



RESEARCH ON INFLUENCING FACTORS OF UNIVERSITY STUDENTS' WILLINGNESS FOR CARBON NEUTRAL EDUCATION

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ABSTRACT

The purpose of this study was to investigate the effect of climate change knowledge and scientific attitudes on adolescents' willingness to carbon neutral education. This study provides guidance and suggestions for the instructional design of carbon neutral education for adolescents. This study emphasizes that (1) Adolescent carbon neutrality education activities should provide knowledge about climate change, foster pro-environmental behaviors, and emphasize the urgency of climate change, and (2) Carbon-neutral education should be designed to increase positive attitudes towards scientific disciplines and careers in science to achieve future carbon-neutral educational outcomes.

KEYWORDS: Carbon neutral education; Knowledge of climate change; Pro-environmental behaviors; Perception of Environmental Responsibility; Attitudes towards the urgency of climate change; Attitude towards science

CHAPTER 1 INTRODUCTION

1.1 Research Background

In China, environmental issues such as climate change and global warming are gaining more and more attention. China has pledged to tackle carbon emissions by 2030, and they expect to be carbon neutral by 2060. However, achieving carbon neutrality is so important to the Chinese government, but increasing public awareness and understanding of carbon neutrality can also help China accelerate its achievement of carbon neutrality. In fact, carbon neutral education is part of environmental education.

1.2 Research purpose

The purpose of this study was to investigate the impact of climate change knowledge and scientific attitudes among adolescents on carbon neutral education intentions. The second purpose of the research is to help the instructional design of Adolescents' carbon neutral education to provide solutions to achieve carbon neutral education for Adolescents in the future.

1.3 Problem Statement

According to the research purpose, the following research questions are put forward: Research question 1: Does Knowledge of Climate Change promotes willingness to participate in Carbon Neutral Education? 2: Are Pro-environmental behaviors an important predictor of willingness to participate in carbon neutral education? 3: Are attitudes towards the urgency of climate change positively associated with willingness to participate in carbon neutral education? 4: Are attitude towards science positively associated with willingness to participate in carbon neutral education?

1.4 Research gap

The literature in the past has mainly focused on the relationship between Pro-environmental behaviors and environmental education, in fact, environmental education includes carrying out environmental education in any dimension. However, past research needs to further refine the dimension of environmental education, therefore,

this study subdivided the dimension of carbon neutrality education in environmental education for measurement to fill in the research on Pro-environmental behaviors and carbon neutrality education.

1.5 Scope of study

The scope of this research is selected to be conducted in Wuhan city's Primary School, China, and the research objects are primary school students in the sixth grade. Study samples were limited to 200 for each male and female. A total of 400 samples were randomly selected for this study.

CHAPTER 2 LITERATURE REVIEW

2.1 Concept of Carbon Neutral Education

Carbon neutrality is the future trend. At present, the realization of carbon neutrality requires educational institutions to enhance students' basic awareness of carbon neutrality, especially students' low-carbon behavior on campus. Therefore, carbon neutral education is critical for schools and students. Popularizing climate change knowledge in schools can help motivate students to actively participate in carbon-neutral education. A study that investigated the impact of climate change knowledge on students' willingness to participate in carbon neutral education found that climate change knowledge improved adolescents' perceptions of carbon neutral education, which contributed to the promotion and popularization of carbon neutral education (Zhang et al., 2022).

2.2 Theoretical foundation

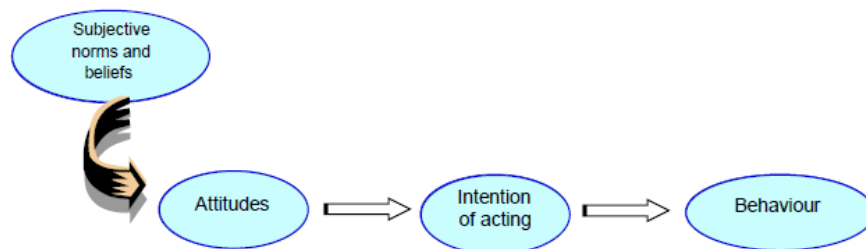


Figure 1 The rational action theory sourced (Ajzen, 1980; Schifter & Ajzen, 1985)

2.3 Knowledge of Climate Change promotes willingness to participate in Carbon Neutral Education

knowledge of climate change is crucial in carbon neutral education. Actually, climate change knowledge uses simulated reality to restore students' perceptions and stimulate their learning interest (Karpudewan, Roth, & Abdullah, 2015; Karpudewan, Roth, & Chandrakesan, 2015). Dresner (1990) found that engaging in a simulated community during the course was beneficial for increasing student engagement in the course. A past study has shown that climate change science and energy conservation education programs help students generate energy conservation and environmental protection awareness and share them with their families (Zografakis et al., 2008). Therefore, this study proposes the following hypotheses:

Hypothesis 1: Knowledge of Climate Change promotes willingness to participate in Carbon Neutral Education

2.4 Pro-environmental behaviors are an important predictor of willingness to participate in carbon neutral education.

A core cognitive driver of Pro-environmental behaviors is a sense of personal responsibility to the environment. So personal environmental responsibility is positively related to the willingness to participate in environmental education, and it represents the willingness of people to participate in carbon neutral education (Zhang et al., 2022).

Therefore, based on the above literature review, we propose the following hypothesis.

Hypothesis 2: Pro-environmental behaviors are an important predictor of willingness to participate in carbon neutral education.

2.5 Attitudes towards the urgency of climate change is positively associated with willingness to participate in carbon neutral education.

At present, the earth's atmosphere is increasingly damaged by the greenhouse effect, and the earth's climate change problem is becoming more and more serious. Due to human pollution, the environment has been seriously damaged. On the impact of climate change on the environment, the United Nations issued an urgency to address

climate change (Nowotny et al., 2018). Climate change education at the university gives students responsibility for the environment and mitigates the problems caused by climate change, thereby achieving carbon neutrality (Cordero et al., 2020; Helmers et al., 2021; Udas et al., 2018).

Therefore, based on the above literature review, we propose the following hypothesis.

Hypothesis 3: Attitudes towards the urgency of climate change is positively associated with willingness to participate in carbon neutral education.

2.6 Attitude towards science is positively associated with willingness to participate in carbon neutral education.

Oliver and Adkins (2020) analyzed the responses to greenhouse gases of 540,000 students from 72 Organization for Economic Cooperation and Development (OECD) and partner countries. The age of these students is 15 years old. They found that students' knowledge of greenhouse gases varied widely, independent of the international ranking of their scores. And they found that science literacy affects students' cognitive gaps, enjoyment of science and interest in science, and that good science courses can enhance their awareness of environmental changes.

Therefore, based on the above literature review, we propose the following hypothesis.

Hypothesis 4: Attitude towards science is positively associated with willingness to participate in carbon neutral education.

2.7 Conceptual Framework and Assumptions

Based on the above theories and literature review, this study proposes four theoretical hypotheses:

H1: knowledge of climate change promotes willingness to participate in carbon neutral education.

H2: Pro-environmental behaviors are an important predictor of willingness to participate in carbon neutral education.

H3: Attitudes towards the urgency of climate change is positively associated with willingness to participate in carbon neutral education.

H4: Attitude towards science is positively associated with willingness to participate in carbon neutral education.

As shown in **Figure 3**.

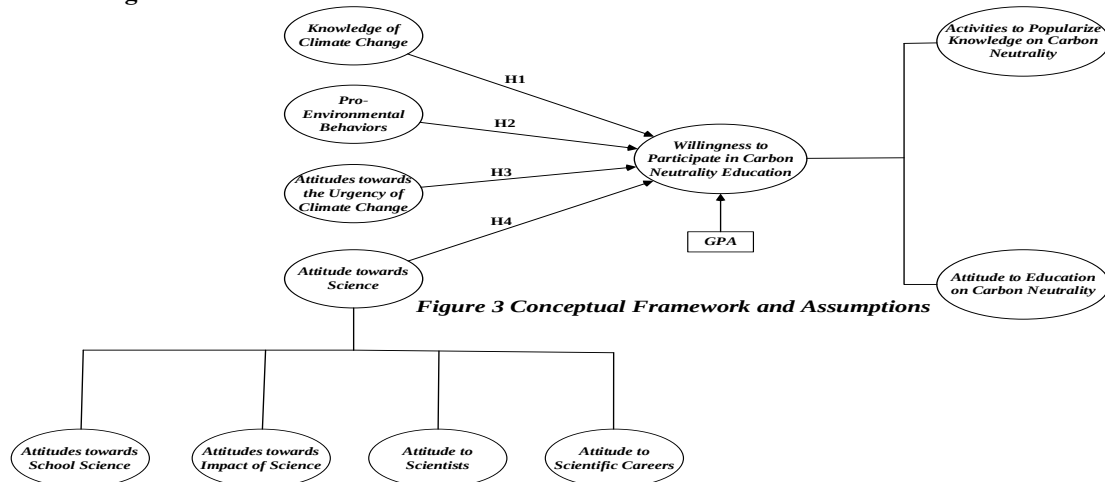


Figure 3 Conceptual framework and assumptions

CHAPTER 3 RESEARCH METHOD

3.1 Research object

The location of this study is Wuhan City, Hubei Province, China. Our research subjects are sixth-grade primary school students, because past research has focused more on adults, while there are relatively less studies on adolescents. We selected sixth-grade primary school students because they were in the early adolescence ages. Their age is generally 11-13 (Salmela-Aro, 2011).

3.6 Data collection process

We notified the head teachers of each class in Wuhan City's primary school to organize a series of activities with the theme of carbon neutral education, we plan to host a carbon neutral education-themed activity. Activities such as: making handwritten newspapers, donating used goods, low-carbon product exhibitions, low-carbon science lectures, extracurricular environmental protection garbage picking, environmental blackboard newspapers or

painting competitions, environmental protection speech competitions, holding climate change knowledge competitions, walking into the school, etc. Finally, we used questionnaires to assess the knowledge gained from the activity and attitudes towards science. These questionnaires were all based on authoritative scales to study the relationship between these climate change knowledge and attitudes towards science and their willingness for carbon neutral education. We will record their GPA after participation (from 1 to 5, 1=under 60; 2 = 60-70; 3 = 70-80; 4 = 80-90; 5 = 90-100) to compare the difference to their pre-participation knowledge level and learning attitude.

CHAPTER 4 RESEARCH RESULT

4.1 Quantitative Data Analysis

In terms of quantitative data analysis, this study first ensured the reliability of the measurement results. At the same time, on the basis of verifying the significant correlation of each variable, this study conducted multiple regression analysis on each variable. The results of the study confirmed the relationship between the questionnaire items and variables. The measurement is valid (J. F. Hair et al., 2006). The study then proceeded with path analysis to show support for the four hypotheses presented in the literature review section.

4.2 Random sampling

The appendix shows a total of 24 observable (measured) items, for path analysis a minimum sample size of 24 multiply by 5 = 120 is required, but 24 multiply by 10 = 240 is preferred (J. F. Hair et al., 2006).

This study conducted a questionnaire survey among Chinese students at Wuchang University of Technology in Hubei. In this study, the questionnaire was distributed online based on Tencent's Questionnaire Star software. With the consent of the interviewees, a total of 387 questionnaires were recovered in this study, and the number of valid questionnaires was 366. Therefore, the study approximately reached Hair's optimal sample standard of 10 times.

4.3 Descriptive Statistics

The mean and standard deviation (SD) of all items for the five variables are shown in the descriptive statistics in Table 1.

This section presents the results of the quantitative analysis. First, quantitative data analysis is mainly aimed at validating the proposed theoretical framework represented by four hypotheses.

This study received 366 valid returns. 54.6% were male, 45.4% were female, 45.6% were 18 to 21 years old, and 54.4% were 22 to 25 years old. In addition, the respondents were all current students who were eligible for an undergraduate degree.

Table 1 Descriptive Statistics

Variables	Gender	N	Mean	Std. Deviation	Std. Error Mean
KC	Male	200	3.7650	.85837	.06070
	Female	166	3.9237	.71129	.05521
PB	Male	200	3.4650	.81369	.05754
	Female	166	3.6446	.73318	.05691
AU	Male	200	3.3833	.76732	.05426
	Female	166	3.5191	.74860	.05810
AS	Male	200	3.2000	.76641	.05419
	Female	166	3.3193	.74613	.05791
WP	Male	200	3.3578	.79198	.05600
	Female	166	3.5455	.69737	.05413

Note: KC = Knowledge of Climate Change; PB = Pro-environmental Behaviors; AU = Attitudes towards the Urgency of Climate Change; AS = Attitudes towards School Science; WP = Willingness to participate in carbon neutral education;

4.4 Reliability Test

This study uses SPSS to test the reliability of the questionnaire, all items are tested, Reliability analysis using Cronbach's alpha was used to assess the internal consistency of the revised scales. A Cronbach's alpha coefficient value (α) of greater than 0.6 indicates an acceptable level of reliability (Ursachi et al., 2015). As shown in **Table 2**, the α values ranged from 0.696 to 0.919. Hence, it is reasonable to conclude that the factors had good internal consistency of reliability. First, this study uses SPSS to measure reliability and conduct the following analyses. First, measure the reliability of the Willingness to participate in carbon neutral education scale, which has a total of 9 items, and the Cronbach Alpha coefficient is 0.919, which indicates that the scale has good reliability.

Second, the reliability analysis of measuring the Attitudes towards School Science scale, a total of 3 items, obtained the Cronbach Alpha coefficient of 0.696, which indicates that the scale has good reliability.

Third, the reliability analysis of the scale for measuring Knowledge of Climate Change, a total of 3 items, obtained the Cronbach Alpha coefficient of 0.892, which indicates that the scale has good reliability. Fourth, the reliability analysis of the scale for measuring Pro-environmental Behaviors, a total of 3 items, obtained the Cronbach Alpha coefficient of 0.845, which indicates that the scale has good reliability. Fifth, the reliability analysis of the scale for measuring Attitudes towards the Urgency of Climate Change, a total of 6 items, obtained the Cronbach Alpha coefficient of 0.910, which indicates that the scale has good reliability. Finally, the reliability analysis of the five scales in the overall test, with a total of 24 items, obtained the Cronbach Alpha coefficient of the overall scale of 0.961, which indicated that the overall scales in this study had good reliability.

Table 2. Factors and Cronbach's alpha.

Factors	Subscales	Cronbach's alpha
1. WP	Items: WCNE1–WCNE9	$\alpha = 0.919$
2. AS	Items: ASS1–ASS3	$\alpha = 0.696$
3. KC	Items: KCC1–KCC3	$\alpha = 0.892$
4. PB	Items: PB1–PB3	$\alpha = 0.845$
5. AU	Items: AUCC1–AUCC6	$\alpha = 0.910$
3. Total scales	Items: WCNE1–AUCC6	$\alpha = 0.961$

Note: WP = Willingness to participate in carbon neutral education; AS = Attitudes towards School Science; KC = Knowledge of Climate Change; PB = Pro-environmental Behaviors; AU = Attitudes towards the Urgency of Climate Change.

4.5 Pearson Correlation Analysis result

This study use SPSS to run correlation analysis and Table 3 shows the correlation matrix for all the variables included in this study. Appropriate with the suggestion Pallant (2020), the independent variables show at least some relation to the dependent variable (higher correlation to 0.400). According to **Table 5**, the variance inflation factors indicate that there are no serious multicollinearity problems. The highest value was 3.286, which is far below the standard cutoff of 5 (J. Hair et al., 2010). Pearson correlation analysis was performed for a total of 5 factors and 24 analysis items. It can be seen from Table 3 that the correlation coefficient values corresponding to the 5 factors are all greater than 0.4, and the correlation is significant at the 0.01 level, which means that the variables in this analysis are suitable for path analysis.

Table 3 Pearson Correlation Analysis

Variables	Mean	Standard deviation	1	2	3	4	5
1.KC	3.8370	.79792	1				
2.PB	3.5464	.78230	.641**	1			
3.AU	3.4449	.76087	.654**	.765**	1		
4.AS	3.2541	.75858	.544**	.646**	.760**	1	
5.WP	3.4429	.75536				.694**	1

*. The correlation is significant at the 0.05 scale (one-tailed). **. The correlation is significant at the 0.01 level (one-tailed).

4.6 Path Analysis Results

This study used path analysis, and Figure 4 and Table 6 show that when KC influences WP, the standardized path coefficient value is 0.091>0, and this path shows a significant level of 0.01 ($z=2.618$, $p=0.009<0.01$), thus indicating that KC will have a significant effect on WP positive influence relationship. When PB influences WP, the standardized path coefficient value is 0.236<0, and this path shows a significant level of 0.01 ($z=5.798$, $p=0.000<0.01$), thus indicating that PB will have a significant positive effect on WP affect the relationship. When AU affects WP, the standardized path coefficient value is 0.452>0, and this path shows a significant level of 0.01 ($z=9.963$, $p=0.000<0.01$), thus indicating that AU has a significant positive impact on WP. When AS affects WP, the standardized path coefficient value is 0.221>0, and this path shows a significant level of 0.01 ($z=6.554$, $p=0.000<0.01$), thus indicating that AS has a significant positive impact on WP. In conclusion, Hypothesis 1, Hypothesis 2, Hypothesis 3, and Hypothesis 4 of this study have been verified.

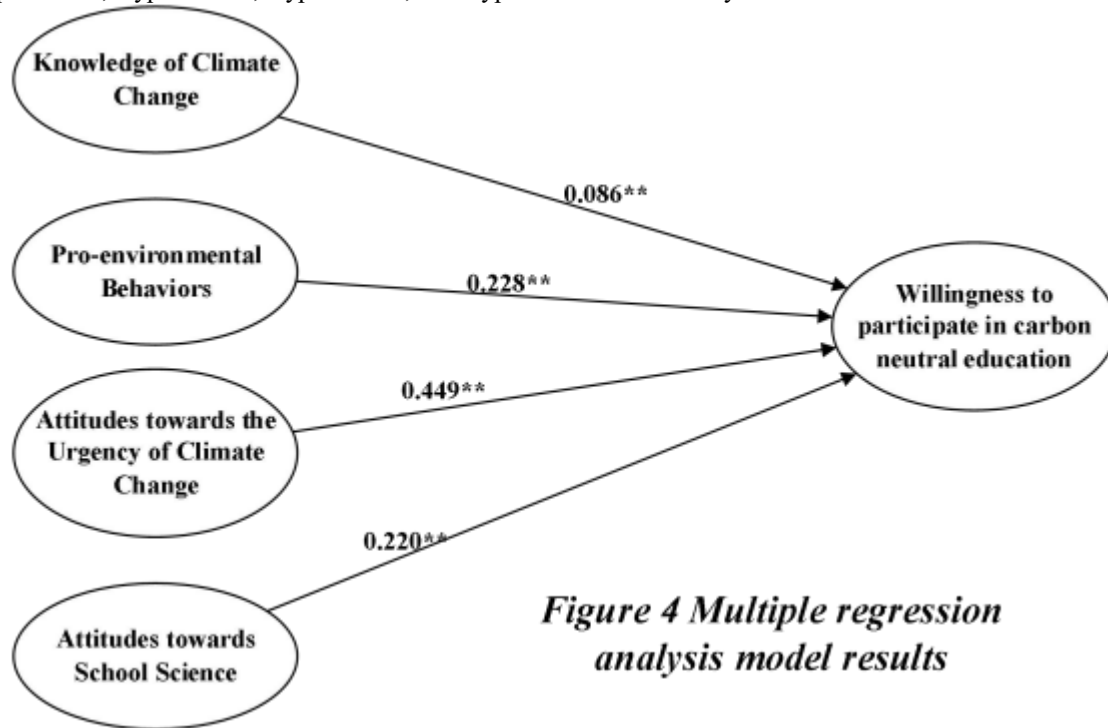


Figure 4 Multiple regression analysis model results

The output results are standardized path coefficients, and (* $p<0.05$, ** $p<0.01$)

Table 6 Model Regression Coefficient Results

Independent variables	Dependent variable	Non-standardized path Coefficients	SE	z (CR value)	p	Standardized Path Coefficients
KC	WP	0.086	0.033	2.618	0.009	0.091
PB	WP	0.228	0.039	5.798	0.000	0.236
AU	WP	0.449	0.045	9.963	0.000	0.452
AS	WP	0.220	0.034	6.554	0.000	0.221

Remarks: → Indicates that the path affects the relationship

CHAPTER 5 RESEARCH LIMITATIONS AND DISCUSSION

5.1 Research Limitations

The limitation of this study lies in the limited number of internal factors analyzed, and future researchers can increase the number of internal factors for more in-depth research. Secondly, this study only adopts quantitative research methods, and future researchers can use qualitative and quantitative methods for further research. Finally, the subjects involved in this study were Chinese students in Wuhan, Hubei, and future researchers can study students from other countries.

5.2 Discussion and prospects

The study found that environmental protection behavior has a very significant positive effect on students' willingness to conduct carbon-neutral education. The study also suggests that universities should actively provide simulation activities related to climate urgency for Chinese students, so that students can personally feel the negative impact of climate change and further fill their awareness of the urgency of climate change. In terms of university curriculum, universities can try to hold carbon-neutral knowledge lectures and campus activities related to environmental protection behaviors to help more students actively participate in carbon-neutral education and reduce the resistance to popularization of the concept of carbon-neutrality. In terms of university administration, university staff can strengthen students' attitudes towards environmental knowledge. Popularizing knowledge of climate change and environmental protection among university faculty and staff can also indirectly help more students receive carbon neutral education.

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