

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

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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	
	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

Communication Strategy	China (N = 259)		US (N = 224)	
	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. Rohrman 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 through 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.



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