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Dear Readers,

With this first issue, I am very pleased to announce the launch of the International Electronic Journal of Environmental Education (IEJEE-Green). IEJEE-Green will be published three times a year. The aim of the journal is to provide a thoughtful forum for environmental researchers, practitioners and scholars to further the study and practice of environmental and sustainability education and it provides opportunities to communicate with colleagues, practicing educators and decision makers.

In the first issue of IEJEE-Green, there are three research articles and one example of instructional practices. In the first paper Hongxia Duan and Rosanne Fortner compared Chinese and American college students' environmental education risk perception and their preference in terms of risk communication and educational strategies. The researchers found that Chinese students were more concerned about environmental risk, and they perceived the environmental issues to be more harmful to health, to the environment, and to social economic development of the nation than did the American students. In the second research article Brian J. Plankis and Meghan E. Marrero, focused on environmental and ocean literacy of K12 students. This paper is a valuable contribution to the field, particularly for those researchers who are interested in environmental literacy. Gokhan Bas addressed the effects of Multiple Intelligences instructional strategy on the environmental awareness knowledge and environmental attitude levels of elementary students in science course. In this experimental study, the researcher found Multiple Intelligences as an effective instructional strategy. The last paper is an example of instructional practices from Edmund A. Marek and Chad A. Parker. In their paper the researchers mentioned the importance of safety guidelines and gave an example for application safety guidelines during an investigation. This informative paper will provide insights especially to teachers.

This work would not have been possible without the guidance, support and encouragement of many individuals. I would like to thank first and foremost, with deep appreciation and respect, The Editorial Board of IEJEE-Green. I believe that IEJEE-Green will become more popular and prestigious with the unreserved support from such a prominent team of researchers. Additionally, I would extend my appreciation to the reviewers of this issue. I rely on their expertise for reviewing and accepting papers to the journal. Therefore their contribution to the journal is invaluable and I am grateful for giving freely of their time to review papers for the journal. I hope they will continue their help us in the future. Finally, I wish to thank the authors who submitted papers to the first issue of IEJEE-Green. I am grateful that they responded to our invitation.

I hope that IEJEE-Green will serve the environmental education research well and this journal will be the main vehicle of representing ideas and research work in the area. Any suggestion on how to improve our work in order to deliver a better journal will be always very much appreciated.

Hope to stay in touch and meeting in our next issue, January 2010.

Sibel OZSOY
Editor

September, 2010

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A Cross-Cultural Study on Environmental Risk Perception and Educational Strategies: Implications for Environmental Education in China*

Hongxia DUAN**

Rosanne FORTNER

Abstract
This cross-cultural study examined college students' environmental risk perception and their preference in terms of risk communication and educational strategies in China and the United States. The results indicated that the Chinese respondents were more concerned about environmental risk, and they perceived the environmental issues to be more harmful to health, to the environment, and to social economic development of the nation than did the American respondents. Both groups desired transparent communications in decision processes and would support educational strategies that foster behavior change for reduction of environmental risks. On the basis of the findings, the paper discusses the changes that would potentially improve non-formal and formal environmental education in China from the perspectives of program foci and approaches.

Keywords**:** Environmental change, environmental risk perception, risk communication and education

Introduction

A primary objective of environmental education (EE) is "Awareness—to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems" (UNESCO, 1977). Since modern EE necessarily deals with global risks to environment and people, it is not enough to know how to educate and communicate. Learning how

* The research paper is from the part of the dissertation completed under the supervision of Dr. Fortner: Social Process of Environmental Risk Perception, Preferences of Risk Management and Public Participation in Decision Making: A Cross-Cultural Study between the United States and China.

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people in different cultures compare in their awareness of environmental risks and their perception of effective communication strategies is of benefit to environmental educators as they choose appropriate methodologies. In this study, based on the first author's dissertation research, the fields of risk communication and environmental education combine on a small scale for a 21st Century look at preferred approaches for environmental education and communication in China and the U.S., with implications for improving environmental education in China.

Environmental risks are usually understood as any environmental hazards or processes with potentially negative consequences to human beings and what they value (Böhm & Pfister, 2000). The risks from environmental change can be seen from two perspectives: human activities cause environmental damage, which poses risks to the natural environment, and environmental changes result in negative effects on humans, which pose risks to the human environment. Thus risk analysis needs to address not only physical processes, but also social, economic, cultural, and political views to provide more insights for environmental risk management (Cvetkovich & Earle, 1992; Stahl et al., 2001). In the research field, environmental risks have been analyzed from a social science perspective to explore public concerns, such as how the public responds to and evaluates various technological and environmental risks, how risks are presented and communicated, and how risks are framed in social processes (Krimsky & Golding, 1992; Lai & Tao, 2003; Lazo et al., 2000, McDaniels et al., 1996).

The U.S., the world's biggest economy, and China, the world's biggest emerging economy, both are facing challenges from environmental problems such as climate change related to burning fossil fuel. However, as the two nations are at different development phases and follow different pathways, environmental problems vary not only in the causes and consequences but also in policies and measures to deal with them. As recognized, China's rapid economic growth is the major contributor to the severe environmental conditions, while the U.S.'s problems are mainly caused by the production and consumption patterns associated with high living standards. Theoretically, people in the U.S. and China may interpret and respond to environmental issues and their risks in accordance with each country's historical, sociopolitical and cultural context (Krimsky & Golding, 1992).

This paper presents a cross-cultural study on college students' environmental awareness from the perspectives of environmental risk perception as well as their preference in environmental communication strategies in China and the U.S. The college students will be the leaders of society or decision makers of institutions, and their concerns and opinions about environmental risks are valuable for environmental managers and

educators to recognize, understand, and adjust to the unique culture of a society for effectively addressing and managing environmental change.

Methodology

Approach to the Investigation

This research was designed to explore perceptions of environmental risks between future decision makers in the western and eastern cultures through addressing the two research questions:

- How do American and Chinese college students perceive environmental risks?
- How do American and Chinese college students evaluate environmental risk communication and educational strategies?

Separate studies addressed each question. A printed survey explored Chinese and U.S. college students' perceptions of 34 environmental risk issues, in total and separately for how they represented risks to human health, to the environment, and to the socioeconomic environment of the country. A second study used four scenarios and seven strategies to assess how the same respondents viewed types of risk communication and educational strategies.

I. Risk perception study. Considering the difference between environmental situations in China and the U.S., environmental risk items included in this research mainly focused on general environmental issues to draw a big picture of the relationships of human activities, the environment, the use of natural resources, and social and economic development for the two big countries in the world. Based on the literature relating to environmental risk perception (Lai & Tao, 2003, Lazo et al., 2000; McDaniels et al., 1995; McDaniels et al., 1996; Steg & Sievers, 2000; Willis, 2002), 34 risk items were selected, including a) traditional pollution-based environmental issues from industry, agriculture and daily life in one or both countries (water, air, and soil pollution) as well as hazardous chemicals and nuclear radiation; b) natural disasters or human-induced disasters; c) human activities that directly or indirectly contribute to ecological systems degradation (e.g., cutting forests, over-grazing, over-fishing, loss of wetlands, species extinction, invasive species) and environmental change (damming, urbanization); d) resource shortage risks (e.g., energy shortage, lack of fresh water and safe drinking water, loss of farming lands, and unsafe food); and e) global environmental issues and dynamic processes (global warming, desertification, ozone depletion, human population growth, and biodiversity loss).

Previous research (McDaniels et al., 1995; Lai & Tao, 2003; Slimak & Dietz, 2006) on environmental risks targeted on people's perceptions on "risk to ecosystems" or "threats to the environment." In this research,

respondents were first asked to express their general concern about each of the 34 environmental risk situations by a five-point scale from not concerned to very concerned. Since human-induced environmental risks can be understood from three risk dimensions -- risk to the environment, risk to human health, and risk to social economic development -- a five-point scale from no risk at all to very serious risk was used to reflect perceived risk level with the selected 34 items on each of the three dimensions.

II. Risk communication and educational strategies study. Strategies were addressed using four short stories in which were embedded various risk situations and communication methods:

- the local government dealing with information delivery to the public when a serious disease was spreading;
- decision makers informing the public about a new commercial development plan through public meetings;
- local media increasing the volume of reporting on environmental issues through adding more channels on TV and new columns in the newspaper; and
- the department of food safety communicating of uncertainty of food safety issues pertaining to pesticides.

After reviewing the stories, respondents were asked to indicate the importance or effectiveness of the four strategies in communicating risks with the public. Educational strategies covered seven approaches and respondents were asked to indicate the importance of each approach for public behavior change. Both communication and educational strategies were rated using item-specific five-point scales.

It should be noted that the data presented in this paper was mainly from the Part II and V of the comprehensive questionnaire originally developed in English for the dissertation project. To ensure the equivalence of the questionnaire in English with the translated Chinese version for this cross-cultural study, we employed a back-translation process recommended by Brislin (1986). Two Chinese natives with background in English literature back-translated the questionnaire to examine the equivalence of the English and Chinese versions of the questionnaire developed for the research. In addition, several techniques were employed to test validity and reliability of the questionnaire, including 1) a panel of four experts at The Ohio State University was invited to evaluate the content validity; 2) American and Chinese reviewers assessed the face validation by filling the questionnaires for both the English and Chinese versions; and 3) The English questionnaire was field tested with 47 American graduates and undergraduates. Values for Cronbach's alpha for each of the four risk

perception indicators (general risk concerns, risk to the environment, risk to social economy, and risk to human health) were calculated with the 34 risk items and all alphas were greater than .90. The alpha value for the seven educational items was .767.

Sample and Data Collection

To conduct a valid cross-cultural study, participants from different cultural groups should be similar in their background characteristics (Leung et al., 1996). Following the rule, this research selected college students from the Ohio State University (OSU) in the U.S. and the Beijing Normal University (BNU) in China to ensure the similarities of the two samples in their academic fields and education backgrounds.

The data collection in the Beijing Normal University was carried out in December 2004 and a total of 280 useable questionnaires were obtained. Volunteers were recruited to distribute the questionnaires door-to-door to students' dorms on campus, and those who received the questionnaires were given a week to return their answers. The majority (77.5%) of the Chinese students were undergraduates, while a small portion (21.8%) was in a master's program. More than 90% of the Chinese participants were aged 17 to 24, fewer than 6% were members of environmental organizations, and 65% of them were female. Nearly 60% of the participants were from cities or central cities, and they represented 26 of the 34 provinces and special administrative regions of the country. Although the participants came from various academic backgrounds, a majority (75.3%) majored in economics-related subjects such as accounting, economics, electronic business, finance, and international business.

American data collection was conducted at the Ohio State University, Columbus campus, during the spring quarter of 2005. Students enrolled in the Business Administration 555 class, Introduction to International Business, were participants of the research. A total of 240 valid questionnaires were used for data analysis. All 240 American respondents were undergraduate students, 98% of them aged 17 to 25; only 3% of the Americans were members of environmental organizations, and 65% were male. The majority (90%) of the respondents were from Ohio, with the remainder representing the states of California, West Virginia, Pennsylvania, Florida, Illinois, and Texas. Nearly 90% of the participants were from rural or suburban areas. Most of the American participants (85.3%) majored in economics-related fields such as business, marketing, international business, finance, insurance and management science, e.g., human resources and information system management.

In summary, this research applied the approach of cross-cultural comparison to investigate the Chinese and the American college students' perspectives on environmental risks and the strategies used for

environmental risk communication and education. Valid information was gathered with less than 300 participants in each country, limited to college students on the two campuses. Considering the total populations in the U.S. and China, the convenient samples were not representative, therefore the results presented in this study should be interpreted very carefully as they may not be generalized to the American and the Chinese population.

Results

I. Perceived Risks of the Environmental Issues

Overall perceptions of risks. The results indicate that the American and Chinese students differed in their overall concerns about the environmental risks. A comparison revealed that the Chinese scored higher for the 33 risk items than did the Americans, and 24 out of the 33 mean differences were statistically significant at the confidence level of 99%. The results indicated that the Chinese respondents were more concerned about the environmental risks than were Americans.

The Chinese students were concerned about human population growth the most (M = 3.867, SD = 0.988), followed by fresh water shortage, safe drinking water shortage, species extinction, sandstorms, cutting of forests, energy shortage, and global warming. The Chinese was least concerned about the risk of livestock waste (M = 2.422, SD = 1.071), followed by over-fishing and soil erosion. Further analysis found Chinese males were concerned about species extinction the most (M = 3.8, SD = 1.1), followed by freshwater shortage, cutting of forests, population growth, and safe drinking water shortage, while Chinese females were concerned about population growth the most (M = 3.944, SD = 0.937), followed by safe drinking water and freshwater shortages. A rating of 5.0 would represent the highest concern. An independent t-test revealed that only two (loss of biodiversity and population growth) of the 34 means were ranked significantly higher by Chinese females than males ($p < .05$). This indicates that data for Chinese student respondents can generally be interpreted without regard to gender.

In contrast, the American students thought hazardous chemical waste was the most risky (M = 3.54, SD = 1.120) over the 34 risk items, followed by species extinction, safe drinking water shortage, nuclear radiation, cutting of forests, freshwater shortage, ozone depletion, and energy shortage. Americans were least concerned about sandstorms (M = 1.933, SD = 1.108), followed by landslides and overgrazing. American female students were concerned about safe drinking water shortage the most (M = 3.71, SD = 1.07), followed by species extinction, energy shortage and hazardous chemical waste. American male students were most concerned about hazardous chemical waste (M = 3.5, SD = 1.14), followed by species extinction, cutting of forests and safe drinking water shortage. Comparing

males and females in American culture, the result showed the mean differences for risks of automobile emissions, drought, safe drinking water, energy shortage, safe food shortage, global warming and biodiversity were significantly higher for female than male respondents ($p <$. 05).

Risk to human health. On the dimension of risk to human health**,** the means of the 34 risk items for the Chinese students were all significantly higher than that of the American students (at least $p < .05$), which suggested that the Chinese saw themselves at considerably more risk from environmental harms than did the Americans. As shown in Table 1, the means of the 34 risk items for the Chinese ranged from 2.689 to 4.197. Risk from hazardous chemicals was ranked as the most harmful issue to human health, followed by nuclear radiation, safe drinking water and freshwater shortages, and the risk of livestock waste was thought to be least harmful to human health. The means of the 34 risk items for Chinese males ranged from 2.621 to 4.101, and safe drinking water shortage was ranked as the most harmful risk to human health, followed by hazardous chemical waste, freshwater shortage, nuclear radiation and population growth. For the female group, nuclear radiation was ranked as the most harmful risk (M = 4.16, SD = 1.05), followed by safe drinking water and freshwater shortages and hazardous chemical waste. Comparing the two Chinese student groups, males gained significantly higher scores for the risk of fossil fuels to human health than did females. Chinese females perceived global warming, desertification, ozone depletion and biodiversity ($p < .05$) significantly more risky to health than did males. There were no significant differences between the two gender groups for other risk items to human health.

In contrast, the means of the 34 risk items for the Americans ranged from 2.071 to 3.550. Like the Chinese students, American students perceived hazardous chemicals as the highest risk to human health (M = 3.550, SD = 1.091), followed by safe drinking water shortages, nuclear radiation, and automobile emissions. The American respondents rated risk from damming of rivers as the least risky issue to human health. Both males and females rated hazardous chemical waste (males M = 3.483, SD = 1.106; females (M = 3.671, SD = 1.09), as the most harmful risk to human health. For males this issue was followed by freshwater shortage, nuclear radiation, safe drinking water and energy shortages. For females the next greatest health risks were safe drinking water shortage, freshwater shortage, and nuclear radiation. An independent t-test found that American females ranked 15 of the 34 items higher than males, especially for the risks of global environmental change, natural resources shortage and natural disaster risks.

Risk to the environment. On the dimension of risk to the environment, 28 means of the 34 risk items for the Chinese students were statistically

higher than that of the Americans (at least $p < .05$). As indicated in Table 1, the means of the 34 risk issues to the environment ranged from 2.888 to 4.166 for Chinese respondents. Nuclear radiation was ranked by the Chinese as the riskiest issue to the environment, followed by hazardous chemical waste, population growth, cutting of forests, species extinction, and ozone depletion. The Chinese considered livestock waste as the least harmful risk to the environment. While males agreed on hazardous waste and females agreed on nuclear radiation the greatest risks to the environment, females rated 9 of the 34 risks significantly higher than the males ($p < .05$), including landslide, over-fishing, overgrazing, natural resources shortage (freshwater, safe drinking water and farming land), and global environmental change (desertification, ozone depletion and losses of biodiversity).

Unlike the Chinese respondents, the American students perceived risks to the environment from the selected issues differently. Table 1 showed that the means for the Americans on the dimension of risk to the environment ranged from 2.424 to 3.786, with hazardous chemical waste the most harmful risk, followed by cutting of forests, global warming, ozone depletion, and nuclear radiation. The issue of sandstorms was perceived by the American respondents as the least harmful risk, followed by damming of rivers and livestock waste. American females ranked ozone depletion ($M = 3.952$, $SD = 1.016$) and global warming ($M = 3.95$, $SD = 1.018$) as the riskiest issues to the environment, followed by hazardous chemical waste, automobile emissions, population growth, and nuclear radiation. By gender, males perceived hazardous chemical waste as the riskiest issue to the environment ($M = 3.716$, $SD = 1.023$), followed by cutting of forests, global warming, population growth and ozone depletion. American females rated 17 of the 34 risk items significantly higher than the male ($p < .05$), mainly focusing on natural disasters, natural resources shortage, ecological degradation and global environmental issues.

Risk to socioeconomic development. On the dimension of risk to socioeconomic development, for each risk item, the mean for the Chinese students was higher than that of the American students, and the mean differences were all statistically significant between the two cultural groups (most at $p < .000$ level). The result indicates that the Chinese considered the environmental issues more harmful to economic development in China than the Americans perceived them harmful to economic development in America.

Chinese respondents identified energy shortage as the riskiest issue to China's economic development (Table 1), followed by population growth, freshwater shortage, safe drinking water shortage, nuclear radiation, and hazardous chemicals. Livestock waste was seen as the least risky issue to China's economic development, followed by solid waste, soil erosion, and

burning fossil fuel. Chinese male students perceived safe drinking water (M = 3.764, SD = .9656) and freshwater shortages (M = 3.754, SD = .9883) as the riskiest issues to China's economic development, followed by energy shortage, safe food shortage and population growth. In this case, it was Chinese female students' perception of energy shortage (M = 4.000, SD = .923) and population growth (M = 3.959, SD = .9381) as the riskiest issues to China's economic development that determined the relative national ratings of the issues. Females ranked 6 of the 34 risk items significantly higher than males, notably burning fossil fuel, waste water, solid waste, wildfire, sandstorms and population growth.

In the American sample both male and female students perceived energy shortage as the riskiest issue to American economic development, and they agreed that safe drinking water shortage and safe food supply were among the top issues. Males included nuclear radiation and chemical waste in their top list as well. The American respondents thought that sandstorms were the least risky issue to American economic development, followed by livestock waste. Only the perception of global warming was significantly higher for the American females than males ($p < .05$), and the remaining 33 risks were not statistically different between female and male perceptions.

II. Preferences of Risk Communication and Education Strategies

In addition to the differences in perception of the various environmental risks, this research also examined how responding individuals in the two cultures felt about the ways risks are communicated and what educational strategies are preferable to them. Each of the scenarios portrayed decision situations, risk topics and communication strategies used by the authorities to inform the public. Table 2 displays mean responses to the four scenarios for the two cultural groups.

In one scenario, a serious disease was spreading among the public. Most Chinese (70%) and American (78%) respondents believed that it was very effective to tell the public the truth about the disease situations, instead of covering up the truth. The mean on this strategy for the American students was significantly higher ($p < .000$) than that of the Chinese students.

On an issue related to development, respondents were asked to judge the importance of the communication method used by the decision makers. Slightly more Chinese (65%) than the Americans (57%) considered the public meeting process as very effective to communicate with the public, compared to informing decisions by official documents and orders. The mean on public meetings for the Chinese was slightly higher than that of the American respondents, but not statistically significant.

The third scenario was about increasing the amount of environmental issue reporting through the mass media such as TV and newspaper. Most Chinese students (80.4%) considered the approach effective for communicating environmental issues with the public, while fewer American students (68.5%) held the view that increasing mass media coverage was effective. The mean on increasing mass media for the Chinese was significantly higher than that for the American respondents ($p < .01$).

Another situation dealt with the extent to which the public should be informed about the uncertainties regarding a food safety issue, including factors such as: the government was not sure if the food had a problem or not, scientists disagreed with each other on the uncertainty issue, what scientists were doing to collect more information.

Half of the Chinese respondents and 58% of the Americans believed that informing consumers about the uncertainties was very effective to help them decide whether to use the food or not. For the American respondents the mean on informing about uncertainties was significantly higher than that of the Chinese ($p < .000$).

Table 1. Chinese versus American college students' perception of environmental risks

Risk Perception	Risk to human health		Risk to the environment		Risk to economic development	
Risk Items	China (*N*=259)	U.S. (*N*=224)	China (*N*=259)	U.S. (*N*=224)	China (*N*=259)	U.S. (*N*=224)
	M/SD	*M/SD*	*M/SD*	*M/SD*	*M/SD*	*M/SD*
Fossil fuel burning	3.407/.760	2.978/.930	3.571/.866	3.433/1.000	3.148/.907	2.964/1.028
Automobile emission	3.439/.760	3.228/.912	3.508/.833	3.576/.925	3.251/.882	3.054/1.027
Wastewater	3.359/.772	3.027/.961	3.426/.767	3.196/.974	3.190/.877	2.853/.989
Solid waste	3.035/.826	2.821/.935	3.243/.889	3.129/.911	2.930/.848	2.754/1.032
Soil erosion	3.297/.840	2.390/.989	3.432/.897	3.040/1.017	3.113/.976	2.634/1.020
Livestock waste	2.689/1.002	2.375/.967	2.888/1.003	2.758/1.059	2.748/1.052	2.429/.982
Heavy metal	3.842/.937	2.973/1.013	3.903/.879	3.366/1.071	3.475/.982	2.914/1.058
Pesticides	3.436/.884	3.094/1.022	3.581/.918	3.344/.958	3.185/.930	2.848/1.077
Fertilizer	3.324/.908	2.753/1.008	3.512/.963	3.067/1.016	3.178/.964	2.710/1.042
Nuclear radiation	4.085/1.088	3.411/1.168	**4.166/.960**	3.647/1.082	3.700/1.176	3.116/1.150
Hazardous chemicals	**4.197/2.621**	**3.550/1.091**	4.042/.953	**3.786/1.014**	3.743/1.052	3.149/1.075
Flooding	3.663/.925	2.808/1.043	3.405/1.016	2.893/1.032	3.649/.971	2.892/1.118
Drought	3.529/.908	2.625/1.114	3.274/.960	2.830/1.054	3.610/.960	2.741/1.150
Wildfires	3.490/.899	2.638/1.092	3.552/.924	2.924/1.075	3.578/.984	2.701/1.126
Landslides	3.309/.975	2.484/1.065	3.124/.961	2.750/1.080	3.233/.986	2.540/1.083
Sandstorm	3.556/.906	2.121/1.088	3.471/.912	2.424/1.114	3.483/.970	2.223/1.165
Damming	3.054/1.119	2.071/.860	3.162/1.070	2.598/1.011	3.170/1.076	2.290/0.894
Over-fishing	3.015/.889	2.183/.965	3.363/.898	2.960/1.021	3.151/.917	2.531/1.006

(Table continues)

Table 1. (Continued)

Over-grazing	3.225/.844	2.201/.956	3.469/.833	2.924/1.032	3.287/.897	2.543/1.030
Cutting of forests	3.884/.882	2.871/1.014	4.000/0.867	3.731/.939	3.595/.973	2.883/1.016
Urbanization	3.124/.907	2.942/1.029	3.479/.869	3.491/.952	3.205/1.035	2.960/1.149
Loss of wetlands	3.421/.905	2.513/1.024	3.649/.921	3.348/1.035	3.228/.951	2.480/1.039
Species extinction	3.776/.998	2.616/1.130	3.973/.901	3.576/1.085	3.456/1.097	2.491/1.124
Invasive species	3.430/.944	2.621/1.150	3.500/.987	3.308/1.128	3.178/1.032	2.550/1.115
Freshwater shortage	4.023/.885	3.197/1.097	3.903/.918	3.419/1.047	3.810/.908	3.098/1.140
Safe drinking water	4.073/.901	3.366/1.164	3.730/.946	3.304/1.123	3.780/.920	3.214/1.140
Energy shortage	3.873/.921	3.170/1.155	3.717/.959	2.924/1.186	**3.911/.980**	**3.563/1.131**
Loss of farming lands	3.699/.864	2.853/1.068	3.486/.933	3.108/1.073	3.636/.950	3.072/1.113
No enough safe food	3.822/.898	3.063/1.273	3.583/.994	3.094/1.154	3.624/.987	3.152/1.192
Global warming	3.713/.923	3.131/1.106	3.864/.911	3.735/1.025	3.537/.977	2.938/1.166
Desertification	3.757/.935	2.360/1.045	3.857/.871	3.076/1.102	3.502/.962	2.441/1.119
Ozone depletion	3.873/.908	3.148/1.127	3.946/.892	3.705/1.017	3.550/1.040	2.762/1.140
Biodiversity loss	3.583/.946	2.576/1.077	3.896/.928	3.344/1.089	3.475/1.050	2.540/1.066
Population growth	3.919/.967	2.978/1.169	4.019/.942	3.674/1.119	3.873/1.005	3.004/1.222

Table 2. Chinese versus American college students' preferences of risk communication and education strategies

	China (N = 259)		US (N = 224)	
Communication Strategy	*M*	*SD*	*M*	*SD*
Telling the truth about a spreading disease	*3.873	1.032	*4.188	.909
Public meeting to inform a development decision	3.753	1.008	3.632	.885
Increasing mass media reports on issues	*3.124	.797	*2.857	1.023
Informing of relevant uncertainties in food safety	*3.416	.957	*3.716	.854
Education Approaches				
Emphasis on individual's responsibility	*3.737	1.012	*3.473	.903
Teaching decision making	*3.213	.989	*3.420	.999
Knowledge of human-induced environmental issues	3.616	.871	3.673	.898
Encouraging participation in risk management	3.564	.983	3.478	.903
Actions on risk mitigation	3.702	.895	3.781	.848
Protection themselves from harmful risk	*4.066	.919	*3.583	.945
Adaptation to the changing environment	*3.602	.981	*3.371	.962

* Significantly different (p < .01)

Respondents evaluated environmental education approaches for their importance in changing people's behavior to reduce risks. The frequencies calculated were:

- 61% of the Chinese and 60% of the American students thought the emphasis on individuals' responsibility for the environment was very important

- fewer Chinese (41%) than American students (50%) considered teaching people how to make decisions to be very important
- 57% of the Chinese and 61% of the American students considered providing detailed information about human-induced environmental risks as very important
- 59% of the Chinese and 51% of American students indicated encouraging public participation in the decision process was very important
- nearly 60% of the Chinese students and 66% of the Americans believed giving information on how to act to reduce environmental risks was very important
- more of the Chinese students (73%) than the Americans (55%) rated teaching people how to protect themselves in risky events as very important
- more of the Chinese students (43%) than the Americans (34%) reported showing people how to adapt to the changing environment was very important.

An independent sample t-test was performed to compare the means of the two groups for the seven educational approaches (Table 2). The American students assigned greater importance than the Chinese for approaches such as teaching decision making, knowledge of human induced environmental issues, and taking action to mitigate risk, but only the mean difference of decision making was significant ($p < .05$) between the two groups. The means of environmental responsibility, protecting themselves, and adaptation to environmental change were significantly higher for the Chinese than for the American students ($p < .05$).

Discussion

The research found that the samples of American and the Chinese college students showed similarities and differences in the top ranked risks regarding overall concerns and the three risk dimensions assessed in this research. The survey did not request information about whether respondents had experience with the issues, an addition that should be considered in future research. It requested information about the risk in the students' own country. The Chinese college students were most concerned about population growth and they considered nuclear radiation the most harmful issue to the environment, hazardous chemical waste the greatest risk to human health, and energy shortage the riskiest issue to China's socioeconomic development. The American college students were not only most concerned about hazardous chemical waste, but also ranked it the most harmful issue to the environment and to human health. Like

the Chinese, the American students considered energy shortage the riskiest issue to the nation's socioeconomic development.

Using a public sample, Zhang (1994) focused on 20 environmental hazard situations in China and found the Chinese public perceived earthquakes, floods, water pollution, air pollution, soil erosion, and water loss issues as the highest dangers. This research updates that study and adds concerns that are more global in nature. Lai and Tao (2003) reported that Hong Kong Chinese ranked pollution from cars as the greatest threat to the local environment and radioactive fallout as the greatest threat to the global environment. From this study, the college students' environmental concerns may demonstrate that people's views change over time but differences from 1994 may also be due to the students viewing the risks from dimensions of human health, environment, and socioeconomic development. Modern perspectives may have alerted the respondents to different ways of looking at the issues.

The results from the American students were also different from other sample groups. For example, based on the awareness of the consequences of risks, Slimak and Dietz (2006) found that lay people ranked hazardous waste as the overall most important risk, and an experienced public (stakeholders participating in U.S. EPA's global change regional assessments) ranked population growth and global warming as the most important risk issues. Lazo et al. (2000) reported that lay people ranked depletion of the ozone layer as the largest overall risk to ecosystems, while experts ranked loss of plant and animal species as the largest overall risk to ecosystems. Samples from Canada showed lay people ranked acid rain as the greatest overall risk to ecosystems, and experts ranked population growth as the riskiest to ecosystems (McDaniels et al., 1996). The choice of greatest risk in these studies also reveals that the salience of issues changes over time, and likely changes more quickly in informed audiences.

Overall, results revealed that the sample of Chinese students perceived the environmental risks to be more harmful to human health, to the environment, and to economic development than did the American sample. Rohrmann and Chen (1999) found a similar risk perception pattern in their study between the Australians and the Chinese, and the result revealed the Chinese had a significant lower risk acceptance (or tolerance) for all hazards than the Australians. The findings of the current research were also in agreement with previous studies (Dunlap, 1994; Sokolowska & Tyszka, 1995) that people in developing countries were more sensitive to dangers caused by technology and environmental risks than people in developed countries. The differences in risk perceptions between the Americans and the Chinese may be related to the different environmental conditions and social situations within the two countries. Living in the most populous country in the world, the Chinese are facing higher

pressures from resource availability and environmental and ecosystems degradation, and they became more concerned about the environmental issues. For example, air pollution, water pollution, drinking water safety and shortage, and emissions from fossil fuel burning have been always listed as severe environmental problems in China by environmental reports. According to Sokolowska and Tyszka (1995), economic factors impact the level of people's tolerance for risks. The different economic wealth between China and the U.S. could contribute to the variety of risk perceptions on environmental issues among the students. Most likely, social vulnerability may be the appropriate factor in explaining differences of risk perception between the developed country and the developing country. People in less developed areas feel less security since their socio-economic circumstances place them in vulnerable living situations in terms of economic wealth and environmental conditions. On the other hand, many developed countries have strong response capacities to deal with disasters and the inherent relief actions needed (UNU-EHS, 2005). The findings of this research would suggest that in understanding social processes of risks, we need to consider the socioeconomic and cultural contexts within which risks are framed and debated (Lai & Tao, 2003).

Since the samples were unavoidably skewed, with more females in the Chinese student group and more males in the U.S. sample, we examined responses by gender. Although the Chinese females and males did not show significant difference in their overall risk perceptions (only two means different), females perceived some of the risks more harmful to the three risk dimensions than did males, notably risks from global environmental change, resource shortages and natural disasters. The American did not show gender difference in risk perception to socioeconomic development, but females were more concerned about the overall risks and they perceived some of the risks more harmful to the other two risk dimensions than did males, typically the risks from global environmental change, resources shortages, natural disasters and ecological degradation. Generally, the research found that females in the American and Chinese groups perceived the risks to be higher to human health and to the environment than did males. Lai and Tao (2003) conducted a study on Hong Kong Chinese rating the levels of threat of 25 environmental hazards, and they found that women perceived the hazards to be more threatening to the environment than did men. Slovic (1997) reported that men tended to judge risks to be less problematic than women. However, a recent study by Slimak and Dietz (2006) found that gender had no influence on people's risk perception. The present research is inadequate for making generalizations about gender response other than those noted.

The findings that the American and the Chinese college students supported the four communication strategies indicate the informed public

in both cultures wants to know even more about environmental risks and desires transparent and democratic risk communication strategies. Regarding the situations such as disease spreading and uncertainty relating to food security, more American respondents supported the strategies in which the government fully informed the public with the truth and uncertainties than did the Chinese. The differences in support for communication strategies may reflect the reality of the risk communication situation in America and China.

The research also found that more Chinese than American college students thought the increased coverage in mass media would improve their understanding of environmental issues. Based on the primary author's experience, traditional mass media such as TV, newspapers and radio are still the primary resources for most of the Chinese public to obtain environmental knowledge and information. Although the 2001 Green Gauge report (Coyle, 2004) found that most American adults relied mainly on traditional media sources to satisfy their environmental information needs, young American college students might rely on different information sources.

Compared with the American respondents, the Chinese college students considered teaching decision-making to be less important. Traditionally, Chinese people think of decision-making as the responsibility of authorities and leaders rather than the general public. The significant higher level for the Chinese than the Americans in responding to environmental responsibility, protecting themselves, and adaptation to environmental change reflects the real environmental education situation in China. In formal EE, a knowledge-focused infusion approach is widely used in schools across the country and there is no special section for EE activities. In class, most often teachers utilize relevant environmental events and statistics from various sources as an easy method to infuse environmental knowledge, and students are supposed to realize the true environmental situations. Teachers are seldom trained on how to develop EE activities in accordance with the curriculum plan and how to instruct students to learn by doing. Some fundamental EE principles and effective approaches employed in the US can't find a niche in China under the exam-oriented educational system.

Implications for Environmental Education in China

This comparative study between the US and China was designed to explore college students' environmental awareness and beliefs from the views of environmental risks and their perspectives on successfully environmental education and communication strategies. The findings provided by the students' samples are meaningful for the field of environmental education

and they would have implications for improving China's environmental education in several ways.

First of all, the higher environmental risk awareness for the Chinese group than that of the American group would imply that it is reasonable for EE in China to include environmental risks in the curriculum contents, such as the emerging climate-related risks and disasters, which could be discussed under a big umbrella of environmental issues. Furthermore, the findings may also suggest that for both non-formal and formal EE programs (at different levels) developed in the future, the focus would be on how individuals get involved in the problems and what they can contribute to the solutions rather than knowledge aspects such as what the problems are. At least three more important dimensions and topic areas should be covered from different environmental topics and perspectives: a) how to mitigate or eliminate the negative impacts and risks of the environmental issues; b) how to adapt to unavoidable risk situations to minimize the risk damages; and c) how to improve individuals' and society's adaptive capacity by reducing vulnerabilities to the environmental risks.

Secondly, from the students' different preferences in communication strategies, the study also gives some hints for improving the public's environmental awareness though non-formal EE activities. Even for college students who have access to modern information sources such as the Internet, they still feel that the traditional mass media are efficient information sources for the public to receive environmental knowledge, which would imply that the role of traditional mass media in EE should not be underestimated in the hi-tech dominated information era in China. Unlike the US, the most important and influential mass media are TV channels, newspapers and radio, all of which are under the central government control. Under such circumstances, a national EE program based on the mass media would be more operational, effective, and successful than any other means. For example, every night China's Central Television, the most reliable information source for the general public, broadcasts news program across the country at 7 pm in conjunction with major local TV channels. It is estimated that more than 0.3 billion people watch the program every day. If an educational program could use this most powerful information source to deliver only 2-3 minutes related to topics calling for the general public to support China's environmental improvement, no doubt the public would pay much attention to the information. They believe the messages signal the central government's priority in addressing these issues. Most likely the public would take part in the activities sooner or later, since they would be perceived as government expectations.

Thirdly, the significant differences between the American and Chinese students in responding to the specific educational strategies would have

implications for improving educational approaches in China. Researchers (Arvai et al., 2004) have pointed out that teaching decision theory and skills is essential to helping individuals become better decision makers and deal with complex environmental issues. The findings of this research imply that decision-making as an important topic has long been ignored by the Chinese environmental education field. There is a need for environmental education programs and curricula to shift toward a more practical approach from a knowledge-focused approach. Young students and adults should be educated in making decisions to choose an environmental friendly lifestyle, to take responsibilities for society and the environment, rather than just being told the environment is getting worse. To fulfill this objective, the development of EE programs would consider how to use the real situations to let the audiences touch the issues related to their daily life and get them involved in environmental managing processes. To this end, audiences would understand the problems in a more tangible and visible way, and they would acknowledge that most environmental risks are controllable and avoidable if proper actions are taken individually and collectively.

Finally, China may also need to learn some good practices from the US. To promote environmental education, the US government enacted the National Environmental Education Act in 1990, which establishes and supports educational programs to improve awareness of environmental problems, encourages students to pursue careers related to the environment, sets up training programs to build capacity, and creates a foundation to develop and operate programs and projects to educate environmental professionals. As a result, the US has more advanced EE programs, diverse teaching materials, and practical EE curriculum, compared with China and other countries. What the Chinese decision-makers would gain is that EE in China should be integrated into the national environmental protection programs and development policies to make the 1.3 billion Chinese to be part of the solutions to environmental problems. For the most populous country in the world, changing people's consumption model and environmental behavior is more cost-effective than investing in environmental technologies, cleaning up the polluted rivers and lakes, and recovering the damaged ecosystems.

Conclusion

It should be noted that the results reported in this research related to the convenient college samples in the US and China could be biased in terms of representation of the population in the two nations, as research has provided evidence that there is a difference of risk perception between people with higher and lower educational level (Slovic, 1997). On the basis of the results from the well-educated groups within the two cultures, the research concludes that the differences in environmental conditions, social

situations and economic development across cultures could contribute to the variety of risk perceptions to the environment issues, and individuals' views on the environmental issues would change over time. Regardless of differences in culture and the reality of risk communication situations, people would desire transparent communications in decision processes and would support educational strategies that foster behavior change for reduction of environmental risks.

♦ ♦ ♦

Biographical statements

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Çevresel Risk Algılama ve Eğitim Stratejileri Üzerine Kültürlerarası Bir Çalışma: Çin'de Çevre Eğitiminin Etkileri*

Hongxia DUAN**

Rosanne FORTNER

Özet

Bu kültürlerarası çalışmada, Çin ve Amerika Birleşik Devletleri'ndeki üniversite öğrencilerinin çevresel risk algısı, risk iletişiminde tercih ettikleri terimler ve eğitim stratejilerini incelenmiştir. Elde edilen sonuçlara göre Çinli katılımcılar, Amerikalı katılımcılara göre çevresel risk konusunda daha ilgili oldukları ayrıca çevresel konuların sağlık, çevre ve ülkenin sosyo-ekonomik gelişimi konusunda olumsuz sonuçlara yol açma konusunda daha fazla endişe duydukları anlaşılmıştır. Her iki grupta karar alma sürecinde açık bir iletişim ve çevresel risklerin azaltılmasına yönelik yapılan girişimci davranışlara yol açacak eğitim stratejilerinin desteklenmesini istemiştir. Bulgulara dayanarak programın odakları ve yaklaşımları Çin'de yaygınlaşan çevre eğitimine yönelik örgün ve yaygın eğitimin gelişmesi ile açıklanmaktadır.

Anahtar Kelimeler: Çevresel değişim, çevresel risk algısı, risk iletişimi ve eğitim

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Recent Ocean Literacy Research in United States Public Schools: Results and Implications

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Abstract
Recent research conducted on adults in the United States indicates low ocean literacy (Ocean Project, 2009b, 1999), but there is a dearth of peer-reviewed research on K-12 students' ocean literacy. This paper presents two research studies that examined the ocean and environmental literacy of 464 K-12 students in five states. Like the majority of American adults, most of the student participants in these studies had low initial levels of ocean literacy. Both of these studies, while conducted with different populations of students, suggest that engagement in an ocean literacy-focused program may lead to higher ocean literacy and increased responsible environmental behaviors that help the ocean. The encouraging results of these studies, and their implications, are discussed in relation to the ocean literacy and environmental education communities and the critical need for further large scale and longitudinal empirical studies to support increased significance of ocean literacy in the United States.

***Keywords*:** Ocean literacy, K-12 environmental education, responsible environmental behaviors

Introduction

The catastrophic Gulf of Mexico oil spill has certainly brought the health of the ocean to the forefront of the minds of some United States citizens, policymakers, and media members. Unfortunately, most Americans probably do not fully understand the issues surrounding the event, due to poor understanding of the ocean, its characteristics and processes, and the interdependency of the ocean and humanity. In other words, public ocean literacy in the United States of America is poor and is likely to impact the public's understanding of the consequences of the oil spill.

Ocean literacy, defined as "an understanding of the ocean's influence on you, and your influence on the ocean," (National Geographic Society, 2006)

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is a relatively new term coined by a group of dedicated formal and informal educators, scientists, government professionals, and others interested in promoting ocean sciences education. Beginning in about 2004, many individuals from across the USA and beyond have convened, both in person and virtually to discuss the ideas related to the ocean with which all citizens should be familiar. The team, supported by organizations including the National Marine Educators Association (NMEA), the National Oceanic and Atmospheric Administration (NOAA), the National Geographic Society, the Centers for Ocean Sciences Education Excellence (COSEE) and others, worked to develop a framework of the *Essential Principles* and *Fundamental Concepts of Ocean Sciences.* Seven *Essential Principles* (Table1) overarch 45 *Fundamental Concepts*, representing the major ideas that high school graduates should know and understand about the ocean and its significance in the earth system. Since the initial *Principles* and *Concepts* were developed, the team has continued work to create a scope and sequence, delineating the ideas and connections that students at the K-4, 5-8, and 9-12 levels should know and make (Schoedinger, Tran, & Whitley, 2010; Strang, DeCharon, & Schoedinger, 2007).

Table 1. The seven essential principles of ocean sciences*

1.	*The Earth has one big ocean with many features.*
2.	*The ocean and life in the ocean shape the features of the Earth.*
3.	*The ocean is a major influence on weather and climate.*
4.	*The ocean makes Earth habitable.*
5.	*The ocean supports a great diversity of life and ecosystems.*
6.	*The ocean and humans are inextricably interconnected.*
7.	*The ocean is largely unexplored.*

* Defined by the Ocean Literacy Network (2008).

Ocean Literacy in the United States

Previous large survey efforts have shown that ocean literacy is low in the United States and that the health of the ocean is a low priority for most Americans (Ocean Project, 1999; Steel, Smith, Opsommer, Curiel, & Warner-Steel, 2005). The most recent national study on ocean literacy shows these trends continuing, "not much progress has been made in the last 10 years in increasing either the literacy of the American public about the ocean or awareness and concern about the environmental issues threatening the future of a healthy, life-sustaining ocean" (Ocean Project, 2009a, p. 2). The study shows that Americans continue to be more literate in entertainment pursuits than the ocean:

> Specific knowledge of ocean issues remains negligible. Of the sampled respondents, 35% cannot identify a single ocean-related issue affecting the

> United States. Compared to similar recent research, the American public possesses significantly greater literacy about topics such as college football, the Academy Awards, luxury automobiles, casino gambling, and video games than it does the ocean (Ocean Project, 2009c, p. 3).

Overall, ocean literacy is low, especially among adults, and "Americans are generally unable to articulate valid reasons explaining the importance of the ocean beyond simple declarations such as, 'We can't live without water' and 'We need fish to survive' (Ocean Project, 2009c, p. 3). The low ocean literacy and low level of concern from the American public about the future of the ocean stands in stark contrast to the high level of concern among scientists about the survival of the ocean's inhabitants and its ecosystems. The peer-reviewed literature contains a diverse assemblage of articles that document the potential collapse of all major commercial fisheries by 2048 (Worm et al., 2006), destruction of the majority of coral reefs by 2050 (O. Hoegh-Guldberg et al., 2007) and the collapse of most coastal ecosystems that has already occurred around the world (Jackson et al., 2001).

One of the most troubling disconnects of the American public is the lack of understanding about the connection between climate change, carbon pollution, and the ocean. "Climate change is the environmental issue of most concern to the public. However, the public does not associate climate change and carbon pollution with ocean health" (Ocean Project, 2009b). Yet, scientists have clearly established several direct connections between carbon pollution and ocean health that have already occurred, including a lowered oceanic pH, decreased ocean productivity, altered food web dynamics, reduced abundance of habitat-forming species, shifting species distributions, and a greater incidence of disease (Hoegh-Guldberg & Bruno, 2010). Partly in response to the overwhelming scientific research that the oceans are not being adequately protected, the USA constituted the Interagency Ocean Policy Task Force charged with developing an ecosystem based National Ocean Policy (NOP) in June, 2009 (Lubchenco & Sutley, 2010). On July 19th, 2010, President Obama signed an executive order to implement the NOP (White House, 2010). An ocean literate public will improve the chances that the long-term aspects of the NOP will succeed.

An encouraging finding in the 2009 Ocean Project survey is that young people are more informed about environmental issues and more concerned about climate change. Unfortunately, ocean science topics are typically minimized or ignored in the K-12 classroom (Lambert, 2001; Walker, Coble, & Larkin, 2000). A major obstacle is that in today's educational culture of accountability, teachers are pressed to find time to teach topics that are not in the standards, and therefore to not appear on state assessments. A 2007 study examined state standards across the USA, with respect to the 35 Ocean Literacy *Fundamental Concepts* related to the earth sciences. The study revealed that 10 states address fewer than five *Concepts*, and no

state included more than 20 (Hoffman & Barstow, 2007). If the public is going to be convinced that ocean health is a critical issue, then policies will need to be implemented that raises the priority of ocean literacy in the K-12 system in the USA and around the world. Critical pieces of information that will be needed to shape any future policy include understanding students' ocean literacy, science literacy, scientific misconceptions, and approaches that work to develop their ocean literacy, engagement, and desire to be part of a solution.

Scientific literacy is most often described as what citizens should know to participate in society and make good decisions based on science, and encompasses the knowledge of scientific concepts, processes, and the nature of science (AAAS, 1989; DeBoer, 2000; Wallace & Douden, 1998). Environmental education has several competing definitions, but is perhaps best defined as:

> that aspect of education that develops individuals who are environmentally knowledgeable and, above all, skilled and dedicated to working, individually and collectively, toward achieving and or maintaining a dynamic equilibrium between the quality of life and the quality of the environment. (Marcinkowski, Volk, & Hungerford, 1990)

Environmental education and scientific literacy should prepare students to be citizens capable of making good decisions when faced with science-based issues such as environmental problems (Bybee, 1993).

While educational programs about the ocean have existed for decades, they have varied widely in quality (National Oceanic and Atmospheric Administration, 1999) and have suffered from many of the same issues facing the integration of environmental education into mainstream science education, namely that it is misunderstood and neglected (Gruenweld & Manteaw, 2007). The currently accepted definition of ocean literacy was not established until 2004 (Schoedinger, Tran, & Whitley, 2010). This has led to a shortage of research studies that have examined ocean literacy at all levels of education.

Although some literature (Schoedinger, Cava, & Jewell, 2006; Schoedinger, Tran, & Whitley, 2010), presentations (Gillan & Capobianco, 2008) and unpublished works (Kinzel, 2009) reference the ocean literacy standards, very limited research (Gillan & Capobianco, 2008; Kinzel, 2009; Rice, 2007) has been presented utilizing the ocean literacy *Essential Principles and Fundamental Concepts*. This article summarizes the results of two research studies that focused on K-12 students' ocean literacy (Plankis, 2009; Marrero, 2009). A focal point for both studies was collecting data on teachers' and students' voices, as environmental education and scientific literacy research have shown that these voices have been severely neglected and are crucial to attaining environmental and scientific literacy (Brown, Reveles, & Kelly, 2005; Eisenhart, Finkel, & Marion, 1996; Hart & Nolan, 1999; Rickinson, 2001). Given the dearth of information about

students' ideas about the ocean since the new ocean literacy *Essential Principles and Fundamental Concepts* were published, studies like these are necessary to begin mapping the mileu of this important research area. Discussion will focus on the students' ocean literacy and how the results can help inform future research and policy programs.

Methods

Marrero, 2009 Methods

Using the conceptual and theoretical frameworks of scientific literacy and constructivism (Matthews, 1993; Piaget, 1973), Marrero constructed a collective case study (Creswell, 2007; Merriam, 1998) to examine the ocean literacy of two classrooms of students, one in New York and one in California. A constructivist theoretical framework examines student learning with the view that they learn from experiences, and that these experiences connect with what they already know and understand. The 19 New York students were 11th and 12th graders at a New York City public high school enrolled in a marine science elective course. The 52 California students were 7th grade life science students located in the San Francisco suburbs. Both classes were ethnically diverse and students ranged in ability level, from classified special education students through gifted learners.

The students under study were engaged in a NOAA-sponsored ocean literacy-focused program called Signals of Spring – ACES. In 'ACES', students learn ocean sciences content topics (including bathymetry, food webs, currents, and more) and apply their understandings as they track live marine animals (e.g., sea turtles, whales, and penguins) online. The instructional design of ACES is built upon a constructivist framework, further supporting the use of the constructivist theoretical framework in this study. In ACES, students use earth imagery, including chlorophyll and sea surface data sets, to explain the movements of animals that are tracked by satellite. The major research question for this study was, "In what ways do students' ideas about the ocean change through engagement in ACES?"

Both teachers had participated in training for the ACES program in the summer prior to the study. These two classrooms were chosen as representative cases for the ACES program, because the teachers were following the ACES curriculum with a high fidelity of implementation (FOI). That is, the teachers used the instructional materials and philosophies intended by designers of the curriculum, as determined by pre-surveys and short (about 10 minute), informal telephone interviews with these educators. The author used purposeful sampling (Merriam, 1998) to choose one school at the middle school and one at high school level that had a high FOI of ACES in their classrooms.

Data sources for the case studies included field notes, open-ended questionnaires administered to students, focus group interviews, teacher interviews, and student-produced documents (student work). Short (20 minute) questionnaires were administered online, by the teachers, at the beginning and end of the year. These questionnaires asked about student experiences with the ocean, and how students perceived the ocean affecting their lives. The author visited both classrooms several times over the course of a school year to observe students working on ACES lessons, including animal tracking, and recorded extensive field notes, which included student comments and ideas shared, observations of student and teacher behavior and engagement, etc. She conducted two 30 minute conversational interviews with each teacher (Merriam, 1998), one early in the school year and one in June. With students, focus groups of 3-6 students were convened at the same times of the year, and lasted between 15 and 28 minutes, depending on the group. Both teachers saved student work including posters, writing assignments, and data activities, throughout the year. Additionally, ACES students write in online journals as they track their animals, providing another source of data to examine student content knowledge. Merriam (1998) notes that documents, in this case student-produced, are a strong data source for qualitative analysis because they are not influenced by the researcher. Data were collected over the course of a school year and analyzed using the methods of grounded theory (Charmaz, 2000; Strauss & Corbin, 1990), a step-by-step, inductive approach intended to make meaning from the data and identify emergent themes. Each data source was considered individually, and then compared to data already analyzed, as analysis was ongoing throughout the school year, a technique known as constant comparison (Strauss & Corbin, 1990; Creswell, 2007). Through these methods, major themes across data sources were identified. In the case of the open-ended questionnaire data, the prevalence of themes were quantified using simple percentages (Ward, 2007). A final step was to relate the emergent themes to the *Essential Principles of Ocean Sciences*. Methods used to establish trustworthiness and creditability in the data analysis included member checking, prolonged engagement, triangulation of data sources, and peer debriefing (Guba & Lincoln, 1989).

Plankis 2009 Methods

Plankis' (2009) study was also based on the theoretical framework of constructivism (Matthews, 1993; Piaget, 1973), the IEEIA curriculum framework (Marcinkowski, 2001), and utilized mixed methodology, combining a quantitative quasi-experimental nonequivalent control-group design and a qualitative component that utilized an embedded case study design (Yin, 2003). A case study approach is the preferred strategy for conducting research to answer "how" or "why" questions that focuses on a contemporary phenomenon within some real-life context. In a case study, the researcher has little control over events and the borders between the

phenomenon and context are not always clear (Yin, 2003). Methods of data collection included two quantitative tests, one for environmental literacy, the Secondary Science Environmental Literacy Instrument (SSELI) (Marcinkowski & Rehrig, 1995), and a new instrument for ocean literacy described below, along with student interviews, teacher interviews, discussion forum postings, and additional student opinion surveys. The two quantitative tests were analyzed utilizing analysis of covariance (ANCOVA), the preferred statistical method for comparing experimental and control group means (Gall, Gall, & Borg, 2003). The level of significance was set at .05. Because the focus of this paper is on the qualitative emergent themes found in both studies, the quantitative results will only be addressed briefly.

The teacher interviews were conducted twice for all four teachers, once at the end of the teacher development training and once at the end of the research study. The two Texas teachers were selected to be the embedded case study teachers and were interviewed two additional times during the course of the study (at approximately weeks 8 and 12). The teacher interviews lasted from 22 minutes to 87 minutes, with an average of 30 minutes for the first interviews and 60 minutes for all remaining interviews. The student interviews were done only at the end of the research study in a teacher office at the high school. The student interviews lasted from 8 minutes to 19 minutes, with an average of approximately 11 minutes. The teacher and student interview scripts contained 8 and 10 initial questions respectively. The interview scripts were developed, administered, and analyzed using Carspecken's (1996) semi-structured interview methodology.

The independent variable was participation or non-participation in the Ocean Foundation-sponsored Connecting the Ocean Reefs Aquariums Literacy and Stewardship (CORALS) ocean literacy program designed by the Reef Stewardship Foundation. The dependent variables were environmental literacy (as measured by the SSELI instrument) and ocean literacy (as measured by the Students' Ocean Literacy Viewpoints and Engagement (SOLVE) instrument, see Appendix A) of the students. The CORALS program is a new ocean literacy program based on the ocean literacy standards that utilizes the IEEIA curriculum framework (Marcinkowski, 2001) and textbook (Hungerford, Volk, Ramsey, Litherland, & Peyton, 2003). The program, which was planned to last 18 weeks, ran for 15 weeks due to three weeks of disruption from Hurricane Ike in Texas and Ohio and tropical storm Fay in Florida. Additional details on the CORALS program can be found in Plankis & Klein (2010).

The study involved three groups of participants. The first participants were four high school science teachers of either environmental science or marine science courses. Both courses are considered integrated science courses, with elements of ecology, chemistry, biology, and physics contained

in the course objectives and curriculum. Integrated science courses have been shown to increase science literacy (Lambert, 2001) and are proposed as the best courses to be used for improving knowledge of environmental problems (Mayer, 2006) in a high school setting.

Three of the teachers were from Title 1 schools in Texas and Ohio and the fourth was from a suburban school in Florida. The teachers were recruited nationally through announcements for on the Reef Stewardship Foundation (RSF) website and through emails to the RSF member list. Local recruiting efforts were done through recruiting announcements and emails at a local teacher professional development provider. Due to strict logistical deadlines for the study, recruiting was only done over a two-month period. Any teachers interested in participating were required to have at least one control and one experimental classroom of students that were enrolled in the same science courses to be considered for inclusion in the study. This requirement was obligatory to avoid comparing disparate curriculum over time (For example, a biology classroom vs. a marine science classroom) or comparing classrooms where different teachers taught the students. A total of 10 teachers applied to participate in the study. Two teachers were eliminated because they could not provide two classrooms of the same curriculum and four others were eliminated because their school administrators wanted all classrooms in their school to receive the experimental curriculum.

The second group of participants was approximately 393 high school students in the teachers' classrooms who were primarily seniors with a few high performing juniors. (169 students in the experimental classrooms, 224 students in the control classrooms) The third group of participants included four expert moderators and scientists that participated via the CORALS discussion forums. Data was collected from all three groups to help analyze the results of the study.

The purpose of the study was to examine the effects of technology-infused issue investigations on high school students' environmental and ocean literacies. While the research study had nine research questions, only the three questions pertaining to ocean literacy will be addressed in this manuscript:

1. What was the effect of the CORALS program on high school students' ocean literacy, as measured by the SOLVE instrument?
2. What were the teachers' thoughts and reactions to the CORALS program?
3. What were the students' thoughts and reactions to the CORALS program?

Development of the Students' Ocean Literacy Viewpoints and Engagement (SOLVE) Instrument

One recognized deficiency for the ocean literacy movement is a lack of reliable and valid assessments (Hoffman & Barstow, 2007). A search of existing ocean literacy and marine science assessment instruments revealed few published instruments, most notably Cudabeck (2008) and Lambert (2001), but none were based on the ocean literacy *Essential Principles* or considered a standard in the literature. With assessment of ocean literacy is still in its infancy, Plankis (2009) developed a new instrument based on the ocean literacy *Essential Principles*.

Plankis developed the Students' Ocean Literacy, Viewpoints, and Engagement (SOLVE) instrument (see Appendix A), which was composed of four parts. Part I is composed of 20 multiple-choice questions examining students' knowledge of five of the seven ocean literacy *Essential Principles*. Part II measures students' knowledge of oceanic environmental problems by asking them to list the problem, cause, and effect. Part III measures students' concern for the oceanic environmental problems they listed in Part II. Part IV, administered during the posttest only, was a series of open-ended opinion questions designed to help expand upon student viewpoints and engagement. Parts II and III of the SOLVE instrument are similar in structure and question format to Test 1, Part I and Test 1, Part II of the SSELI instrument, respectively. However, the questions were modified to address ocean literacy and coral reefs, instead of environmental problems in general.

Plankis collaborated with a group of ocean literacy experts from a team assembled by the U.S. Satellite Laboratory in Rye, NY. A total of three scientists, five educators, and one graduate student who work on ocean literacy education reviewed the questions for face validity, grammar, and suggested question alterations. The feedback received resulted in minor changes that improved some of the questions.

Reliability coefficients for the SOLVE instrument are presented in Table 2. Both Part II and Part III are scales that meet the +.70 minimum standard for Cronbach's Alpha. Part I is not intended to be a composite scale, it is simply a collection of knowledge items, so the low reliability coefficient is less of a concern. The resulting SOLVE instrument was designed to be completed in one class period (45 minutes) or less and all teachers reported their students were able to finish within the allotted time.

Table 2. Reliability coefficients for three sections of the SOLVE

Section	Reliability coefficient
Knowledge of Ocean Literacy *Essential Principles* (Part I)	.28
Ability to Identify Oceanic Environmental Problems (Part II)	.72
Attitude (Part III)	.85

* *Cronbach's Alpha*

It should be noted that the SOLVE instrument was developed from the beginning to be a partial ocean literacy instrument. This was done because the CORALS program was not intended to be a full ocean literacy program addressing all seven of the *Essential Principles* and an instrument designed to reliably and validly measure all seven principles would have been too long to administer to the students in this study. Because of the low reliability coefficient for Part I, and that Part I contained questions on multiple *Essential Principles*, the results of the SOLVE instrument cannot be used to state that a student either understands or doesn't understand a particular *Essential Principle*. Additional work is needed to develop the SOLVE instrument into a full measure of ocean literacy, but the instrument is presented here as a potential starting point given the lack of existing instruments.

Reliability of Subjective Scoring

Analysis of Part II of the SOLVE instrument relies on subjective scoring of the student responses to open-ended items. It is important in research studies with subjective scoring of tests to report reliability figures to support the study's validity. Riffe, Lacy, & Fico (1998) insist, "failure to report reliability virtually invalidates whatever usefulness a…study may have" (p. 134). Percent agreement is the most commonly reported ratio of reliability figures, but is not considered a standard.

There are several coefficients that account for chance agreement with no standard, so the researcher selected Krippendorff's alpha (see Krippendorff, 2004). Krippendorff's alpha was calculated using Hayes & Krippendorff's (2007) SPSS macro and percent agreement was calculated manually in Excel. Percent agreement was reported even though it doesn't account for chance agreement, because reporting multiple reliability indices is of importance considering the fact that no unambiguous standards are available to judge reliability values (De Wever *et al.*, 2006).

To improve the validity of the scoring of SOLVE Part II that required subjective scoring decisions, a portion of the posttests were independently graded by the researcher and a fellow graduate student who was trained on the SOLVE scoring procedures. The researcher and fellow graduate student met face-to-face twice to discuss the scoring procedures. The purpose of the first meeting was to discuss the scoring procedures of both instruments and to practice scoring one classroom of tests together. A subsequent meeting was held to independently score additional tests and discuss scoring problems after the scoring was completed. The results of this validity check are presented in Table 3.

Table 3. Reliability figures for subjective scoring decisions of SOLVE Part II

Scoring run	Scoring decisions	Percent agreement	Krippendorf's alpha
Training	74	0.89	0.82
Independent Scoring	281	0.80	0.67

The values reported for the independent scoring run are the most important. Percent agreement for the SOLVE instrument Part II scoring was .80. There is no consensus on what is considered the minimal level of agreement for percent agreement, with De Wever et al. (2006) mentioning the cut-off figure as 0.75-0.80. Neuendorf (2002) and Rourke, Anderson, Garrison, & Archer (2001) state that a value of .70 can be considered reliable. Utilizing both standards, the SOLVE scoring can be considered reliable according to percent agreement.

The value calculated for Krippendorff's alpha for the SOLVE Part II scoring was 0.67. Krippendorff has suggested that a value above 0.75-0.80 indicates excellent agreement, values below 0.40 poor agreement beyond chance, and values in between represent fair to good agreement beyond chance. The value for the SOLVE instrument is therefore considered good agreement and falls just short of the minimum value for excellent agreement. So the subjective scoring of the SOLVE instruments can be considered reliable according to both percent agreement and Krippendorff's alpha. Additional details on the SOLVE instrument development and validity can be found in Plankis (2009).

Results and Discussion

SOLVE Instrument Quantitative Results

The results from the SOLVE instrument quantitative sections were significant and indicated that the students held a moderate to high level of ocean literacy at the end of the study, compared to the low to moderate ocean literacy they held at the beginning of the study. Table 4 summarizes the effect sizes and their significance by the main effect of class type (whether or not the students were in experimental or control room classrooms) and the class type*teacher interaction (whether or not individual teachers had more or less of an effect than all teachers combined). The main effect of class type was found to be significant for the SOLVE total score, $F(1,229) = 67.97$, $p < .01$, students' knowledge of ocean literacy principles subscale, $F(1,229) = 79.64$, $p < .01$, students' ability to identify oceanic environmental problems subscale, $F(1,173) = 25.46$, $p < .01$, and students' attitudes concerning the ocean subscale, $F(1,163) = 8.00$, $p < .01$. The interaction of class type*teacher was found to be significant for the SOLVE total score, $F(2,229) = 30.27$, $p < .01$, students' knowledge of ocean literacy principles subscale, $F(2,229) = 54.30$, $p < .01$, students' ability to identify oceanic environmental problems subscale, $F(2,173) = 8.55$, $p < .001$. The interaction of class type*teacher was not found to be significant for the students' attitudes concerning the ocean subscale.

It is encouraging to see that the students in the experimental classrooms in Plankis (2009) had a large increase in ocean literacy overall, but the individual teachers also appeared to have a statistically significant impact. It should be noted that the students for Teacher B had the highest initial ocean literacy scores (considered moderate) and the students for Teacher D had the lowest initial ocean literacy scores (considered low) and had the most dramatic gains in their scores, with scores for Part II more than doubling from their initial values. Given the moderate size of the SOLVE instrument sample (121 experimental group students) and the small number of students for Teacher D (15), these results are encouraging, but replicate studies are needed to get a more accurate picture of the impact of the CORALS program on students' ocean literacy.

Table 4. Summary of effect sizes for SOLVE total score composite scale and SOLVE instrument subscales by class type and class type x teacher

		Class type x teacher effect sizes		
Scale	Class type effect size	Teacher B	Teacher C	Teacher D
SOLVE total score composite scale	+0.90**	+0.34**	+0.64**	+2.21**
Knowledge of ocean literacy essential principles subscale (Part I)	+0.94**	+0.19**	+0.31**	+3.84**
Ability to identify oceanic environmental problems subscale (Part II)	+1.10**	+0.39**	+0.31**	+3.11**
Attitude towards oceanic environmental problems (Part III)	+0.48**	+0.38	+0.75	+0.34

*$p < .05$. **$p < .01$.

Combined Qualitative Results from Both Studies

The results of the SOLVE instrument scores are presented in Table 4 to provide a sample of the quantitative results from Plankis (2009), but the focus of the remainder of the paper is on the similar qualitative finds from both studies. Even though the two studies examined different populations of students in five states, three major themes emerged concerning the study groups' ocean literacy: 1) initial interest but low knowledge levels about the ocean, 2) low awareness of the urgency of ocean issues, and 3) student-reported interest in behavior changes to protect the ocean.

Initial Interest but Low Knowledge Levels about the Ocean

Both authors found that at a baseline level, students found the ocean to be something interesting and worthy of study, but only knew about the ocean at a very superficial level. Before the beginning the ACES program, the New York and California students responded to an online open-ended questionnaire, monitored by their teachers. One question asked, "Why is the ocean important?" Sixty-seven student questionnaires were analyzed

and coded, and the major themes quantified. The most prevalent themes were *ocean as a source of food* (39% of respondents) and *to support marine organisms* (25% of respondents).

Responses coded under the first theme included:

- *because we eat things from there. ex. fish, sharks*
- *so we can eat the fishes*
- *we get food from it*

Sample responses for the second theme, *to support marine organisms,* included:

- *because if there was no ocean a lot of animals would be dead*
- *it is home to many plants and animals*
- *keeps many creatures alive*

Another question posed to students in the questionnaire was, "How does the ocean affect your life?" Similarly, 25% of student responses centered upon food; 35% of students, however, were either "*it doesn't affect my life*," or "*I don't know,"* indicating that more than 1/3 of students surveyed, all of whom went to school within 10 miles of the nearest bay, could not name one way in which the ocean affects their lives. The interview data supported this finding. For example, when Christopher, a New York 12th grader, was asked how the ocean affects his life, he explained,

> *In a sense, in a way, it doesn't. . . but then again, it does because when you look at the ocean, you say to yourself, wow, it takes up like the whole Earth. You don't realize that, from land, how big it is.*

The above student answers reflect the predominantly superficial level of responses, which was also noted in other data sources, including the focus group interviews. Data collected from these interviews also focused on food and animals. When asked what they knew about the ocean in focus group interviews, students noted that there are fish and other living organisms, that it is a source of seafood, etc. When asked what she found most interesting about the ocean, Kylie, a 7th grader in California, explained that she was always interested in animals, noting, "*They are all so different. Like, when you see them underwater, it is so cool.*" Benjamin, an 11th grader in New York described his experience of going to the ocean on vacation:

> *. . .one of the beaches, there were all different types of fish, and if you go a little further, there's sharks-- but we didn't go that far. There are a lot of different fish, there's a lot you can see through, so you can hardly even see them, and then there's goldfish and Nemo fish, clownfish, many different kinds . . . I've seen seaweed, when you come to the beach, there's a small path covered in seaweed.*

This student, like many others, focused on the living things in the ocean. When asked why the ocean was important, he indicated the ocean's role as a habitat for living things, reiterating some of the ideas above about seaweeds and fish. In one California focus group, four students discussed that the ocean was important food source for them, noting that they enjoyed seafood such as tuna fish sandwiches, shrimp and sushi. These results are similar to those found in large-scale studies of adults (Ocean Project, 1999, 2009b; Steel, Smith, Opsommer, Curiel, & Warner-Steel, 2005).

Similar to Marrero (2009), Plankis found that CORALS students were interested in the ocean, but had low levels of knowledge and awareness. Question 34 on the SOLVE instrument asked "Think about when you began the research study. Has your view of the ocean changed? If so, how?" Of the 91 students who responded, 65 (71%) indicated that their view of the ocean had changed, 14 (15%) indicated that their view had not changed significantly, and 6 (7%) indicated they were already informed about the ocean. Ninety-one students provided a written response that elaborated on how their view of the ocean had changed. The results were analyzed and assigned to a category of the *Essential Principles of Ocean Sciences* and a summary is presented in Table 5.

Table 5. Student written responses classified by Essential Principles of Ocean Sciences

Response	Count
EP 1: The Earth has one big ocean with many features	*0*
EP 2: The ocean and life in the ocean shape the features of the Earth	*0*
EP 3: The ocean is a major influence on weather and climate.	*0*
EP 4: The ocean makes Earth habitable.	*0*
EP 5: The ocean supports a great diversity of life and ecosystems.	*8*
EP 6: The ocean and humans are inextricably interconnected.	*57*
EP 7: The ocean is largely unexplored.	*0*
No, No, it didn't change, or No, my view did not change.	*14*
No, previously interested/informed about the ocean	*6*
Could not be coded to an Essential Principle	*6*

Of the 65 written comments that could be assigned to an *Essential Principle (EP)*, 12% reflected EP 5 and 88% reflected EP 6. A sample of the student comments related to EP 5 included:

- *because I never knew half of the stuff about the smaller organisms of the ocean before this year*
- *because I didn't know so many organisms depended on coral reefs*
- *a little, in depth of species in the ocean*

Some sample student comments related to EP 6 were:

- *I never had known that our ocean became so important to humanity*
- *the view of the ocean has definitely changed because I see the harm we are causing it*
- *because I now know how the ocean is so important to our environment*
- *the ocean has a much larger effect on the way we live & the situation of the world today than I thought*

Many of the student comments indicated that the students had low ocean literacy to begin with and that the study raised it. While a few comments partially reflected EP 1-4 and 7, the majority of the length of all comments still reflected EPs 5 and 6. Even though the comments reflect what the students were remembering from the study, it should be noted that it may not be an accurate reflection of their knowledge of or interest in all seven EPs, because the CORALS program deliberately focused on EP 5 and EP 6 due to limited instructional time.

While the discussion forum postings in Plankis (2009) were initially required for students and teachers and detailed analysis was planned utilizing open coding (Strauss & Corbin, 1990), the three weeks of lost time due to the tropical storms and difficulty in accessing computer labs at the schools resulted in the researcher dropping the requirement for discussion forum participation by week ten of the research study. Some highly engaged students did continue to post on the discussion forums, but their usefulness as a research tool was greatly reduced. One student posting did reflect on one of the implications of this paper, that more emphasis needs to be placed on ocean literacy in the K-12 system for the current low awareness and knowledge levels to be raised:

> Title: I have beef with the school system.
>
> Post: "Since I've lived in Florida, I have never seen a warning sign stating the effects of touching coral or other human interaction with biodiversity issues. Actually I never really knew much about the reefs or anything else related to the ocean until I started taking marine bio. I've lived in Florida for most of my life and I was never aware of these oceanic environmental problems. Why isn't there more stress put upon the importance of the ocean when we live on a peninsula? Why wasn't I taught this in integrated science or previous sciences I took in middle school? Is marine bio. and oceanography a fairly new science? Or is there opposition to its importance? I've talked to a few of my friends and they feel the same way." (Student Tracy, personal communication, November 2, 2008)

This student discussion forum posting does reflect the findings from (Hoffman & Barstow, 2007) that Florida's current state standards poorly

address ocean literacy, with only 6 of the 35 *Essential Principles* addressed compared to the national average of 9.6.

Low Awareness of the Urgency of Oceanic Environmental Issues

The second theme that developed out of both research studies was that many students were not aware of the urgent need to address oceanic environmental issues, which mirrors the results for adults in the Ocean Project survey (2009b). Question 36 on the SOLVE instrument asked "Before this research study began, were you aware that 2008 had been designated the International Year of the Reef (IYOR)?" The IYOR was an international effort to raise awareness of the immediate dangers facing coral reefs and encourage people to take action (IYOR, 2008). Of the 113 students who responded to the question in August 2008, almost eight months into the IYOR, only ***one*** knew 2008 had been designated the IYOR.

Of the 91 CORALS student comments summarized in Table 3, 19 (21%) of them indicated the student was either not aware of oceanic environmental issues to begin with, or that they initially thought the issues were unimportant or not urgent. Student comments on the CORALS discussion forums and from student interviews also reinforced that many of the participating students were not aware of the urgency of oceanic environmental issues. ACES students' initial views about oceanic environmental issues also did not reflect a sense of urgency or importance. In the post-program focus groups, students discussed how their ideas had changed over the course of the school year. Andrea, a 12th grader talked about her views of pollution prior to ACES, saying,

> *Yeah, like, usually when you think about polluting something, you only think about your general area. You never think that trash or whatever can get all the way to the ocean . . . like through the streams or rivers or whatever. Well, here it goes to the bay.*

Her classmate added, "Learning about the animals makes you care about them—and the ocean, more. So maybe it makes you more concerned. I know it does for me." These students and others implied, without directly stating, that their concern about oceanic environmental issues was low upon beginning the program.

Students in both programs began without a sense of urgency or connection to oceanic environmental issues, much like most adults—as found in large-scale studies (i.e., Belden, Russonello, & Stewart, 1999; The Ocean Project, 1999a, 1999b). It is promising, however, that their views began to shift after engagement in ocean literacy programs, although both programs were of short duration. Longitudinal studies are needed to determine whether the students' sense of urgency reverts to pre-program levels, or whether they truly internalize the understandings and concern they have built.

Student-reported Interest in Behavior Changes to Protect the Ocean.

For the CORALS students, when responding to Question 26 on the SOLVE instrument ("To what extent will you change any aspect of how you live based on what you have learned in this research study? Explain.") The question had the students rate their planned changes on a scale from 1 to 5, with 1 indicating to no extent and 5 indicating to a great extent. The majority of the respondents, 83 of the 115 students (72%), indicated a "3", "4", or "5" on the scale. While the question did not specifically ask if the students planned positive changes, of the 37 students who provided a detailed written statement, 6 students indicated they were already environmentally responsible and 20 indicated they were planning positive changes (increased recycling, reduced littering, etc.). Only one student indicated a negative attitude by responding he didn't plan to change to help the environment as he thought "environmental problems were overrated."

The SOLVE Part III posttest score, indicated a moderate improvement of the already positive attitude the participants held concerning the ocean. The experimental group M increased to 7.06 from 5.84 on the pretest, which was statistically significant ($p < .01$) and moderately educationally significant (Cohen's $d = +0.48$). With 10 points possible, a score of 2-4.7 would indicate a negative attitude, 4.8-7.5 a moderately positive attitude, and 7.6-10 a strongly positive attitude. The unadjusted posttest means for Teacher B (6.76) and Teacher C (5.93) and Teacher D (7.06) all indicate a moderately positive attitude for their students.

For the ACES students, 53 of 65 students (82%) indicated that their experience and knowledge would lead to a change in behaviors in a positive way based on what they learned ("How, if at all, will what you learned in ACES change your behaviors, now and when you are an adult?"). The balance of students' responses (18%) indicated that they were unsure; no students indicated negative behaviors. Questionnaire responses coded as 'positive behavior changes' included:

- *Stop throwing garbage in the water when I go to the beach.*
- *I will take into conciteration (sic- consideration) the things I throw on the ground.*
- *it will affect how i am with my trash and also how i will vote on things that could affect the ocean*
- *it might reconcitar (sic - reconsider) taking my bike instead of my car*

Focus group interviews revealed the same theme of intention to take positive behaviors. Students described their concern about the ocean and reported steps that they would be willing to take in order to contribute to ocean protection. Caryn, a California 7th grader, explained

> *I think I'm going to have a lot more compassion for like, the animals and the different types of . . . when I'm voting, and I see something that has to do with the ocean, I'm going to vote to protect it, because I feel like I*

> *understand it more. I don't think it's just this big . . . blue, thing of water. I think it's more of something that we should keep protecting.*

During the same focus group, students were asked what they were willing to do in their everyday lives to protect the ocean. One student, Benita noted,

> *Yeah, I think that eating less fish, and less meat, well, not really eating less of it, but just knowing what you're eating and where the fish came from. So, like, taking fish from one of the nets that doesn't have a release for turtles or if it was caught in a protected area, you should know about that and not eat it. . . Sometimes, tuna fish, on the can, it will say 'dolphin safe" or things like that. Or, you can go to that website, if it's a fish and it will tell you where and how it is caught and then you can know.*

Benita acknowledged that there were indeed behaviors within her control, and described specifically how she could enact these behaviors, e.g., by visiting a website that delineates sustainable seafood choices. In the excerpt below, three 7th graders report how they are willing to change their behaviors based on their new understandings of the ocean.

Travis:	*Recycle more ...*
Interviewer:	*How would that help?*
Travis:	*They wouldn't have to make more plastic.*
Interviewer:	*And why is it bad to make more plastic?*
Travis:	*Because, we were learning something about plastic pellets, which maybe we could lower down what we use….*
Stanley:	*If we reuse things, we'll be saving resources on land. And, less will be getting in the ocean.*
Stephen:	*Like Stanley said, if we keep on making more plastic, the turtles, they mistake plastic for jellyfish and other food, so maybe they'll go and eat it.*
Travis:	*Plastic in the ocean breaks down to those plastic pellet things and those are really bad for birds and stuff.*
Interviewer:	*So what are some ways to prevent that?*
Travis:	*Recycling.*
Stephen:	*Not throwing things into the ocean…. I try not to pollute.*
Travis:	*Yeah, now I think about the ocean because now I know about the animals and stuff.*
Interviewer:	*But specifically, did you actually stop polluting or doing something, or were these things that you were doing already*
Stanley:	*I don't throw stuff on the ground near the ocean because it ends up in the ocean, even if you are far away, because it still can get to the ocean.*
Interviewer:	*Are these things that you did before? Did you sometimes throw things on the ground?*
Stanley:	*Well, no.*

Travis: *Yeah, occasionally I did.*
Interviewer: *So, now what? Do you think twice about it?*
Travis: *Yeah.*
Interviewer: *For real?*
Travis: *Yeah, really.*
Stephen: *Yeah.*

These students, after an approximately 10 month engagement in the ACES program, began to show concern for the ocean, and also reported intent to change their behaviors, including making seafood choices and littering. The discussion also reflected a deeper level of understanding than the pre-ACES focus groups. As they discussed their littering behavior, these boys also indicated an understanding of *how* their behaviors on land directly affected the ocean, for example, demonstrating an understanding of watersheds. These students knew that any litter thrown on the ground in their neighborhood could, through the watershed, end up in the ocean.

In summary, across the two studies, the most commonly expressed student conceptions of the ocean (aligned to *Essential Principles*) included:

- The ocean is an important source of food. (EP 6)
- The ocean is a place to visit and for recreation. (EP 6)
- The ocean is habitat for many diverse species. (EP 5)
- The ocean is important in human civilizations. (EP 6)
- Humans have many negative effects on the ocean. (EP 6)

All of these ideas are important understandings about the ocean. It is not surprising that many students focused on the relationship between humans and the ocean, as pre-adolescents and adolescents often have an egocentric view of the world and what they are learning (Elkind, 1967). Ocean literacy programs in the future should strive to develop students' understandings related to the other *Essential Principles*, e.g., EP 1: The Earth has one big ocean with many features.

Implications for Further Research

Although these two studies had separate populations and similar, but still disparate methodologies, the similarities in results are encouraging for the marine education community. The major implications for future research and program development are:

- Ocean literacy-focused programs, even shorter term interventions of one or two semesters, can lead to improved student knowledge and intent to change behavior.

- 'Hooks' for student engagement can be effective means for promoting ocean literacy.
- Longitudinal studies are needed to determine whether students do, in fact, change their behaviors.
- Additional work needs to be performed in order to develop a full ocean literacy assessment instrument to allow future studies to be compared, reliably and validly measure all seven *Essential Principles*, and for tracking progress in attempting to improve ocean literacy over time.

In the cases studied, middle and high school students were engaged in either half year or yearlong technology-based ocean literacy programs. Findings suggest that students can begin to change their ideas about the ocean in a relatively short time, and report intentions to change their behaviors. The goals of these and other programs are to promote ocean literacy and responsible environmental behaviors (REBs), which ultimately means that one "is able to make informed and responsible decisions regarding the ocean and its resources" (National Geographic, 2006`, n.p.). The collective findings suggest that formal education programs in a variety of settings (e.g., urban/suburban, middle/high school, coastal/inland), may indeed assist students in moving toward becoming ocean literate.

The 'hooks' for the two programs were coral reefs and animal tracking, respectively. When referencing their changes in ideas, the students often referenced the hooks, indicating that they were effective means for promoting student engagement. Marine educators should look for other ways to engage students in learning ocean science and about oceanic environmental issues, and relate these topics to the students' everyday lives.

The results from these two research studies are encouraging for the implementation of and potential impact of ocean literacy curriculum in the United States and represent a significant advance in the understanding of student thinking about ocean literacy in the peer-reviewed literature. One limitation of these studies is that they were not longitudinal. This limitation is not unique, as many studies on student thinking, engagement, and understanding fail to report long term impact on students' motivation for further responsible environmental behavior (REB) on environmental issues (Cobiac, 1995). In an effort to address this concern, Plankis contacted the four teachers from the CORALS research study one year after it ended and asked for an update on the activities of their students. One teacher did not answer, two teachers indicated they were continuing to develop their recycling programs and awareness programs with a new group of students, and the fourth teacher, from Florida, reported her students had indeed initiated REB.

Two of the students who had participated in the CORALS program had convinced the teacher to form a new after-school student club called Students Protecting Land and Sea Habitats (SPLASH). The students, with guidance from the teacher, had conducted activities that directly benefited the environment (a wetlands cleanup) and other activities that were designed to increase awareness of oceanic environmental issues in the local community (educational programs for the local elementary school students, as well as volunteering for local environmental education projects). In a follow-up interview, the two CORALS students that spearheaded the formation of SPLASH indicated that their participation in the CORALS program was a key motivational factor in forming the club.

The quantitative and qualitative results from both of these studies recorded an increase in students' ocean literacy and a desire by the majority of the students (72% of students in CORALS and 82% of the students in ACES), to increase their own REB. However, previous research indicates that the desire to increase REB is only a minor variable in determining if students actually take REB (Hungerford & Volk, 1990). The follow-up discovery of the SPLASH club demonstrates that at least two of the students did indeed take REB, on an even larger scale than anticipated by the researchers. Longitudinal studies that report on the long term impact of ocean literacy curriculum on students' ocean literacy, students' thinking, teachers' thinking, and fostering of lasting REBs are crucial to providing a research base that supports increasing the importance and prevalence of ocean literacy and environmental education in the United States.

Conclusion

Like most Americans, most of the student participants in these studies had low levels of ocean literacy, mirroring previous studies of adults in this area (AAAS, 2004; Ocean Project, 1999, 2009b). In many cases, students were unable to explain their own connection to the ocean, or how the ocean affects their lives, indicating that at a very basic level, they had not achieved the definition of ocean literacy, "an understanding of the ocean's influence on you, and your influence on the ocean" (National Geographic Society, 2006).

While the studies were conducted with different populations of students, the results suggest that engagement in an ocean literacy-focused program may lead to students considering changing their behaviors toward protecting the ocean. Larger scale and longitudinal empirical studies are needed to determine whether students do in fact behave differently than their peers who have not been engaged in ocean literacy-focused programs, what factors contribute to ocean literate and engaged students, and ways of fostering future REBs.

Paul Hart points out that we are facing different environmental problems today, "unlike the '60s and '70s when environmental issues were

local, we now seem to be facing global issues with their major implications" (Hungerford & Simmons, 2003, p. 10). If the ocean and its vast biodiversity are to be protected and global environmental problems are to be solved, it will be important for educators to find local connections, determine students' understanding of the problems, and examine how to make ocean literacy and global environmental problems relevant. Previous empirical research suggests that the formal classroom setting, utilizing quality long term programs, is the best environment for accomplishing this goal (Zelezny, 1999).

Hart and Nolan (1999) stress the importance of understanding global environmental problems and how theory and metatheory for practice is critical:

> Environmental problems and issues are not going to simply disappear. Quite the contrary, as human population continues to grow, these problems will intensify and the consequences will have global (as opposed to local) implications…What could be more elementary than our common future and more fundamental than our own critical dialogue about 'getting right' the presuppositions of theory and metatheory for practice. (p. 40)

The development of an ocean and environmentally literate citizenry is a high priority for the ocean literacy and environmental education communities. However, ocean literacy and environmental education continues to be marginalized in the K-12 and university systems in the United States, resulting in a citizenry that is not equipped to deal capably with many environmental problems that are considered out of sight and out of mind. With increasingly severe local and global environmental problems, time is running out to develop an ocean literate citizenry that is capable of understanding, supporting, and demanding the policy changes necessary to protect the ocean.

♦ ♦ ♦

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Appendix A

NOTE: This copy of the SOLVE instrument has been modified from the original instrument administered to the students in the CORALS program to eliminate questions that performed poorly or were not relevant to this publication, and to reduce length. If you would like more information about the SOLVE instrument, please contact the lead author.

Student Codename: _____

Students' Ocean Literacy Viewpoints and Engagement (SOLVE) Post-Test

Part I: Knowledge of Ocean Literacy *Essential Principles*

Directions: Please circle the letter of the correct response for each corresponding multiple-choice item on this test form.

Example Item:

45. Which of the following is part of the water cycle?
    a. erosion
    b. ocean tides
    c. evaporation
    d. decomposition

The correct answer is c, so you would circle "c" on this test.

1. Approximately how much of the water on Earth is contained in the ocean?
    a. 50%
    b. 70%
    c. 90%
    d. 97%

2. A major reason that the temperature of Earth is more stable than the Moon is because
    a. the Earth rotates on its axis more quickly
    b. the Moon is closer to the Sun
    c. much of the Earth's surface is covered by water
    d. the Moon is geologically inactive

3. Approximately how much of the ocean has been explored?
    a. 95%
    b. 25%
    c. 75%
    d. 5%

4. What percent of the populations of predatory fish and shark species have been harvested by fishing the ocean since the beginning of the industrial revolution?
    a. 90%
    b. 60%
    c. 30%
    d. 10%

5. The most common organisms in the ocean are
    a. seaweeds
    b. bacteria
    c. shellfish
    d. fish

6. Most of the space on Earth for living things to live is found
    a. in lakes
    b. on land
    c. in the ocean
    d. in the atmosphere

7. Anemones and clownfish protect each other from predators. This type of relationship can
   best be described as:
    a. parasitism
    b. mutualism
    c. competition
    d. commensalisms

8. The most productive area of the ocean is the open ocean.
    a. true
    b. false

9. The relationship between coral polyps and zooxanthellae can best be described as:
    a. competition
    b. commensalism
    c. parasitism
    d. mutualism

10. The most biodiversity found on the planet Earth is located:
    a. in lakes and streams
    b. in the ocean
    c. on land
    d. biodiversity is roughly equal between the ocean and land

11. Which of the following ocean ecosystems is not dependent on sunlight as a source of energy:
    a. coral reefs
    b. kelp forests
    c. mangrove forests
    d. hydrothermal vent communities

12. Which of the following environments are not used as nurseries for many marine and aquatic species?
    a. estuaries
    b. coral reefs
    c. mangrove forests
    d. the open ocean

13. Which of the following environments is the source of most of the world's oxygen supply?
    a. the ocean
    b. tropical rain forests
    c. temperate forests
    d. agricultural crops

14. What percentage of the world's population lives within 100km of the ocean?
    a. 90%
    b. 70%
    c. 40%
    d. 20%

15. Of the following communities, which is typically the first ecosystem degraded or destroyed by coastal development?
    a. coral reefs
    b. seagrass beds
    c. mangrove forests
    d. hydrothermal vent communities

16. Which of the follow human sources contributes the largest percentage of worldwide release of oil into the ocean?
    a. urban runoff and discharges from industry
    b. air pollution
    c. oil tanker accidents
    d. drilling for oil

17. Human activity has had _____ on the health of the ocean.
    a. no impact
    b. little impact
    c. moderate impact
    d. significant impact

18. It is estimated that coral reefs contribute economic benefits of _____ annually to the global economy.
    a. $775 million
    b. $125 billion
    c. $375 billion
    d. $950 billion

19. Which of the following absorbs nearly 50% of the carbon dioxide added to the atmosphere by human activities each year.
    a. tropical rainforests
    b. the ocean
    c. wetlands
    d. temperate rainforests

20. The ocean covers approximately _____ of the Earth's surface.
    a. 40%
    b. 60%
    c. 70%
    d. 80%

Part II: Ability to Identify Oceanic Environmental Problems

21. Oceanic Environmental Problems With Which I am Familiar

Directions: In this part, please present causes and effects of environmental problems with which you are familiar: (A) up to 5 environmental problems impacting any part of the ocean; (B) up to 5 environmental problems impacting coral reefs; **Do not list any problem in more than one section**.

The example below shows you how to **include both a cause and an effect of each problem you include in your list**.

#	CAUSE	-->	EFFECT
Ex.	Removing kelp from the ocean	-->	Loss of animal food/habitat

A. Environmental Problems Impacting Any Part of the Ocean

1._____
2._____
3._____
4._____
5._____

B. Environmental Problems Impacting Coral Reefs

1._____
2._____
3._____
4._____
5._____

Part III: Attitude

Think carefully before you **circle the 'X' that best reflects how <u>you</u> feel.** There are <u>no</u> right or wrong answers. If you are <u>not sure</u> about your response to the item, <u>leave it blank</u>. **Please be completely honest.**

22. To what extent are you concerned about the environmental problems you listed in your responses to question 21A? (Environmental problems related to the ocean)

X	X	X	X	X
No Extent		A Moderate Extent		A Great Extent

23. To what extent are you concerned about the environmental problems you listed in your responses to question 21B? (Environmental problems related to coral reefs)

X	X	X	X	X
No Extent		A Moderate Extent		A Great Extent

Part IV: Additional Post Research Study Questions

24. Has this research study affected your career plans? _____ Yes _____ No Explain.
25. To what extent did this research study help you understand how global environmental problems are connected to your everyday life and community? Explain.

X	X	X	X	X
No Extent		A Moderate Extent		A Great Extent

26. To what extent will you change any aspect of how you live based on what you have learned in this research study? Explain.

X	X	X	X	X
No Extent		A Moderate Extent		A Great Extent

Questions 27, 28, & 29 omitted as not relevant to this publication,
30. Which topics did you find most interesting? Why?
31. Which topics did you find least interesting? Why?
32. If you could change something about this research study to make it more interesting to students like you, what would you change? Why?
33. As a result of your participation in this research study, do you feel more confident in the field of science? _____Yes _____ No Explain.
34. Think about when you began the research study. Has your view of the ocean changed? If so, how?
Question 35 omitted as not relevant to this publication.
36. Before this research study began, were you aware that 2008 had been designated the International Year of the Reef (IYOR)? _____Yes _____ No If yes, where did you hear about IYOR?
37. Do you have any additional comments or ideas about this research study that were not asked above?

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Amerika Birleşik Devletleri'ndeki Devlet Okullarında Okyanus Okuryazarlığı ile İlgili Bir Araştırma: Sonuçlar ve Çıkarımlar

Brian J. PLANKIS*

Meghan E. MARRERO

Özet

ABD'de yetişkinler üzerinde yapılan son araştırmalar düşük okyanus okuryazarlığı (Ocean Project, 2009b, 1999) gösterir ancak, K-12 öğrencilerinin okyanus okuryazarlığına yönelik hakemli araştırma sayısında bir eksiklik yoktur. Bu çalışmada beş eyaletten 464 K-12 öğrencisinin çevresel ve okyanus okuryazarlığına yönelik iki araştırma yapılmıştır. Amerikalı yetişkinlerin çoğu gibi, bu çalışmalarda da katılımcı öğrencilerin çoğunun okyanus okuryazarlığı hakkında düşük başlangıç seviyesi vardı. Çalışmaların her ikisi farklı öğrenci grupları ile yapılmıştır. Okyanus okuryazarlığı odaklı program, yüksek okyanus okuryazarlığına ve okyanuslara yönelik sorumlu çevresel davranışlar göstermelerini sağlamıştır. Bu çalışmanın ümit verici sonuçları ve sonuçların etkisine göre okyanus okuryazarlığı ve çevre eğitimi toplulukları, daha geniş ölçekli boylamsal çalışmaların yapılmasının desteklenmesinin Amerika Birleşik Devletleri'ndeki okyanus okuryazarlığına yönelik ilgide önemli bir artış olabileceğini göstermektedir.

Anahtar Kelimeler: Okyanus okuryazarlığı- K-12 çevre eğitimi, sorumlu çevresel davranışlar

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The Effects of Multiple Intelligences Instructional Strategy on the Environmental Awareness Knowledge and Environmental Attitude Levels of Elementary Students in Science Course

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Abstract

The aim of the research was to investigate the effects of Multiple Intelligences strategy and traditional methods of instruction on elementary students' environmental awareness knowledge levels and their attitudes towards the environment. The pre/post-test control group research model was used in this study. The research was carried out in 2009 – 2010 education-instruction year in an elementary school in Nigde, Turkiye. Totally 60 students in two different classes in the 7th grade of this school participated in the study. The data obtained in the study were analysed by the computer programme SPSS 15.0. The arithmetic means and standard deviations were calculated for each group. In order to test the significance between the groups, the t-test was used. The significance level was taken as .05. The results of the research showed a significant difference between the environmental awareness knowledge levels and attitude scores of the experiment group and the control group. It was also found out that the multiple intelligences instructional strategy activities were more effective in the positive development of the students' attitudes and their environmental awareness knowledge levels. At the end of the research, it is revealed that the students who are educated by Multiple Intelligences instructional strategy have more environmental awareness knowledge levels and have a higher motivation level than the students who are educated by the traditional methods of instruction. It was also found out that the students participated in the experimental process which multiple intelligences strategy was applied enjoyed the activities, had great fun and they became more aware of the environmental issues.

***Keywords*:** Environmental education, environmental awareness knowledge level, environmental attitude, multiple intelligences strategy, science and technology course

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Introduction

All of the factors that affect physical, biological, socio-psychological, social-economic and cultural lives of people can be defined as "the environment" (Özmen, Çetinkaya & Nehir, 2005; Şama, 2003). Broadly speaking, environment is defined as the sum total of all conditions and influences which affect the development and life of all organisms on earth (Kumar De & Kumar De, 2004).

The developments of the scientific and technological fields since the industry revolution have brought many problems with them. The developments in regard for the development of the quality of life have affected the ecosystem and led to the death of many living beings in the environment. It is the people who can say "stop" and solve these problems that threaten the environment. One of the most important responsibilities of the nations is to educate their people and to sustain "environmental education" at school so as to make them gain environmental awareness knowledge and positive attitudes towards the environment (Erol & Gezer, 2006; Palmer, 1998; Uzun & Sağlam, 2006). In this regard, it is assumed by some that increased knowledge about the environment promotes positive attitudes (Bradley, Waliczek & Zajicek, 1999).

There is a general concern about the increasing deterioration and exploitation of the natural environment (Bozkurt et al., 2005; Chacko, 1998). According to Erdoğan, Kostova and Marcinkowski (2009) and Sethusha (2006), it can be observed that most of the environmental degradation that occur today is the result of the failure of our society and educational systems to provide citizens with the basic understanding skills needed to make aware about the environment. In this sense, it can be said that it is very important to inform people about the environment and make them gain awareness and positive attitudes towards the environment since the education that will be given to people is considered to be crucial. For the success of this issue, it is essential to make students gain awareness about the environmental problems and positive attitudes towards the environment. This can only be sustained by formal education carried out at school (Ballantyne & Packer, 1996; Hungerford & Volk, 1990; Sethusha, 2006; Smyth, 2006; Uzun & Sağlam, 2006). An increased recognition of the importance of environmental education provides an important reason for developing students' understanding of the environment (Brown, 1997; Sethusha, 2006).

There are legal regulations in the world and it has been accepted that the protection of the environment is a citizenship duty. People should be educated and made aware about the environment itself in order to protect it and prevent the environmental problems. This can be sustained via formal environmental education by schools (Aslan, Sağır, & Cansaran,

2008). One of the main approaches in preventing the environmental problems is environmental education.

Environmental education aims to direct learners to explore and investigate their own surroundings or their environment (Sethusha, 2006). It is an important tool in assisting children to develop a greater understanding of their ever-changing world (Wilke, 1997). Through environmental education, it is expected that children will gain the knowledge, skills and values needed to make decisions and to take action, which will sustain rather that deplete the planet (Murdoch, 1993; Sethusha, 2006).

As Gambro and Switzky (1996) and Helden (1995) want to help children obtain more extensive knowledge and awareness of the environment, then they would be able to create teaching situations in which children's ideas and skills can be challenged and/or extended since some different occasions should be created for children to gain knowledge and awareness for the environment. As Boyes & Stanisstreet (1998) suggest, "environmental campaigns should be organised at schools for students to know more about the environment" (p.2). In this regard, research has clearly indicated that a well-trained and caring educator is the most critical element in a quality classroom (Baş, 2009; Isbell & Exelby, 2001; Phillips et al., 2000). Educators have to strive to provide children with many opportunities to expand their knowledge by actively participating in an environment that is appropriate for their level of development. A good learning environment empowers children to become confident learners (Sethusha, 2006; Stevenson, 2007). Apart from the children's level of knowledge and supporting the idea that environmental education has to be seen as a strategy in achieving environmental improvement, other studies point towards the role of educators in helping children develop environmental awareness and knowledge. In their understanding of children's knowledge and awareness, several researchers regard the educator's role as crucial (Doyle, 1977; Sethusha, 2006). As Chacko (1998) notes that "better informed and trained educators can help students become more aware of the environment with the application of some teaching methods at school" (p.66). On the other hand, environmental education is not restricted to in-class lesson plans. There are numerous ways children can learn about the environment in which they live. From experiential lessons in the school yard and field trips to national parks to after-school green clubs and school wide projects, the environment is a topic which is readily and easily accessible (Smyth, 2006).

It has been known that the basic for many environmental problems are irresponsible environmental behaviour. One of the most important influences on behaviour is the attitude. Young people's and children's attitudes are particularly crucial since these people ultimately will be affected by and will need to provide solutions to environmental problems

arising from present-day actions (Bradley, Waliczek & Zajicek, 1999). Therefore, it appears that effective environmental education for students is very important. In general, childrens' attitudes towards the environment and environmental issues begin to develop at a very earlier age. In this sense, it can be stated that increased knowledge about the environment promotes positive attitudes (Bradley, Waliczek & Zajicek, 1999). According to Şimşekli (2010), "achieving a sufficient and efficient environmental education for children would be the most important step taken on the way to prevent the probable serious environmental problems in the future. However, the place, content and methods of the environmental education in syllabuses are still a controversial matter" (p.552).

Like in many other countries, the topics about the environment are covered in syllabus within the framework of Science and Technology Education course in Turkey (Erdoğan, Kostova, & Marcinkowski, 2009; Kiziroğlu, 2000; Stokes, Edge, & West, 2001). There are studies on how formal and informal (Palmer, 1998; Wojcik, 2004) educational processes treat the issues such as children's *sensitivity to environment* and *environmental consciousness* (Atasoy & Ertürk, 2008; Gooch, 1995; Gökçe, et al., 2007; Özmen, Çetinkaya, & Nehir, 2005; Scott & Willits, 1994; Yılmaz & Andersen, 2004; Wysor, 1983), *the place and scope of environmental education* in syllabuses (Brown, 1997; Grodzinska-Jurczak, 2004; Hassan, Juahir, & Jamaludin, 2009; Hungerford & Volk, 1990; Jacobs, 1995; Jeronen, Jeronen, & Raustia, 2009; Schlottmann, 2009; Skanavis & Sarri, 2002; Stevenson, 2007; Ünal & Dımışkı, 1999), and the *shortcomings in the sources and practices* (Ballantyne & Packer, 1996; Disinger, 1982; Palmer, 1993; Goussia-Rizou & Abeliotis, 2004; Dunlap & Van Liere, 2008; Kostove & Atasoy, 2008; Schlottmann, 2009; Şimşekli, 2010), attest to the *importance of environmental education* and the necessity that it be given a broader scope with different instructional methods and syllabuses (Şimşekli, 2010).

The greatest part of the environmental education is given via science and technology, geography and biology courses before university education (Demirkaya, 2006). In this regard, for many years to get rid of difficulties in environmental education and to satisfy the needs of students and the society, new approaches for raising students' environmental awareness knowledge and attitude levels have been proposed. There are lots of different learning theories that can be used to help guide a teaching/learning process. One of them is *the theory of multiple intelligences*.

Multiple Intelligences Theory

Using Gardner's (1993) theory of multiple intelligences proposes a means to understanding many ways in which people are intelligent. That explains how we process, learn, and remember information, in contrast to the

prevailing notions of intelligence testing, which posit a general intelligence (Goodnough, 2001). Gardner (1993, 1999, 2000) states that while individuals are capable of processing information in at least eight different ways.

Gardner's theory is generally centred on the premise that there are many different types of talents or knowledge that could help to enrich one's life and respond effectively to one's environment (Douglas, Burton, & Reese-Durham, 2008, p.182). The end product of his research is the eight intelligences: (1) visual-spatial- capacity to perceive the visual-spatial world accurately and to modify or manipulate one's initial perceptions (2) bodily-kinaesthetic- abilities to control one's body movements and to handle objects skillfully (3) musical-rhythmical-abilities to produce and appreciate rhythm, pitch, and timbre, and appreciation of the forms of musical expressiveness (4) interpersonal-capacities to discern and respond appropriately to the moods, temperaments, motivations, and desires of other people (5) intrapersonal- knowledge of one's own feelings, strengths, weaknesses, desires, and the ability to draw upon this knowledge to guide behaviour (6) logical-mathematical- the abilities to discern logical or numerical patterns and to handle long chains of reasoning and (7) verbal-linguistic-sensitivity to the sounds, rhythms, and meanings of words; sensitivity to the different functions of language (8) naturalistic- the potential for discriminating among plants, animals, rocks, and the world around us, as used in understanding nature, making distinctions, identifying flora and fauna (Douglas, Burton, & Reese-Durham, 2008, p.182-183). In light of this, the application of the theory comes in the form of making use of instructional techniques that align with the standards and practices of Multiple Intelligences.

It is crucial for teachers to care about multiple intelligences in their courses. There are ten top reasons why teachers should care about Multiple Intelligences in the classroom of which using of multiple intelligence in the classroom will better prepare students for tomorrow's complex making, making the curriculum accessible to all students, and making the content area engaging and exciting to all students are only three (Kagan, 2000). Students should be taught based on their ability and ways of learning; active and involved teaching is a step towards students' academic success. Multiple Intelligences theory asks the question, in what ways are students smart, rather than, are they smart. Teachers generally adopt the belief that most of the students are capable of achieving; Multiple Intelligences instructional strategy considers this and indicates the materials, instructional strategies that will bring forth such success (Denig, 2004).

Traditionally, school has been directed at verbal-linguistic and logical-mathematical intelligences (Emig, 1997). Students who are weak in neither of these intelligences are usually disadvantaged in school. The learning of science should entail more than the verbal-linguistic and logical-

mathematical intelligences; teachers should capitalise on all ways of knowing (or all of the multiple intelligences) in order to make science more meaningful, relevant, and personalised for all students (Goodnough, 2001).

Multiple Intelligences theory offers teachers eight ways of teaching and eight ways of learning to students. The theory of Multiple Intelligences offers eight ways of teaching and learning styles. In this regard, armed with the knowledge and application of the multiple intelligences, teachers can ensure they provide enough variety in the activities they use so that as much of their pupils' learning potential can be tapped as possible (Baş, 2010). Some teachers are not in favour of using Multiple Intelligences in the classroom since there occurs some problems (Baş, 2010) and some of the teachers are strictly tied to traditional methods of instruction, because it is very easy to use traditional methods of instruction so that the teacher generally address the information verbally and the students have to listen to it carefully and get what they hear. In this sense, traditional instruction involves teachers' detailed lecture or presentation and students' questions during or after the session. On the whole, the students remain passive in the class (Demirel, 2005). Teachers want to make their students learn things shortly and fast and also traditional instruction methods save time so that teachers mostly prefer traditional methods of instruction in their classrooms (Ahmad & Mahmood, 2010). However, teachers using Multiple Intelligences have to work hard on the course plan and organise the learning environment in order to address in eight ways of learning to the students in the classroom. The work of Vygotsky (1978) is very important since he emphasised the role of "social atmosphere/interaction". He sees children as constructing their understating from the social interaction of their learning contexts with all its possibilities and limitations. In this regard, as Anning (1991) suggests that children are unique in what they bring to the learning experience but tend to draw on the same kinds of learning strategy. This means that we must think of learners as having individual differences so that teachers need to pay attention to the organisation of their classrooms. They must also consider their students' "intelligence types/profiles" (Gardner, 1993) in the classroom.

Reviewing the literature about the environmental education, multiple intelligences and its applications in classrooms revealed that many schools started to integrate the Multiple Intelligence instruction strategy into their classrooms and even whole curriculum and many researchers have carried out studies to investigate the effects of this strategy on many disciplines apart from science and technology. Various studies about Multiple Intelligences instruction strategy yielded different results in terms of its usage in classrooms. Therefore there is a need to investigate the effects of Multiple Intelligences instructional strategy in the environmental education at elementary level of education.

Several researchers have noted that the knowledge and awareness of students with regard to the environment are at a low level (Sethusha, 2006). So, the current research examines how Multiple Intelligences instructional strategy affects the environmental awareness knowledge and environmental attitude levels of students in Science and Technology course. The results suggest that performance on a post environmental education assessment for students exposed to Multiple Intelligences instructional strategy will show considerable increase when compared to those taught using traditional methods of instruction.

It is suggested that in our educational system that we have emphasised the linguistic and logical-mathematical intelligences. As we learn more about the mind and how it learns, we should consider earning activities that draw on a wider variety of intelligences and give students a better chance to develop their strengths, apply them to a greater range of problems and challenges, and showcase their knowledge and attitude levels (Alaz, 2009).

The main purpose of this study is to stress the importance and functions of the techniques and methods which take into consideration students' individual differences. In this regard, it is believed that students will gain the needed knowledge, awareness and attitudes towards the environment in terms of learning by multiple intelligences strategy. The applications in this study are believed to be used widely in the environmental education whether the applications become successful.

The research was done for determining the applicability of multiple intelligence theory on the environmental education and aiming to show the effects of this theory to the students' environmental awareness knowledge levels and attitudes towards the environment which inclined environmental education for developing in a positive way.

The problem of the current research was to determine whether elementary students achieve higher environmental awareness knowledge and environmental attitude levels when they are taught using Multiple Intelligence instructional strategy than when they are taught using the traditional methods of instruction. Subsequently, the aim of this research was to summarise and evaluate the subset of literature that has special relevance to the comparison of Multiple Intelligence instructional strategy and traditional methods of instruction.

In order to identify the differences between the students of the experiment group and the students of the control group, the following sub-problems were tried to be evaluated in the light of the acquired data in the study:

1. Is there a significant difference between the environmental awareness knowledge test scores of the students in the experiment group

and the students in the control group in terms of the usage of Multiple Intelligences in the teaching process?

2. Is there a significant difference between the environmental attitude test scores of the students in the experiment group and the students in the control group in terms of the usage of Multiple Intelligences in the teaching process?

Methodology

Research Design

An education programme was prepared in order to make students develop their environmental awareness knowledge and attitude levels. In this study, an experimental method with a control group has been used (Karasar, 2005) in order to find out the difference between the students who were taught by multiple intelligences instructional strategy in the experimental group and the students who were taught by traditional instructional methods in the control group. The pre/post-test group research model is one of the most widely used research models in educational sciences (Dugard & Toldman, 1995).

Both groups were employed a pre-test and pre-attitude test prior to the experimental process. The subjects were given an environmental awareness knowledge and attitude scale tests towards the environment as a pre-test. Meanwhile, both the environmental awareness knowledge and attitude scale tests were employed to both groups after the experimental process as a post-test. Pre-test/post-test experimental design with a control group was used in the study (Karasar, 2005; Kerlinder, 1973). In this design, which uses two groups, one group is given the treatment and the results are gathered at the end. The control group receives no treatment, over the same period of time, but undergoes exactly the same tests (Kerlinder, 1973). A small number of homogenous subjects provided us with information over a period of four weeks. To begin with, the subjects described what they actually did in the process of Multiple Intelligences instructional strategy.

Subjects of the Study

Two classrooms of 7th grade class students from an elementary school in Nigde, Turkey formed the subjects of the study. This study was performed amongst 60 elementary school students. 30 students from the 7-A class formed the experiment group and the rest of the students (30 students) from the 7-C class formed the control group of the study. The main reason for choosing this level was that in the reaching sequence of Turkish science and technology classes, topics related to the environment is first introduced to students at this level in the integrated science and technology courses. All of the students in the study were about 13 years old. There were 18 (60%) male, 12 (40%) female students in the experimental group and 16

(53%) male, 14 (47%) female students in the control group. The families of the students in both groups had similar socio-economic backgrounds. The groups can be seen in the experimental design in Table 1 below:

Table 1. Organisation of the experiment and the control groups

Experimental Group	The group on which multiple intelligences instructional strategy was applied
Control Group	The group on which traditional instructional methods were applied

In order to investigate students' environmental awareness knowledge levels and their attitudes towards the environment, a specific lesson plan was prepared for the students in the experimental group. The environmental awareness knowledge and the attitude scale tests towards the environment were administrated to both groups in a single session as a pre-test. In four weeks, the experiment group was given various strategies for multiple intelligences in the teaching session, but not the control group. Four weeks later, each of the groups was administrated the environmental awareness knowledge and the environmental attitude scale tests given as a post test. As Manson & Bramble (1997) pointed out that the longer the time spent, the greater the probability that something could influence the subjects' environment that in turn would affect the results. Duration of four weeks was deemed appropriate to see the effects of the experimental treatment.

Procedures of the Study

In the experiment group, the following procedures have been applied. In the control group, traditional instructional methods have been used in the process of the study. The design of the study can be described as in the table below:

Table 2. Experimental design used in the study

Groups	Pre test	Experimental Design	Post test
Experiment	$T1_{12}$	Multiple Intelligences Strategy	$T2_{12}$
Control	$T1_{12}$	Traditional Instructional Methods	$T2_{12}$

$T1_1$ ⟶ Environmental Awareness Knowledge Test

$T1_2$ ⟶ Environmental Attitude Scale Test

As can be seen in Table 2 above, one can see the scales applied on the subjects of the study. The environmental awareness knowledge and attitude scale tests were applied on the subjects of the study for two times before and after the experimental process.

This instructional treatment was conducted over four weeks in the 2009-2010 first term at an elementary school in Nigde, Turkey, 7th grade students of two classes were enrolled in the study. The classes were selected randomly from the other classes of the elementary school. Firstly, the environmental awareness knowledge and the environmental attitude tests were performed as a pre-test. In the next step, the environmental awareness courses of the elementary school 7th grade students were taught to the control group by using the traditional instruction methods and to the experiment group by using the Multiple Intelligences strategy.

After the environmental topics to be studied were selected, the researcher developed related activities for the procedure. It was crucial to develop appropriate techniques and provide necessary materials that reflect the principles of Multiple Intelligences Theory. Drawing on relevant research all activities were developed by the researcher. Lesson plans for the procedure were based on Gardner's (1993, 1999) suggestions on teaching for a deep learning. In this study, experiment group studied the topics of the environment through Multiple Intelligences based activities while the control group studied the same topics through more traditional activities.

In the control group, the teacher directed strategy represented that the traditional instructional methods were used in the course. The student was instructed only with traditionally designed environmental text. Mostly of time, the teacher presented the topic and the students listened to their teacher and answered the questions asked by their teacher. At the same time they carried out activities in their text-books. The instruction for the control group varied in the following ways. In terms of direct instruction, the practice best applicable to this method was drill and practice; students were taught the objectives through teacher-directed lectures, notes on the overhead, notes on the board, practice problems from the textbook, teacher developed worksheets, and the student workbook, which accompanies the text. However, in the experimental group, the activities were prepared in light of Multiple Intelligence theory. Different types of activities were taken for different types of intelligences of students by taking the lesson plan samples prepared for the Multiple Intelligences instruction strategy.

The environmental awareness course assessed was developed and taught as a separate course of science content courses in elementary education. All courses attempted to model eight ways of multiple intelligences. The course structure incorporated two major conceptual frameworks for instruction. One was the multiple intelligences learning ways (Armstrong, 2000), and the other was a model for teaching environmental education which incorporated understanding ecological and environmental concepts with values clarification and action group projects (Van Matre, 1990). In the beginning of the study, the students were appointed to eight multiple intelligences heterogeneous centres. These

heterogeneous centres were created according to the principles of multiple intelligences theory. The students were given subjects dealing with some of the topics of the environment such as "air/water/soil pollution, global warming, tree/forest protection, forest fires, erosion, etc." The students worked in identical multiple intelligences centre so that the students were made to work on at least four different subjects of the environment in the centres.

Firstly, students studied the environmental topics in working centres. The experimental process of the study was as below:

Table 3. Experimental process applied in the study

Verbal-Linguistic Intelligence Centre	The procedure started with a reading session as a whole class-activity. The reading text, which was about the environment and its problems, was written by the researcher. It was hoped that this topic would be interesting for the students especially for the ones with highly developed verbal-linguistic intelligence. Before the text was given to students, some pictures of the environment and its problems were demonstrated to draw students' attention and provide a preparation for the topic to be taught. The students were asked some questions about the text itself
Musical Intelligence Centre	The participants listened to a selection of the environmental problem sounds (i.e., sound of a fire, flood, etc.). As a second musical activity, they learnt a song adapted and changed from English into Turkish, "We are the World". The lyrics of this song were changed by the researcher in order to cover the basic vocabulary and insight of the environment.
Visual-Spatial Intelligence Centre	Students watched some documentary on the problems of the environment. Also, they were made to draw pictures on the problems of the environment and these pictures were demonstrated at school.
Bodily-Kinesthetic intelligence Centre	The students played a game which was developed by the researcher and then they acted out a drama which reflected the problems of the environment at school.
Interpersonal Intelligence Centre	Students organized an "environment club" at school and then made short visits to the classrooms in their school and to the people in their hometown and informed them about the problems of the environment. They also published information cards about the problems of the environment and then distributed them both to the students and the people around.

(Table continues)

Table 3. (continued)

Intrapersonal Intelligence Centre	Students were given pictures about the past and the present conditions of the world and they were asked to compare these pictures and then empathise the people and animals living in these places of the world.
Naturalist Intelligence Centre	Students tripped to the rural area of the city and some of the environmental problems were introduced and then students were made to plant trees in the garden of their school. Also, in this intelligence centre, students were provided with a map of the world on which various environmental problems were distributed according to their hometowns along with their features, there were also many environment and nature magazines both in English and Turkish languages.
Logical-Mathematical Intelligence Centre	Students investigated the environmental changes of their hometown during ten/twenty years via the Internet and other sources.

Secondly, the students created projects and activities according to the profile of their intelligence centre. When the students created their projects, they were reassigned to different groups in order to make them work in different multiple intelligences centres. The students studied on the environment by using different means of learning such as reference books, the internet, video conferencing, interviewing, etc. The students also learnt more from other resources including the teachers at school. In this process, the teachers helped the students for finding the materials and information, etc. for the creation of their projects. Following the learning cycles, students participated in collaborative action group team which selected a local or regional environmental issue and studies them in both scientific and social contexts. The students in these multiple intelligences centres studied in eight groups so that they studied to gain awareness towards the environment. The main aim in this education was to develop skills and qualifications important for nature conservation, such as sensitivity for the environment, knowledge about nature and ecology, environmentally responsible emotions and values, understanding of environmental questions, critical thinking skills, social action skills, ethical growth, and responsible environmental behaviour (Jerosen, Jerosen, & Raustia, 2009).

Instruments

Environmental awareness knowledge test. In order to collect the data related to environmental awareness knowledge of the students, "the environmental awareness knowledge test" developed by the researcher was

conducted. A multiple-choice test including fifty items (each item is 2 points; total score is 100), the reliability and validity of which have been made. This test is used to measure the students' knowledge levels of the environmental awareness. The test items which measure the objectives of environmental awareness knowledge levels of the students in the science and technology course in the elementary school curriculum in Turkey.

The test was administrated on a total number of seventy-five students in an elementary school. In the first place, the item and test statistics of the achievement test were computed for reliability and validity. The reliability of the knowledge test was done by KR-20 method (Tekin, 1996; Yılmaz, 1998) so that the reliability value of the test was found as r = .84 and the test difficulty (Pj) was found as .57 and the test discrimination (rjx) was found as .45 so that it is revealed that the test is reliable and it was applied on the students both in the experiment and the control groups.

Table 4. Statistics for the environmental awareness knowledge test

Number of the Students	Number of the Question	$\overline{X}$	Std. Dev.	KR-20	Average Test Difficulty	Average Discrimination of the Test
60	50	66.82	11.04	0.84	0.57	0.45

As looked at the table above, the environmental awareness knowledge test has a reliability of .84, an average level of test discrimination (.45) and an average level of test difficulty (.57). In the light of the data gathered for the knowledge test, it can be said that the test has a high level of reliability, a medium level of difficulty and a high level of test discrimination.

Environmental attitude scale test. In this research, the "*attitude scala towards the environment*" was used in order to measure students' attitudes towards the environment. The scale was developed by Leeming, Dwyer & Bracken (1995). The scale was rearranged by having done the reliability and validity studies and used to evaluate the attitudes of elementary school students towards the environment by Aslan, Sağır, and Cansaran (2008). The scale was both translated and then adapted into Turkish by the researchers themselves. In the reliability and validity studies of the scale, the survey model was used. The attitude scale test was applied to measure the attitudes of the students towards the environment in the study. The attitude scale test is a *five-point likert type scale* (which was used to differentiate orientations from 1 as *low* and 5 as *high*) reliability and validity of which have been made by t-test, including 24 items that measure students' attitudes towards the environment. The reliability value of the attitude scale test was found as r = .86 and the *Cronbach's Alpha* value was found as α = .86. The mutual factor variances of the items differ between .333 and .717 in the scale. The Kaiser-Meyer-Olkin (KMO) sampling adequacy result was found as .874 and the Bartlett test result

was found as $\chi^2 = 2279.979$ ($p = .000$). These results show that there is a strong correlation amongst the items. In light of the data, it can be said that the attitude scale test is both reliable and valid to be used in the current research.

Analysis of the Data

In this study, the statistical techniques such as *mean* ($\overline{X}$), *standard deviation* (Std. Dv.) and *t-test* were used in the analysis of the data. *P value* was held as 0.05. Significance level was decided by taking *p* values into consideration $p > 0.05$, meant there was not a meaningful difference, $p < 0.05$ meant there was a meaningful difference. The statistical analyses have been made by means of *SPSS 15.0* statistical package programme for windows.

Limitations of the Study

Small sample size is one of the limitations of the study. The number of the participants in the study was limited to the number of 7th grade class students (totally 60 students) in an elementary school in Nigde, Turkey. Another limitation arises from the subject of science and technology course since "*human and environment unit*" was used in the experiment and the control groups. In the experiment group, Multiple Intelligences instructional strategy was used. In the control group, traditional instructional methods were used in the study. On the other hand, the study is also limited to the statistical evaluation of comparison of pre-test and post-test of students.

It was aimed to examine and observe how the Multiple Intelligences instructional strategy influences students' gaining of environmental awareness knowledge and environmental attitudes in this study. The findings obtained from this study cannot be generalized to other settings.

Findings

Analysis of the 1st Sub-Problem

The first sub-problem of the study was "Is there a significant difference between the environmental awareness knowledge test scores of the students in the experiment group and the students in the control group in terms of the usage of Multiple Intelligences in the teaching process?"

Table 5. Comparison of pre-test scores of the students in the experiment and the control groups

Groups	*N*	$\overline{X}$	*Std. Dv.*	*df*	*t*	*p*
Experiment	30	19.0	12.2	58	-0.277	0.78
Control	30	19.9	12.1			

In Table 5 above, the pre-test environmental awareness test scores of the students in the experiment group and the control group have been

compared. The average score of the students in the experiment group has been found as $\overline{X}$= 19.0±12.2; and the average pre-test score of the students in the control group has been found as $\overline{X}$= 19.9±12.1. The difference between the students of these two groups has been analysed through the independent t-test. The accounted t-value is $t_{(58)}$ = -0.277. According to these results, there is no statistically significant difference between the pre-test scores of the students of these two groups in 0.05 level (p = .78, p > .05).

Prior to study's experimental process, it can be said that both groups' pre-learning levels on the environmental awareness knowledge levels are equal to one another.

Table 6. Comparison of post-test scores of the students in the experiment and the control groups

Groups	*N*	$\overline{X}$	Std.Dv.	*df*	*t*	*P*
Experiment	30	60.8	11.8	58	4.02	0.0002*
Control	30	47.5	13.8			

The post-test environmental awareness test scores of the students in the experiment and the control groups have been compared in Table 6 above. The average post-test score of the students in the experiment group has been found as $\overline{X}$= 60.8±11.8; and the average post-test score of the students in the control group has been found as $\overline{X}$= 47.5±13.8. The difference between the two groups has been analysed through the independent t-test. The accounted t-value is $t_{(58)}$ = 4.02. The students in the experiment group ($\overline{X}$= 60.8) showed significant environmental awareness knowledge levels compared to the students in the control group ($\overline{X}$= 47.5). So according to these results, it can be said that there is a statistically significant difference between the post-test scores of the two groups in 0.05 level (p = .0002, p < .05). In this regard, it can be clearly stated that the students gained more environmental awareness knowledge compared to those in the control group. Activities based on Multiple Intelligences theory have more positive impact on the students for gaining knowledge on the environmental awareness than the students who are taught by traditional instructional methods.

Analysis of the 2nd Sub-Problem

The second sub-problem of the study was "Is there a significant difference between the environmental attitude test scores of the students in the experiment group and the students in the control group in terms of the usage of Multiple Intelligences in the teaching process?"

Table 7. Comparison of pre-test attitude scores of the students in the experiment and the control groups

Groups	*N*	$\overline{X}$	*Std.Dv.*	*df*	*t*	*p*
Experiment	30	2.00	1.26	58	-0.104	0.92
Control	30	2.03	1.22			

In Table 7 above, the pre-attitude scores of the students in the experiment and the control groups could be seen. The average pre-test attitude score of the students in the experiment group has been found as $\overline{X}$ = 2.00±1.26; and the average pre-attitude score of the students in the control group has been found as $\overline{X}$ = 2.03±1.22. The accounted t-value between the average scores of the two groups is $t_{(58)}$ = -0.104. The data obtained are not statistically significant in 0.05 level since the pre-test attitude scores of the students in these two groups are similar.

Table 8. *Comparison of post-test attitude scores of the students in the experiment and the control groups*

Groups	*N*	$\overline{X}$	*Std.Dv.*	*df*	*t*	*p*
Experiment	30	4.17	0.874	58	4.50	0.0001*
Control	30	2.83	1.37			

The post-attitude scores of the students in the experiment group and the control group can be seen in Table 8 above. The average post-attitude score of the students in the experiment group has been found as $\overline{X}$ = 4.17±0.874; and the average attitude post-test score of the students in the control group has been found as $\overline{X}$ = 2.83±1.37. The t-test value obtained from the average scores of the two groups is $t_{(58)}$ = 4.50 which shows a statistically significant difference (p = .0001, p < .05). In light of the data acquired in the research, it can be said that the students in the experiment group have reached higher attitude scores compared to those in the control group. The experiment method where multiple intelligences based teaching was applied has enabled the students to develop positive attitudes towards the environment.

Conclusion

On the basis of the findings in the research above, the following conclusions can be put forward below:

1. There is a significant statistical difference between the environmental awareness knowledge levels of the students who have been educated by multiple intelligences strategy and the students who have been educated by the traditional instructional methods.

The students who have been educated by multiple intelligences strategy have gained more environmental awareness knowledge than the students who have been educated by the traditional teaching methods.

2. In terms of the attitude towards the environment, there is a significant statistical difference between the experiment group and the control group. The students who have been educated by multiple intelligences strategy have been found out to have more positive attitude levels to the environment than those who have been educated by the traditional instructional methods.

Discussion

As a result of the study, it was found out that there is a significant statistical difference between the environmental awareness knowledge levels of the students who have been educated by multiple intelligences strategy and the students who have been educated by the traditional instructional methods. The students who have been educated by multiple intelligences strategy have gained more environmental awareness knowledge than the students who have been educated by the traditional teaching methods. The results of this study are consistent with the larger scale research conducted by the creator of Multiple Intelligences and its principles, Gardner, in which the purpose was to understand and enhance learning, thinking, and creativity in the arts, as well as humanistic and scientific disciplines, at the individual and institutional levels (Douglas, Burton, & Reese-Durham, 2008). As Al-Balhan (2006) reported that the students whose multiple intelligences were applied to learning, performed better overall academic success than the students in the control group who studied traditional teaching methodology. Although there are few studies which work directly on the effects of multiple intelligences on environmental education (Çolak, 2005), there are studies which reflect the effects of multiple intelligences on other subjects. The findings obtained from this study, resembles other studies which evaluate the instruction methods depending upon Multiple Intelligences Theory for the student success, knowledge levels and attitudes. In the studies carried out on Multiple Intelligences, it has been seen that Multiple Intelligences Theory has increased the success, conceptual understanding and attitudes of students, when compared with traditional methods of instruction (Kaya, 2002). Some other studies support our results. For example, Ucak, Bag, & Usak (2006) investigated whether there is a significant difference between multiple intelligence instruction and traditionally designed science instruction on students' understanding of concept with the "the Structure of material and its transformation" unit. As a result of this study it was found out that multiple intelligence theory, when compared to the

traditional instruction methods, created positive effects on students' knowledge levels. The studies carried out by Acat, (2002), Açıkgöz, (2003), Akamca and Hamurcu, (2005), Alaz, (2009), Bümen (2001), Campbell (1989), Canbay (2006), Coşkungönüllü (1998), Dilek (2006), Douglas, Burton, and Reese-Durham (2008), Gazioğlu (2006), Güneş (2002), Gürçay and Eryılmaz (2005), Kaptan and Korkmaz (2000), Kaya (2002), Korkmaz (2001), Mehta (2002), Nyugen (2000), Oran (2006), Öz (2005), Özdemir (2006), Şahin (2001), Sezginer (2000), Temur (2007), and Yıldırım and Tarım (2008) have parallel results with the results of the current study.

In terms of the attitude of students towards the environment, it was found that there is a significant statistical difference between the experiment group and the control group. The students who have been educated by multiple intelligences strategy have been found out to have more positive attitude levels to the environment than those who have been educated by the traditional instructional methods. In this regard, it can possibly be said that the results of the current study show that students have positive attitudes towards the environmental problems. These results support the findings of previous studies that showed students' positive attitudes towards the environment. For example, the results of the studies carried out by Akamca and Hamurcu (2005), Bümen (2001), Dilek (2006), Gazioğlu (2006), Kaptan and Korkmaz (2000), Kaya (2002), Korkmaz (2001), and Şengül and Öz (2008) correlate with the results of the current study. On the other hand, there are other studies which reflect the positive results of the environmental education on students' attitudes towards the environment. For instance, Smith-Sebasto and Cavern (2006) studied the effects of pre- and post trip activities associated with a residential environmental education experience on students' attitudes towards the environment. At the end of this study, it was revealed that students who were educated with pre- and post trip activities associated with a residential environmental education gained more positive attitudes towards the environment. This conclusion correlates the conclusion of our study since the students in the current study made environmental trips and planted trees on some of the places in the garden of their school in terms of by using the "natural intelligence" of the theory of Multiple Intelligences. Çolak (2005) investigated the application on the environmental education by using the theory of multiple intelligences so that he found out that the students showed more positive attitudes towards the environment than those which traditional instructional methods were used. In a similar study, Kyridis *et al.* (2005) analyzed the attitudes of pedagogical students towards environmental education in Greece. The results of this study show that pedagogical students have not only realized the importance of environmental education in primary education but have also been sensitized to the environment and the issues involved in this. Attending practical courses on the environment seems to help towards this sensitivity. In this regard, the students participated in our study stated

that they have liked the environment very much and have gained sensitivity towards the environment and its problems so that the conclusion of Kyridis *et al.* (2005) correlate with the results of our study. Some other studies support our results. For example, the results of the studies carried out by Al-Raabani and Al-Mekhlafi (2009), Bradley, Waliczek, and Zajicek (1999), Brown (1997), Cohen and Wingerd (1993), Demirbaş and Pektaş (2009), Jaus (2006), Soussan (1992), Stepaniak *et al.* (1998), and Volk and Cheak (2003) correlate with the results of the current study.

Champell (1997) states that in the primary school whose instruction is arranged with activities that include the eight fields of the theory, the applications provide the satisfaction of student, teacher and parents. Hoerr (2004) states that Multiple Intelligence Theory affects the instruction styles undoubtedly, but looking at the Multiple Intelligences theory only in terms of instruction and pedagogy means ignoring its great contributions in New City School. Bradley, Waliczek, and Zajicek (1999) in their study found out that there is a significant relationship between students' environmental knowledge and environmental attitudes since it is assumed by some that increased knowledge about the environment promotes positive attitudes (Arcury, 1990; Arcury & Christianson, 1990). In the current study, results indicated significant differences in both knowledge gain and attitudes of students after exposure. Students' environmental knowledge scores increased after they completed the environmental science education based on Multiple Intelligences instructional strategy. In addition, the students' environmental attitudes became more environmentally favorable. These results of the current study correlate with the results of the studies carried out by Arcury (1990) and Arcury and Christianson (1990).

As a result of the obtained results from the study; it is seen that the instruction strategy depends upon the Multiple Intelligences instructional strategy has made positive contributions for the students' attitudes towards the environment and their environmental awareness knowledge levels. The thoughts of the experiment group about the studies in the lesson and the class activities made support to the statistical findings. It has been observed that the experimental group, during the lesson, participated actively in practices like writing poems and stories, composing/singing songs, drawing schema/pictures which summarize what they understand, using worksheets, playing games amongst groups. Besides, the students stated that they took pleasure from the course and they did not get bored during the courses. The researcher in this study saw that the analysis of the experimental study has indicated that the experimental group students' environmental awareness knowledge level was significantly higher than those taught using traditional instructional methods. The most important thing in the research was the experimental

group students had more fun when they were learning so that they did, touched, saw, and talked about the things they learnt and they also had the change of socialization and cooperation which are more important for them in these ages (Piaget, 1951; Vygotsky, 1962). The researcher also sees that Multiple Intelligences instructional strategy helps students develop such skills as; physical, intellectual, social and emotional skills which are the skills the students have to develop. In the process of the experimental instructional study, students used different types of intelligences. In the experimental process, the students created projects integrating eight types of intelligences in the theory of Multiple Intelligences. By this way, the students not only had high environmental awareness knowledge levels in science and technology course, but they also had chance to practice their different skills such as drawing, writing, thinking, criticizing, etc. as well as using their different intelligence types like spatial, musical, verbal, social intelligences, vs.

Due to the length of the current research conducted, two of the four improvements were observed: improved environmental awareness knowledge levels and positive environmental attitude improvements. Therefore, it can be concluded that as compared with the traditional instructional methods, Multiple Intelligences strategy garners significant increases in several areas of importance to a student's academic, social, and emotional well-being. In the classroom, this task is accomplished by developing innovative lesson plans that will meet the needs of a diverse learning population. In conclusion, on the basis of the gathered findings in the study it can be said that Multiple Intelligences instructional strategy can be used in the environmental education effectively.

Suggestions

As a result of this study, in which the effects of multiple intelligences learning strategy on attitude levels of students towards the environment have been examined, the following suggestions can be given depending on the findings obtained in the research:

1. In light of the gathered data in the study, Multiple Intelligences strategy has been found out to be more effective on students' environmental awareness knowledge levels and attitudes towards the environment than the traditional instructional methods. So, it is recommended that the teachers should use this strategy in the environmental education in a separate course or in science and technology courses.
2. Seminars and courses should be organized so as to train teachers both on the theory and practice to use this strategy effectively in

their classrooms so that they can create a more positive classroom atmosphere for the environmental education.

3. Teachers should direct the process of the strategy effectively so that if they cannot direct the strategy effectively, students can be frustrated and demoralized, they can be bored with the activities so that the strategy can be unsuccessful from the beginning of the process of instruction.
4. Teachers should try to use eight types of intelligences in the theory of multiple intelligences as far as they can.
5. Subjects should be added in elementary courses in order to develop students' environmental awareness and environmental attitudes by using the theory of multiple intelligences.
6. A specific "environmental education" course should be implemented in the elementary curriculum so that students can develop positive environmental attitudes and gain environmental awareness from the earlier ages.
7. Environmental education should be made so as to make students participate in activities (i.e., indoor or outdoor) actively so that the activities should be organized carefully.
8. "Environmental Protection" clubs in elementary schools should be developed in order to better train students so as to make them gain more environmental awareness and positive environmental attitudes.
9. The school curriculum should be reassessed and then the environment awareness units should be integrated with the other school subjects at elementary level of education. In this regard, students should be educated on the environmental problems and issues not only in science and technology course, but they should also be educated on the environmental problems and issues during the other courses at school.
10. Further studies should be carried out on the effectiveness of multiple intelligences on the environmental education in elementary schools in different districts.
11. Further studies should be conducted using Multiple Intelligences in other subject areas.

12. Studies should also be conducted in different cultures amongst students attending private and government institutions as well as different residential areas.
13. Studies should be carried out in order to reflect the views of parents.

♦ ♦ ♦

Biographical statement

Gökhan Baş, MS, works in Selcuk University Educational Sciences Department. His research interests include educational administration and supervision, curriculum and instruction, educational psychology, multiple intelligences, environmental education, computer assisted language teaching, and educational measurement and evaluation. He has had many published international and national articles in the stated disciplines. He has the award of International English Education Research Association's 2009 outstanding article award.

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Çoklu Zeka Öğretim Stratejilerinin Fen Bilgisi Dersinde İlköğretim Öğrencilerinin Çevre Bilinci Bilgisi ve Çevresel Tutum Düzeyleri Üzerine Etkisi

Gökhan BAŞ*

Özet

Araştırmanın amacı, çoklu zeka stratejisinin etkisini ve geleneksel eğitim alan ilköğretim öğrencilerinin çevre bilinci bilgisini ve çevreye yönelik tutumlarını araştırmaktır. Çalışmada öntest-sontest kontrol gruplu araştırma modeli kullanılmıştır. Araştırma Niğde, Türkiye'de 2009-2010 eğitim-öğretim yılında ilköğretim okulunda gerçekleştirilmiştir. Araştırmaya iki farklı 7. sınıftan toplam 60 öğrenci katılmıştır. Veriler SPSS15.0 bilgisayar programı ile analiz edilmiştir. Her grup için aritmetik ortalama ve standart sapma hesaplanmıştır. Gruplar arasındaki farklılığı tespit etmek için t-testi kullanılmıştır. Anlamlılık değeri .05 olarak kabul edilmiştir. Sonuçta deney grubu ve kontrol grubu arasında çevre bilinci bilgisi ve çevresel tutum düzeyleri arasında anlamlı fark çıkmıştır. Ayrıca çoklu zeka stratejilerinin öğrencilerin çevre bilinci bilgisi ve çevresel tutumları üzerinde etkili olduğu tespit edilmiştir. Araştırmanın sonunda çoklu zeka kuramı stratejisi ile eğitim alan öğrenciler geleneksel eğitim alan öğrencilere göre daha yüksek çevresel bilinci bilgisi ve motivasyona sahip oldukları anlaşılmıştır. Deneysel etkinliklerde çoklu zeka uygulamalarına katılan öğrenciler etkinliklerden hoşlandıklarını, çok eğlendiklerini ve çevresel konulara yönelik farkındalıklarının arttığı gözlenmiştir.

Anahtar Kelimeler: Çevre eğitimi, Çevre bilinci bilgisi düzeyi, çevreye yönelik tutum, çoklu zeka stratejisi, fen ve teknoloji dersi.

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INSTRUCTIONAL PRACTICE

Safely Caring for Animals during Inquiry Investigations: Exploring Microecosystems

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"Science is a process of discovering and exploring the natural world. Exploration occurs in the classroom, laboratory or in the field. As part of your science class, you will be doing many activities and investigations that will involve the use of various materials, equipment, and chemicals…" (NSTA, 2010). Safety is always of utmost importance in an inquiry based science program and special safety rules and cautions apply when students keep and use animals in their classes.

Students' interactions with living things are important to monitor carefully because students likely don't know as much about animals as the teacher. All student interactions with animals in the classroom must be supervised. Without careful supervision, students could hurt an animal or an animal could hurt students. Furthermore, students should not remove animals from their enclosures; the teacher should do this to reduce the chances of harming or stressing any of the animals utilized in science investigations.

Space and privacy are very important factors to consider when live animals are part of students' investigations. Animals should be provided spaces that are appropriate for that species, such as a cage or aquarium, and the necessary materials within their environments for certain critters to hide. Most animals that are appropriate for classroom explorations tend to hide more than not during the day so they should be provided the environment to do so. The lack of privacy can drastically increase stress for some animals, which can be fatal sometimes.

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If preserved animals are part of an investigation, perhaps for dissections, doing so safely involves caution because of the chemicals used to preserve specimens. Proper handling of preserved specimens includes protection with latex gloves and possibly wearing facemasks. If using preserved organisms is unacceptable in a science program, safe alternatives to preserved specimens are plastic or rubber models. Of course, students directly observing once-living specimens can have profound effects on students; but safety concerns for humane treatment to animals may override the decision to use preserved specimens.

Sick animals can, potentially, pass their disease to humans depending upon the infection. Students should not touch, or in any way interact, with a sick animal; nor should they touch the droppings. Only the teacher should handle sick animals and then only if necessary and while wearing gloves. Disease-causing organisms should be kept in locked enclosures where only the teacher has access. If an animal is very sick, the teacher should consider taking it to a vet. If medication is required, of course the teacher should administer the dosage.

Some spiders and snakes produce venom, which can pose serious dangers to humans if bitten. If the teacher is going to display such creatures, extreme caution must be exercised; for example, securely locked cages may be displayed for the students but cages must be kept in a secure location where only the teacher has access.

The legalities of displaying and keeping animals in the classroom are extremely important to teachers, administrators, parents, and the school district. In addition to safety considerations for all involved, laws exist that are designed to protect animals, especially those on endangered lists. Perhaps special permits are required for keeping or experimenting with certain animals. It is the responsibility of the teacher and administrators to know and follow the laws and procedures for safely and humanely including animals in the school curriculum. Students can learn a great deal working directly with animals but their investigations must be done safely and humanely.

Applying Safety Guidelines during an Investigation

Let's do an investigation that includes the use of animals and identify places where safety guidelines apply. The following investigation represents open-ended inquiry with minimal structure, as compared to a learning cycle (Marek, 2009; Marek and Cavallo, 1997), which is structured inquiry. This long-term activity uses animals and is designed to allow students to set up a special biological system and to discover a variety of concepts associated with or inherent in an aquatic microecosystem.

Engage students in the investigation with the question: what is a microecosystem? Students likely hold various understandings and misunderstandings of a microecosystem and these will become apparent

while discussing the engagement question. An *ecosystem is an environment plus the associated organisms* so a microecosystem is a small environment. For our investigation, we will build and observe a type of a fresh water "aquarium". [Related concepts associated with microecosystems will be discussed and developed throughout this long-term investigation. The *names* of some of these *concepts* include: *pollution, producers, consumers, decomposers, decomposition, ecosystem, balanced ecosystem, biotic and abiotic factors, death and dying if fish or other animals or plants die.*]

After setting up and observing this aquatic microecosystem for several weeks, students will participate in discussions led by the teacher and guided by the central question, what concepts and skills did you learn from building, observing and safely maintaining a microecosystem? The concepts should be identified and developed, or described, during these class discussions.

Let's Get Started

The materials needed per group of 2-3 students are a) one gallon, plastic or glass container, which has been carefully cleaned; b) sand or soil; c) tap water aged at least one day; d) various aquatic plants and animals which can be collected from area ponds, lakes, or purchased from a pet store; and e) light source. Examine the safety guidelines described previously and insert the appropriate safety rules in the materials list and in the following procedures. In other words, apply what your learned from reading the guidelines for safely caring for animals used in the classroom.

Place about an inch of soil on the bottom of a clean, one-gallon container. Add tap water to the container and fill to about one inch from the top of the container. Let the water set or "age" for at least one day. [Why do we need to age the tap water?] Collect an assortment of aquatic plants and animals from a pond or purchase them from a pet shop. Add a variety of each to the microecosystem, cover, and place near a light source.

Observe your microecosystem daily and record changes. Prepare data sheets to make observations for several weeks. Continue observations and recordings as long as needed for students to experience changes in their "special aquaria". After the first couple of weeks, students will record changes when they occur and not necessarily every day. They should draw and color their microecosystem on the first day, the last day, and sometime in between. Encourage the students to carefully maintain thorough notes throughout the open inquiry investigation.

Suggested questions to guide observations and discussions are a) what observations did you make; b) what changes did you observe in your microecosystem; c) what skills did you gain from this investigation; and d) what science concepts did you learn from this investigation? Discussions will occur throughout the investigations or when something special

happens (e.g. newly hatched fish or snails, an animal dies, decomposition of organisms, condensation forming on the top of the microecosystem).

Endnote

Foci of class discussions will vary, of course, depending upon the observed changes in the microecosystems, students' observations and interests, and your (the teacher's) interests and priorities. Keep in mind the fundamental guideline for this unstructured inquiry: what are students learning and when is "enough, enough"!?

♦ ♦ ♦

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