Applying Virtual Reality to Study the Effects of Environmental Education on College Students' Ethics and Environmental Literacy

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ABSTRACT

Environmental risks and dilemmas in the global climate changes in past years have threatened human life. Scholars propose to reflect from the depth of human beings and establish the mutual ethic relationship between humans and natural environment to solve environmental problems. Various problems caused by the advance of technology could merely be solved by delivering correct value and natural ethics through education. Taking 360 students of Yangtze University, Hubei, as the research samples, the 32-week (3 hours per week) experimental research is preceded in this study. Among 360 distributed copies of questionnaire, 289 copies are valid, with the retrieval rate 80%. The research results show significant correlations between 1.environmental education and environmental ethics, 2.environmental ethics and environmental literacy, and 3.environmental education and environmental literacy. According to the results, suggestions are proposed, expecting to apply proper teaching methods to environmental education for smoother environmental education and effectively cultivating students' environmental ethics and environmental literacy.

Keywords: virtual reality, environmental education, environmental ethics, environmental literacy

INTRODUCTION

Since Industrial Revolution, the establishment of factories, the invention of railways and automobiles, and the promotion of chemical products have made convenient and rich human life. Meanwhile, large amount of resources on the earth are consumed and the large use of fossil fuel enhances the emission of carbon dioxide to indirectly result in global climate changes and obvious global warming. Environmental changes, e.g. changing rainfall, increasing strength of storms, tornados, flood, and drought, and climate changes are threatening human health. People present infinite expectation on technologies and believe that the development of technology could change the world. However, humans' living quality and living environment are getting worse with changing technologies. In face of worsening environment and continuous ecological risks, people excessively depend on technologies to solve environmental problems, rather than dealing with ethic relationship between humans and the nature. New environmental problems are therefore emerged.

Environmental risks and dilemmas in past years are threatening human life. It is not the lack of technology knowledge, but not applying wisdom and destroying the world with technologies. Scholars therefore propose to reflect the depth of humans and establish the mutual ethic relationship between humans and the nature to solve environmental problems. Such problems caused by the advance of technologies could be changed by delivering correct value and natural ethics through education. It might become a negative measure, when the environment is damaged but not being compensated or discussing the roots of such environmental damages and survival risks of creatures. For this reason, people have to enhance the cognition and confirm personal belief to break through current environmental dilemmas and risks. Environmental ethics is essential for the world as it stands for the principles, value, belief, habits, and attitudes which humans are willing to obey for the environment as well as the

Contribution of this paper to the literature

- Team discussion and environmental experience sharing allow students effectively enhance the expression ability, benefit by mutual discussion, and integrate personal ideas to enhance personal environmental skills and environmental action experience.
- Education sectors are suggested to arrange time and locations for regular exchange or study, seminars, and action research of environmental education teachers in order to enhance the teaching profession.
- Schools could combine with community environment to enhance students' skills in investigating the living environmental problems and the intention and experience in participating in environmental education activities through community visits.

behavioral criteria for humans to follow. It shows that humans are responsible for maintaining global resources and respecting future generations. The process of education is long, but it could influence people's thoughts and value as well as change humans' lifestyles and attitudes towards the nature. The use of appropriate teaching methods for environmental education could achieve the learning effect and affect students developing correct environmental thinking attitudes and behaviors. Teachers applying proper teaching methods and available materials to enhance students' environmental ethics and environmental literacy could have smoother teaching and better teaching effect. In this case, virtual reality is applied in environmental education in this study to discuss the effect on college students' ethics and environmental literacy.

LITERATURE REVIEW

Virtual Reality

Morris (2014) explained virtual reality (VR) as to construct an environment with computer simulation and include real and virtual pictures in the simulated situation to make the situation present real pictures. The environment presented highly real interactive characters, allowing users viewing various pictures computed by the computer as well as operating the objects through human-computer interface. Users could freely move in the space to appear the senses of integration and participation and experience the environment. Baumgartner (2014) pointed out virtual reality as allowing users observing the simulated world from different angles and interacting with any objects in the virtual world. Virtual reality, a situated world constructed with computer scientific technology, transforms entities in the real environment and digital data into observable and even touchable 3D virtual scenes; matching with various human-computer interfaces, people become the direct participants in the virtual world, as in a real environment. Lederman, Antink, and Bartos (2014) regarded virtual reality as the combination of computers and the peripherals, allowing users being in the 3D space generated in the computer model. In the 3D virtual reality, the computer interaction is extended from the purely visual interaction to diverse interaction that users could interact with objects in virtual reality with sensory experiences and cognitive abilities as in the real world and browse the feeling close to the changes in the natural world. Chung, Yoo, Kim, Lee, and Zeidler (2014) described virtual reality as the best practice of situated teaching theory. The situations in virtual reality could provide users with a natural interface between the real world and the abstract logic, allowing users' cognition exceeding the knowledge in books and further developing self-concept and relationship.

Environmental Education

Nazir and Pedretti (2015) explained environmental education as the process of cognitive value and concept clarification to develop, understand, and appreciate skills and attitudes essential for the mutual relationship among humans, culture and the creature, and physical environment. Environmental education was also applied to decision-making related to environmental quality and behavioral norms of self-orientation. Pai et al. (2014) regarded environmental education as an education process aiming at the correlation between people and the natural and artificial environment, including the problems related to human environment such as population, pollution, energy distribution and energy conservation, natural conservation, technology development, transportation construction, and urban and rural plans, allowing the citizens understanding the relationship between humans and environment through education. Ak and Kutlu (2015) pointed out environmental education as the lifelong learning process for people understanding the complicated natural world and the relevant issues. Based on the integration of knowledge in various fields, individual and social decisions made with various strategies had people present the attitudes and behaviors "to change the world". Focusing on school education, Lee et al. (2016) defined environmental education as educators concerning about the environment, including current or possible environmental problems in the education process, and containing environmental competence in the related course and teaching activity into the education design to effectively pass down to the next generation to

concern about the peripheral environment in daily life, protect the environment, do not damage the environment, actively participate in solving environmental problems, and present environment problem-solving competency to cope with difficult environment problems. Dyment et al. (2014) mentioned that environmental education was the process aiming to achieve the improvement, the education process to clarify concepts and form value, and the knowledge, skills, and attitudes required for human development and experiencing the mutual relationship among humans, culture & creature, and physical environment. Environmental education also taught people to make decisions and develop self-behavior principles when facing the issues related to environmental quality.

Referring to Cheng et al. (2015), environmental education contains three dimensions of environmental knowledge, environmental skills, and environmental attitudes in this study.

(1) Environmental knowledge: To assist social groups and individuals in acquiring various experiences and basic understanding about the environment and the problems.

(2) Environmental skills: To provide social groups and individuals with skills to identify and solve environment problems.

(3) Environmental attitudes: To assist social groups and individuals in acquiring the value concerning about the environment and the promise to actively participate in environmental improvement and protection.

Environmental Ethics

Ethics is the common value of the society that it could be revised or changed with changing society. Ethics sometimes might appear conflicts, but they are coexisted and integrated. There were human-environment coexisting philosophy and environmental ethics in past Chinese and western philosophy (Liddicoat & Krasny, 2014). Bearman et al. (2015) proposed that ethics was the morality existing between people and environmental ethics and the moral relationship between humans and natural environment, i.e. the ethic responsibilities of humans and natural environment. Ethics contained belief, attitudes, and value. Regarding the development of environmental ethics, Pai et al. (2017) mentioned that environmental ethics was the post-modern reflection after technological civilization, the new culture developing through self-center, culture or social center, different culture treatment, humanitarianism or human center to ecology center, and the globally consistent local reflection. Lindahl and Folkesson (2016) regarded human ethics as the product of evolution. For survival, mutual cooperation among humans was the result of natural selection. After humans' morality and ethics evolved from social ability, it would be expanded from family and neighbors to regions and nations through the promotion of culture (Frantz & Mayer, 2014). Environmental ethics referred to the moral relationship between humans and natural environment which could be used for controlling human behaviors towards natural environment (Van Uden, Ritzen, & Pieters, 2016).

Referring to Hsu and Wu (2016), environmental ethics in this study includes the following dimensions.

(1) Human ethics: It is considered that human value is the center of the world, merely ethic principles are applied to humans, and human needs and profits present the highest value and importance.

(2) Bioethics: All creatures present gifted value and are worth of respect.

(3) Eco-ethics: The close relationship between humans and the nature is perceived, and humans without conforming to the rules in the natural ecology would be in ecological risks.

Environmental Literacy

Ko et al. (2016) pointed out environmental literacy as an observable behavior that an individual was willing to and capable of making decisions to be responsible for the environment, generating the behavior to balance life and environmental quality, and concerning about the environment and beloved people, affairs, and objects (Zorrilla-Pujana & Rossi, 2014). Biasutti (2015) contained the perception and appreciation of natural environment and artificial environment, the knowledge of natural systems and ecological concepts, the understanding of current environmental issues, and even the environmental problem-solving by applying investigation, critical thinking, writing, and communication abilities in environmental literacy. Environmental literacy in ecology dictionary referred to the knowledge of natural systems and ecological concepts, the understanding of environmental issues, and the environmental problem-solving with investigation, thinking, and communication (Liu & Lin, 2014). Hall and Allan (2014) pointed out environmental literacy as individual knowledge and attitudes related to the environment and environmental issue, skills and motivation to solve environmental problems, and willingness to maintain the dynamic balance between life quality and environmental quality. Rashid and Asghar (2016) proposed that environmental literacy should focus on responsible environmental behaviors and environmental education should teach students, before the changes of behaviors, about ecology concepts related to environment and the implied mutual relationship among environments. Environmental literacy was the ability to sense and explain the health of environmental systems and the action to maintain, recover, or enhance the health of environment systems (Pai et al., 2015).

Referring to Chen and Pai (2015), environmental literacy in this study covers the following dimensions.

(1) Environmental sensitivity: The perception of distinct environmental damage and pollution as well as the appreciation of and sensitivity to natural environment and artificial environment.

(2) Action experience: The environmental protection behaviors taken in daily life and the actual participation in environmental protection activities.

Research Hypothesis

Ak and Kutlu (2015) indicated that the final goal of environmental education was to create responsible attitudes and develop environmental ethics, which agreed that human world was not a material world but a value world; and, the morality of environmental education was to have the citizens comprehend and comment such value (Vainio & Paloniemi, 2014). Lee et al. (2016) argued that environmental education was to develop individual morality and ethics through education process. Hsieh (2014) pointed out the cultivation of environmental ethics as the ideal of environmental education. Dyment et al. (2014) pointed out the teaching of environmental ethics and the emphasis on the cultivation of students' positive environmental attitudes as the differences between environmental education and other subjects. Shephard et al. (2014) pointed out the key in practicing environmental education as to establish correct environmental ethics that teachers should reinforce the cultivation of environmental ethics, which was the key success factor in environmental education. Cheng et al. (2015) regarded the final goal of environmental education as the cultivation of active environmental ethics. Environmental ethics could also be called environmental morality, which was people's behavioral norms and principles (Liddicoat & Krasny, 2014). Accordingly, the following hypothesis is proposed in this study.

H1: Environmental education reveals notable correlations with environmental ethics.

Yahaya, Zain, and Karpudewan (2015) indicated that environmental education activities could induce students' perception of and sensitivity to environment, enhance the knowledge related to environmental sustainability, provide students with correct environmental ethics about the interaction between people and environment, and present the cognition and skills to improve or solve environmental problems when facing regional or global environmental issues to establish learners' environmental action experience and to become the citizens with environmental literacy. Rivers, Wickramasekera, Pekala, and Rivers (2016) mentioned to cultivate students' positive environmental ethics through the teaching and emphasis on environmental education so that students could appreciate the nature and the operation system, enhance the environmental literacy, appreciate and accept different culture, concern about disadvantaged groups, and further concern about the survival and development of future generation. Hsu and Wu (2016) proposed that environmental education could be applied to cultivate the citizens' environmental ethics, enhance the knowledge, attitudes, skills, and value to protect the environment, promote the environmental literacy, enhance the emphasis on environment, and take actions to achieve the sustainable development (Van Uden et al., 2016). The following hypothesis is therefore proposed in this study.

H2: Environmental ethics presents significant correlations with environmental literacy.

Ko et al. (2016) regarded the final goal of environmental education as to cultivate the citizens with environmental literacy. Sellmann (2014) indicated that the promotion of environmental literacy relied on the promotion and practice of environmental education, which was the responsible perception, when facing the environment, to cultivate the positive environmental attitudes, actively participate in environmental protection actions, and enhance environmental literacy through the concept of natural ecology conservation and the environmental justice. Rashid and Asghar (2016) proposed to develop the function of environmental education through educational goal and teaching methods, inspire humans' perception of and sensitivity to environment, enrich environmental protection concepts, practice environmental protection actions, and cultivate environmental ethics and value. Those were covered in the promotion of literacy and the solution for environmental threats. Tung and Pai (2015) considered the relationship between environmental literacy and environmental education that environmental literacy was the goal of environmental education, while environmental education was the process of people acquiring environmental literacy. Environmental literacy should be the development process, rather than the end; environmental literacy was the continuity of knowledge, skills, attitudes, and mental habits. Although the level of literacy was not pure and definite, it appeared the order of educational function (Pai et al., 2015). In this case, the following hypothesis is proposed in this study.

H3: Environmental education shows remarkable correlations with environmental literacy.

METHOD AND SAMPLE

Research Object

Total 360 students of Yangtze University, Hubei, are proceeded 32-week experiment, 3 hours per week, in this study. Total 289 valid copies of questionnaire are retrieved, with the retrieval rate 80%. Located in Jingzhou City, Hubei Province, Yangtze University is a comprehensive university with the largest scale and complete subjects in Hubei Province. It is the backbone university in the key construction projects in Hubei Province, is the "double fist-class" university domestically, is the selected university in "National Basic Ability Construction Project of Western and Central China", and is the trial university of Excellent Engineer Education Cultivation Program, Excellence in Agriculture and Forestry Talent Training Program, and Excellent Doctor Education and Training Program of Ministry of Education. Moreover, it is co-constructed by Hubei Provincial People's Government, China National Petroleum Corporation, Sinopec, the China Petroleum and Chemical Corporation, and China National Offshore Oil Corporation as well as the university co-constructed by Hubei Provincial People's Government and Ministry of Agriculture.

Analysis

Regression Analysis is applied to understand the relationship among students' environmental education, environmental ethics, and environmental literacy.

ANALYSIS RESULT

Operational Definition and Measurement of Variable

Environmental education

Environmental education contains environmental knowledge, environmental skills, and environmental attitudes, and the overall reliability coefficients appear environmental knowledge 0.85, environmental skills 0.81, and environmental attitudes 0.87.

Environmental ethics

Environmental ethics includes human ethics, bioethics, and eco-ethics, and the overall reliability coefficients show human ethics 0.82, bioethics 0.84, and eco-ethics 0.89.

Environmental literacy

Environmental literacy covers environmental sensitivity and action experience, and the overall reliability coefficients reveal environmental sensitivity 0.90 and action experience 0.88.

Regression Analysis of Environmental Education and Environmental Ethics

Regression Analysis is utilized for testing the hypotheses and the theoretical structure. The first regression tests the effect of environmental education on human ethics. The results reveal positive effects of environmental knowledge, environmental skills, and environmental attitudes on human ethics (Beta＝0.231, p＝0.023; Beta＝0.242, p＝0.011; Beta＝0.283, p＝0.000). The second regression tests the effect of environmental education on bioethics. The results show positive and significant effects of environmental knowledge, environmental skills, and environmental attitudes on bioethics (Beta＝0.248, p＝0.006; Beta＝0.266, p＝0.000; Beta＝0.294, p＝0.000). The third regression tests the effect of environmental education on eco-ethics. The results present positive and remarkable effects of environmental knowledge, environmental skills, and environmental attitudes on eco-ethics (Beta＝0.271, p＝0.000; Beta＝0.287, p＝0.000; Beta＝0.302, p＝0.008) (**Table 1**). Accordingly, H1 is supported.

Table 1. Regression Analysis of environmental education towards environmental ethics

Dependent variable → Independent variable ↓	Environmental ethics					
	Human ethics		Bioethics		Eco-ethics	
environmental education	Beta	P	Beta	P	Beta	P
environmental knowledge	0.231	0.023	0.248	0.006	0.271	0.000
environmental skills	0.242	0.011	0.266	0.000	0.287	0.000
environmental attitudes	0.283	0.000	0.294	0.000	0.302	0.000
F	21.736		27.815		33.627	
R^2	0.225		0.291		0.328	
adjusted R^2	0.193		0.264		0.293	
*p<0.05 **p<0.01						

Data source: Self-organized in this study

Table 2. Regression Analysis of environmental ethics towards environmental literacy

Dependent variable → Independent variable ↓	Environmental literacy			
	Environmental sensitivity		Action experience	
environmental ethics	Beta	P	Beta	P
human ethics	0.288	0.000	0.269	0.000
bioethics	0.297	0.000	0.274	0.000
eco-ethics	0.311	0.000	0.283	0.000
F	25.412		31.637	
R^2	0.272		0.294	
adjusted R^2	0.245		0.268	
*p<0.05 **p<0.01				

Data source: Self-organized in this study

Regression Analysis of Environmental Ethics and Environmental Literacy

Regression Analysis is used for testing the hypotheses and the theoretical structure in this study. The first regression tests the effect of environmental ethics on environmental sensitivity, where human ethics, bioethics, and eco-ethics show positive effects on environmental sensitivity (Beta＝0.288, p＝0.000; Beta＝0.297, p＝0.000; Beta＝0.311, p＝0.000). The second regression tests the effect of environmental ethics on action experience, where human ethics, bioethics, and eco-ethics appear positive and notable effects on action experience (Beta＝0.269, p＝0.000; Beta＝0.274, p＝0.000; Beta＝0.283, p＝0.000) (**Table 2**). H2 is therefore supported.

Regression Analysis of Environmental Education and Environmental Literacy

Applying Regression Analysis to test the hypotheses and the theoretical structure, the first regression tests the effect of environmental education on environmental sensitivity, in which environmental knowledge, environmental skills, and environmental attitudes present positive effects on environmental sensitivity (Beta＝0.291, p＝0.000; Beta＝0.303, p＝0.000; Beta＝0.334, p＝0.000). The second regression tests the effect of environmental education on action experience, in which environmental knowledge, environmental skills, and environmental attitudes appear positive and significant effects on action experience (Beta＝0.286, p＝0.000; Beta＝0.314, p＝0.000; Beta＝0.343, p＝0.000) (**Table 3**). Accordingly, H3 is supported.

Table 3. Regression Analysis of environmental education towards environmental literacy

Dependent variable Independent variable	Environmental literacy			
	Environmental sensitivity		Action experience	
environmental education	Beta	P	Beta	P
environmental knowledge	0.291	0.000	0.286	0.000
environmental skills	0.303	0.000	0.314	0.000
environmental attitudes	0.334	0.000	0.343	0.000
F	32.588		36.192	
R^2	0.304		0.354	
adjusted R^2	0.285		0.331	
	*$p < 0.05$ **$p < 0.01$			

Data source: Self-organized in this study

CONCLUSION

From the research results, virtual reality experience and operation courses could more easily induce students' interests, deepen the learning image, and promote the environmental ethics and environmental action experience. In addition to achieving the cognitive goal, more importantly, the practice of environmental education could achieve the goal of environmental ethics cultivation, allowing students practicing environmental skills in the virtual reality experience and cultivating action experience, as well as teaching students to study environmental problems and evaluating possible solutions. Apparently, the application of virtual reality to the practice of environmental education presents certain effect. Teachers therefore could combine the support of virtual reality related resources for more opportunities to apply virtual reality to students' exploration and experience in environmental education, select locations or issues in which students are interested, design course activities matching with environmental characteristics, seek people with professional knowledge for interpreting the environment, as well as expand students' learning vision and contact with the nature so as to promote the effect of environmental education.

SUGGESTION

By concluding the results and findings, the following practical suggestions are proposed in this section.

1. Team discussion and environmental experience sharing allow students effectively enhance the expression ability, benefit by mutual discussion, and integrate personal ideas to enhance personal environmental skills and environmental action experience. Parents matching with and assisting in school courses could have students cultivate good environmental ethics and environmental literacy to achieve the effect of environmental education.

2. Education sectors are suggested to arrange time and locations for regular exchange or study, seminars, and action research of environmental education teachers in order to enhance the teaching profession. Moreover, teachers could share the teaching experience in environmental education and mutually observe and discuss lessons to improve the environmental education teaching skills, prepare lessons together, and present self-development.

3. Students' learning styles should be understood in order to design the best environmental education programs combined with the learning styles, cultivate students' environmental ethics, and further improve the explicit environmental literacy. It is also suggested that schools could combine with community environment to enhance students' skills in investigating the living environmental problems and the intention and experience in participating in environmental education activities through community visits. What is more, environmental education sectors should more actively make plans to encourage students' environmental action experience, attract students actively participating in environmental action, effectively cultivate students' environmental ethics, and promote students' environmental literacy.

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