için önemli bir kriterler olduğunu bulundu.

Anahtar Kelimeler: Çevre Eğitimi, Alan gezisi, okul dışı, memnuniyet, doğrulayıcı faktör analizi

* Bu araştırma NSF REESE Projesi #635559 kapsamında destek almıştır.
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ISSN: 2146-0329
www.iejeegreen.com

International Electronic Journal of Environmental Education
Vol. 1, Issue 2, January 2011

Teaching Science Using the Language of Nature: Winter Comes to Our Campus*

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Kemal YÜRÜMEZOĞLU
Songül SEVER

Abstract

Through science education that provides integration with nature, students can enter into a positive relationship with scientific knowledge and find the opportunity to have a meaningful learning experience. This study on the theme "winter comes to our campus" was carried out with the interwoven techniques of observation and experimentation. The concept of photosynthesis, a subject of biology, has been treated here with an integrated approach that combines geography (the world's axis, natural phenomena), chemistry (the method of separation of molecular structures), physics (the interaction between light and matter) and fine arts (the harmony of colors displayed by plants at the changing of the seasons). The project stimulates students to adopt an integrated perspective on science.

Keywords: light-chlorophyll interaction, photosynthesis, chromatography, integrated thinking and learning, scientific observation

Introduction

Nature, in matchless harmony and interaction as it harbors within it all entities, alive or dead, reveals so many phenomena for us to observe every day. The story behind the scenes of these events, which seem to us so ordinary, is much more complicated than we think. Most of us have witnessed the efforts of ants as they prepare for the winter by gathering food for themselves all through the summer or the behavior of animals that settle down to hibernate in order to maintain their body temperatures. In the same way, plants too, make preparations for the approaching winter season. The leaves on some of these plants change in color, turn yellow and fall off. These ordinary events that can be observed by any one of us are a sign of the continual changes that take place in nature. In one of our science classes, we found ourselves tracking the answer to a question about one of these changes: "How do trees that shed their leaves get nourished in

* Paper presented at the national conference of Tevfik Fikret Eğitim Günleri

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ISSN: 2146-0329
www.iejeegreen.com

the wintertime?" Do the changes we observe in the trees as the seasons revolve have anything to do with changes in the level of energy (light) reaching the plant or in the amount of chlorophyll it contains?

This project was undertaken to explain the phenomenon of falling leaves in some trees in the winter, using one of the chemical methods of separation, chromatography, and combining this with concepts of light and chlorophyll. The study was carried out with the interwoven techniques of observation and experimentation. Studying the interaction of light and chlorophyll, a factor that leads to physiological changes in plants at the changes of season, is a recommended introductory activity to facilitate the comprehension of photosynthesis, a subject in school curriculums (National science educational standards, 1998) that is generally difficult to understand. A secondary objective of the endeavor has been to stress the importance of observation in science education while at the same time creating awareness about the skills required in the scientific process that combines observation and experimentation.

Misconceptions study participants had about photosynthesis before the activity

In order to determine the level of knowledge students had about the interaction of light and chlorophyll, which is the beginning of the process of photosynthesis, and identify possible misconceptions, the students in the classroom environment were asked: "How do trees that shed their leaves get nourished in the wintertime?" Several misconceptions that some were common with previous studies were determined. Students' misconceptions and some examples from previous studies were presented as follow:

- Photosynthesis only occurs in the green leaves of plants (e.g., Amir & Tamir, 1994; Giordan 1990).
- Chlorophyll is only contained in the green leaves of plants (e.g., Mikkila, 2001).
- A plant that sheds its leaves in the winter months does not go through photosynthesis and is therefore nourished until the spring by the minerals it absorbs from the earth (e.g., Cañal, P. 1999; Ray & Beardsley, 2008).
- Plants get their food from the earth through their clusters of branches.
- In sunny seasons they prepare for winter by producing their own food and storing it (e.g., Cañal, P. 1999).
- Because plants go through the dark stage of photosynthesis in winter, they don't need chlorophyll.
- The falling of leaves has nothing to do with the seasons; shedding leaves is a method of excretion for plants.

Light - Chlorophyll Interaction

Photosynthesis brings about the formation of all bacterial, plant and animal life, or what is today known as organic life on the earth, through its source, the sun. A plant is able to survive without freezing, even at the earth's poles, by using its own photosynthesis factory; this factory enables it to be born, to grow, die and be re-born. In that case, whenever the questions surrounding the miracle of photosynthesis can be fully answered, a multitude of more questions and problems on this earth will also have been answered or solved (İçli, 2009).

The source of the energy that ensures the continuation of life on the earth is the stimulation of a pigment molecule electron by a photon emitted from the sun (Keeton & Gould, 1999). This phenomenon is the beginning of photosynthetic reactions. In plants that go through the process of photosynthesis, electrons in the chlorophyll molecules of plants are excited to a higher energy level by solar energy. The electron jumps to the next level of energy and returns to its ground state. The atoms, molecules and ions tend to be released from the absorbed energy. This process is achieved through phenomena such as heat or light emission. Chlorophyll is then converted, by means of chloroplasts and a series of reactions catalyzed by various enzymes, into a type of energy that can readily be used by the plant. This energy is chemical energy (Gurel & Kuleli, 1991). Photosynthesis is not a phenomenon that only occurs in green plants. Yellow and orange pigments are always found in leaves but are generally masked by chlorophyll. Depending on the physical conditions of the environment, these auxiliary pigments become more visible. The auxiliary pigments in the plants absorb different wavelengths of light than what chlorophyll a is able to capture (Keeton & Gould, 1999). These pigments make the process of photosynthesis in the plant possible even when there are only small amounts of chlorophyll present.

The Changes of Seasons and Plants

The seasons occur because of the slant in the Earth's axis and its orbiting motion around the Sun. The slant is 23.5◦. During the period June 21 – September 23, when the northern hemisphere is inclined toward the sun, rays of sunlight hit the regions of the Earth that are even the farthest from the equator. As a result, the northern hemisphere experiences longer days and more moderate climates. In the same period, the southern hemisphere experiences shorter days and the winter season. As from December 22, more rays of sun start hitting the southern hemisphere, this time causing the northern hemisphere to experience winter (American Forest Foundation, 2002).

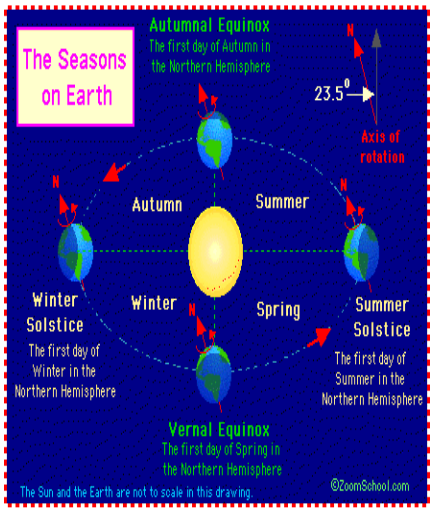

Figure 1. The Slant of the Earth's Axis and its Orbit around the Sun. (Zoom Astronomy, http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Seasons.shtml).

Because of the tilt of the Earth's axis and the path of its orbit around the sun, the angle of the Sun's rays and therefore the wavelengths of these rays and their energy change. This is why the sun appears to be red at sunset. The color scale for the electromagnetic spectrum is shown below.

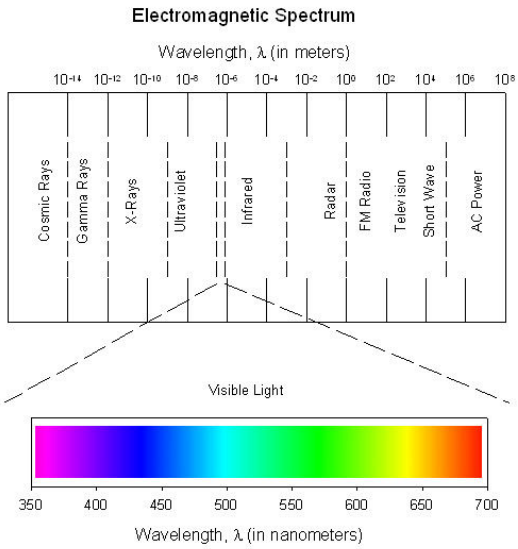

Figure 2. Color Scale in the Visible Electromagnetic Spectrum (McCourt, http://www.psych.ndsu.nodak.edu/mccourt/Psy460/Light%20as%20a%20stimulus%20for%20vision/electromagnetic%20spectrum.JPG).

The differences in the angles in which the rays of the sun are emitted are what cause plants to perceive the seasons. The effects of these changes

can be seen in the amounts of chlorophyll produced by plants. Establishing what these amounts are through the use of a chromatographic technique will enlighten us in our project.

Chromatographic Technique

Chromatography involves the chemical separation of mixtures with similar chemical and physical properties whereby the analyte is separated and flushed through the system by passing mixtures dissolved in their mobile phases through a stationary phase at different rates (Karaer, 2007). This activity will make use of paper chromatography, which is one of the chromatographic techniques, simply because it is a method that requires simple materials that can be found in every environment.

A better term for paper chromatography here is "dispersion chromatography" because of the use of the filter paper that easily and strongly absorbs water and performs the function of the stationary phase in the process of chromatography (Karaer, 2007).

Performing the Experiment

This project is carried out with activities both inside and outside of the classroom. In the first stage, the students are taken outdoors in the fall or winter season and asked to make observations about the signs of winter (particularly about trees that are shedding their leaves). The students are first asked how plants get their nourishment. Then, a problem is posed with the question, "How do trees that shed their leaves get nourishment?"

The second stage involves the students' trying to find an answer to the question resulting from their observation of nature, centering around a laboratory experiment. A tree is chosen from the area of observation and some green, yellow and dried leaves as well as fresh and dry branches are gathered. The tree chosen from the area for the experiment can be seen below (Figure 3). Equal amounts of green, yellow and dry leaves are gathered from the tree (Figure 4) as well as some fresh and dry branches (Figure 5).

Figure 3. The tree chosen for the experiment from the area of observation

Figure 4. Equal amounts of green, yellow and dry leaves gathered from the chosen tree

Figure 5. The fresh and dry branches gathered from the chosen tree

Paper chromatography is undertaken in the laboratory: Equal samples of the green, yellow and dried leaves and of the fresh and dry branches (2g) are extracted from the group and ground in separate mortars with an equal amount of alcohol (25 ml). Long bands of filter paper are dipped into the solution that has formed and left to stand for 15-20 minutes. During this period and at its completion, the pupils are asked to observe the changes in the filter papers and take notes. The setup of the experiment is shown below (Figure 6).

Figure 6. Experiment Set-up

Experiment Results

As time passes, it is seen that the solution from the green leaves turns into yellow, green and orange on the filter paper. The solution from the yellow leaves is observed to exhibit less of a green color compared to the green leaves but more yellow and orange. The solution attained from the dry leaves however shows no color change at all. The filter paper after the chromatography of the green, yellow and dry leaves is shown below (Figure 7).

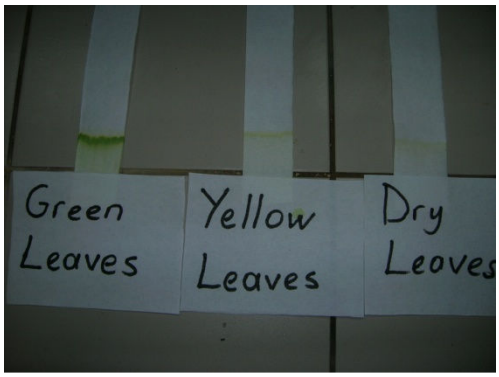

Figure 7. Results of chromatography of green, yellow and dry leaves on filter paper

When the filter paper in the different solutions resulting from the fresh and dry branches are studied, it can be seen that the fresh branches display less of a green color. The dry branches show no color at all. The chromatography of the fresh and dry branches on the filter paper can be seen below (Figure 8).

Figure 8. Results of paper chromatography of fresh and dry branch

What the experiment teaches about photosynthesis

Cold weather and short days affect plants as well. Trees that shed their leaves start going through certain changes. The cells on the leaves attached to their stems begin to die and therefore water and nutrients can no longer

be transported to the tree. Chlorophyll activity in the leaves slows down as the other color pigments become active. This is how the yellow, orange and red leaves that we see in the fall are formed. Due to the dying cells, the stems holding the leaves to the branches weaken and eventually break off, causing the leaf to fall. When its leaves fall off, the tree is less affected by the cold. Because the leaves that carry out photosynthesis have fallen, the tree's metabolism slows down. New leaves appear with the warming of the weather (American Forest Foundation, 2002). We can actually observe this phenomenon that takes place especially in the leaves of plants by studying the changes in the amounts of chlorophyll contained in the leaves.

While students were saying before the activity that chlorophyll was contained only in the green leaves of the plants, at the end of the experiment, they were able to detect the chlorophyll in the tree branches that were of brown tones. This helped them to completely dispel the misconception that trees that shed their leaves do not contain chlorophyll. Thus the students had the opportunity to show, in the environment of the laboratory, how a tree that had shed its leaves could remain alive. The experiment also dispelled the misconception that "photosynthesis takes place in only green plants." This new knowledge meant that photosynthesis takes place when chlorophyll is present; therefore, since the yellow leaves and the fresh branches had chlorophyll in them, they too could undergo photosynthesis.

The question posed by the experiment about how light and chlorophyll interact to cause the physiological changes that plants go through at the changes of season is explained by the answer given to the question, "How do trees that shed their leaves get nourished in the wintertime?" The way that trees shed their leaves in winter is a method of adaptation that ensures that the plants will be less affected by the cold.

Through science education that provides integration with nature, students can enter into a positive relationship with scientific knowledge and find the opportunity to have a meaningful learning experience. This activity on the theme "Winter comes to our campus" can be used to increase students' skills of observation. The project can be used to explain the interaction of light and chlorophyll through observational skills with the support of a laboratory experiment.

The concept of photosynthesis, a subject of biology, has been treated here with an integrated approach that combines geography (the world's axis, natural phenomena), chemistry (the method of separation of molecular structures), physics (the interaction between light and matter) and fine arts (the harmony of colors displayed by plants at the changing of the seasons). In short, the project stimulates students to adopt an integrated perspective on science, providing them with the opportunity to internalize their experiences in nature and in the laboratory, and to incorporate these into their own lives.

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International Electronic Journal of Environmental Education
Vol. 1, Issue 2, January 2011

Doğanın Dilini Kullanarak Fen Öğretimi: Kış Bizim Kampüse Gelir*

Ayşe OĞUZ ÜNVER**
Kemal YÜRÜMEZOĞLU
Songül SEVER

Özet

Doğa ile bütünleşme sağlayan fen eğitimi sayesinde öğrenciler, bilimsel bilgi ile olumlu bir ilişki içine girmek ve anlamlı bir öğrenme deneyimi fırsatı bulabilirler. "kış bizim kampüse gelir" başlıklı bu çalışma gözlem ve deney tekniklerinin beraber kullanılmasıyla yapılmıştır. Biyoloji konusu olan fotosentez kavramı, coğrafya (dünyanın ekseni, doğal olaylar), kimya (moleküler yapıların ayrılması yöntemi), fizik (ışık ve madde arasındaki etkileşim) ve güzel sanatlar (değişen mevsimler ve bitkiler üzerinde görülen renklerin uyumu) birleştiren bütüncül bir yaklaşımla verilmiştir. Bu proje ile öğrencilerin bilime yönelik bütünsel bir bakış açısı kazanması sağlanmıştır.

Anahtar Kelimeler: Işık-klorofil etkileşimi, fotosentez, kromotografi, birleştirilmiş düşünme ve öğrenme, bilimsel gözlem

* Bu çalışma, Tevfik Fikret Eğitim Günleri'nde sunulmuştur.

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ISSN: 2146-0329
www.iejeegreen.com