

A Study of the Impact of Online Environmental Gamification Applications on the Citizenship Behavior of College Students in Environmental Organizations

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Abstract: In the context of the "dual-carbon" goal, the environmental behavior of college students is crucial to the realization of the strategic goal of environmental protection. In this study, we focus on online environmental protection gamification applications, taking Ant Forest as an example, and explore the influence mechanism of Ant Forest on the citizenship behavior of university students' environmental protection organizations based on the learning model and cognitive-emotional system theory. Through literature review, the research questions are clarified, theoretical models are constructed and empirical studies are conducted, aiming to provide theoretical basis and policy suggestions for green education in colleges and universities and motivating college students' environmental protection behaviors. The study found that online environmental gamification applications can significantly promote college students' environmental organizational citizenship behaviors by enhancing the mediating variables of environmental responsibility, efficacy and enthusiasm. Based on this, a series of targeted policy recommendations are proposed for colleges and governments to promote college students' active participation in environmental protection actions.

Keywords: Online environmental gamification application, College students, Environmental organization citizenship behavior, Cognitive-affective systems theory.

1. Introduction

As global environmental problems become more and more serious, the proposal of the goal of "striving to peak carbon dioxide emissions by 2030 and striving to achieve carbon neutrality by 2060" marks a new stage in the construction of China's ecological civilization. As the backbone of the new era and the main force of future social construction, college students' environmental awareness and behaviors are of great significance to the realization of the "dual-carbon" goal and the promotion of the construction of a green eco-society. However, studies have shown that most college students are not aware of environmental awareness and citizenship of environmental protection organizations, that is, although they have a high awareness of environmental protection, the proportion of actually practicing environmental protection is relatively low. The emergence of online environmental gamification applications provides a new opportunity to improve this situation. The environmental game application represented by Ant Forest has successfully mobilized a large number of university users to participate in the "green cash" activities from virtual to real through innovative game mechanisms. For example, Ant Forest users accumulate energy through daily green behaviors (such as walking, online payment, etc.), and when the energy reaches a certain value, they can plant a virtual tree in the virtual scene, and when the virtual tree grows up, Ant Forest will plant a real tree in reality, which effectively stimulates the environmental protection enthusiasm of users. Therefore, it is of great theoretical and practical significance to study in depth the influence mechanism of online environmental protection gamification application on the civic behavior of college students' environmental protection organizations.

2. Background of the Study

2.1. Significance of the Study

2.1.1. Theoretical implications

This study expands the field of research on the antecedents of college students' civic behavior in environmental organizations. Although existing studies have focused on the influence of factors such as school pro-environmental climate, behavioral attitudes, and perceived behavioral control on college students' environmental behaviors, less research has been conducted on the emerging factor of online environmental gamification applications. Based on the learning model (GLM) and cognitive-emotional theory, this study investigates the influence mechanism of environmental gamification on college students' civic behavior in environmental organizations, which enriches the theoretical system of college students' environmental behavior influencing factors, and provides new perspectives and theoretical basis for the subsequent related studies.

2.1.2. Relevance

It provides theoretical support for universities to formulate policies that motivate college students to engage in the civic behavior of environmental protection organizations. In the Internet era, the combination of digital technology and environmental education has become an inevitable trend. Understanding the influence mechanism of online environmental protection gamification application on college students' environmental protection behavior will help universities to formulate more targeted green education policies and guide college students to actively participate in environmental protection actions, thus promoting the development of environmental protection education in

colleges and universities, and helping to realize the goal of "dual-carbon" and the task of "anti-pollution attack". The task of "pollution prevention and attack" will be realized.

2.2. Current Status of Domestic and International Research

2.2.1. The current situation of the research on college students' environmental protection organization citizenship behavior

College students' environmental protection organization citizenship behavior refers to the spontaneous behaviors that students implement on their own initiative that are beneficial to the environmental protection of the class, faculty and school without the requirement of clear rules and regulations of the school, such as double-sided printing and turning off the lights by hand, etc. (Zou Wei, 2010). However, college students have many problems in environmental protection behaviors. Yang Xinyu and Yang Guang (2020) pointed out that college students have insufficient intrinsic drive, insufficient understanding of the connection between low-carbon life and society and the state, and lack of social responsibility awareness, which leads to a lack of subjective initiative in low-carbon life. Shen Zijiao and Liu Huan (2017) found that college students have a high degree of recognition of environmental protection behaviors, but the proportion of actual regular practice is very low. According to Geng Yan (2023), the subconscious "big ego" and the social praise effect make college students recognize that they have strong environmental awareness, but the "small ego" factors (e.g., laziness, trouble, etc.) prevent the environmental awareness from being transformed into practical actions, and there is a "discrepancy between knowledge and action". However, "ego" factors (e.g. laziness, trouble, etc.) prevented environmental awareness from being transformed into actual action, resulting in the phenomenon of "inconsistent knowledge and action. In addition, Zhang Yixiang's study shows that positive energy-saving attitude and perceived behavioral control have a promoting effect on employees' willingness to save energy, and that organizational energy-saving atmosphere and subjective norms indirectly affect employees' willingness to save energy by influencing energy-saving attitude, which provides a certain reference to the study of college students' environmental behavior.

2.2.2. Current Research Status of Online Environmental Gamification Application

The concept of gamification was proposed by Deterding in the early 21st century, and has been receiving more and more attention from scholars since 2010, and has played an active role in various fields. According to Deterding, the use of game elements in non-game environments is gamification, and its purpose is to use the motivational potential of games to promote user participation and trigger behavioral change through an enjoyable interactive experience. enjoyable interactive experiences that trigger behavioral change. Scholars Seaborn K and Sailer M point out that gamification creates a willingness to use game elements by creating game experiences in non-game tasks and scenarios, and makes them perceive activities in non-game environments as more game-like. In the field of environmental protection, the application of gamification provides a new way to solve the problem of environmental education and behavioral guidance, especially for the situation of "inconsistent knowledge and action" in the environmental life of college students, the introduction of the concept of gamification helps to explore effective ways to

enhance the civic behavioral intentions of college students' environmental organizations.

3. Research Objectives and Main Content

3.1. Research Objectives

This study aims to achieve two main objectives. The first is to construct a theoretical model of the influence mechanism of online environmental gamification application on the civic behavior of college students' environmental protection organizations. Through in-depth investigation and research, we systematically summarize the influencing factors of online environmental gamification applications on college students, and use scientific theories and methods to build a model of influencing mechanism that can accurately reflect the interrelationships between these factors. Secondly, we propose a policy system to enhance the civic behavior of college students' environmental protection organizations with the background of the Internet. Based on the constructed theoretical model, combined with the actual situation of colleges and universities and the society, we provide a comprehensive, systematic and operable guidance system for green education in colleges and universities, so as to effectively motivate college students to actively participate in the civic behavior of environmental protection organizations.

3.2. Main Content

First, the research question is clarified. Through extensive reading of relevant literature at home and abroad and in-depth analysis of the current situation and problems of the civic behavior of college students' environmental organizations, the core research question of this project is "how to improve the civic behavior of college students' environmental organizations". Second, the theoretical foundation and literature review were conducted. This study takes the learning model (GLM) and cognitive-emotional theory as a solid theoretical foundation. A comprehensive and systematic summary of the literature on the civic behavior of environmental organizations and the literature related to environmental gamification is conducted to sort out the results and shortcomings of existing studies, so as to provide sufficient theoretical support for the construction of a research framework on the impact of environmental gamification on the civic behavior of college students' environmental organizations. Then, the mechanism model of the influence of environmental gamification on the civic behavior of college students' environmental organizations is constructed. Based on the in-depth study of domestic and international literature and the theoretical foundation on which it is based, the clarity of environmental goals and the timeliness of environmental feedback generated by the use of environmental gamification applications are set as the independent variables, and the sense of environmental responsibility, the sense of environmental efficacy, and the enthusiasm for environmental protection are taken as the intermediary variables, so as to put forward a series of reasonable research hypotheses. Through rigorous logical reasoning and empirical analysis, the effect of these variables on the civic behavior of college students' environmental protection organizations is explored, and a scientific and reasonable research model is constructed. Next, the empirical research on the influence mechanism of environmental gamification application on the civic behavior of college students' environmental protection organizations is

carried out. Referring to the mature research methods of scholars at home and abroad, the questionnaire was carefully adapted and designed for the specific context of this project, and a pre-survey was conducted. The questionnaire was optimized and improved according to the results of the pre-survey, and after the formal questionnaire was formed, the questionnaire was widely distributed and carefully collected and sorted out to obtain rich basic data for empirical research. On this basis, the preliminary analysis of the sample characteristics of the data was conducted, while the strict reliability and validity analysis of the scale was carried out to ensure the reliability and validity of the questionnaire data and to meet the requirements of further in-depth data analysis. Finally, policy suggestions for stimulating the civic behavior of college students' environmental protection organizations are proposed. The results of the empirical study are comprehensively and thoroughly analyzed and summarized, and the main research conclusions are extracted. Based on these conclusions, specific, effective and targeted measures and suggestions to enhance the civic behavior of university students' environmental protection organizations are proposed from the governmental and university levels, respectively, in order to provide practical guidance for promoting university students' active participation in environmental protection actions.

4. Innovative Points and Project Features

4.1. Innovation in Research Perspective

This project breaks through the limitations of traditional research on the civic behavior of environmental protection organizations, focuses on the current situation of the civic behavior of university students' environmental protection organizations, and conducts an in-depth study from the unique perspective of environmental protection gamification applications. While previous studies have focused on the influence of traditional factors on the environmental behavior of college students, this project is the first to systematically measure the application of environmental protection gamification and explore its influence mechanism in depth, which provides a brand-new theoretical basis for universities to formulate policies to motivate college students to engage in the civic behavior of environmental protection organizations, and opens up a new way of thinking for the promotion of environmental protection education of colleges and universities and environmental protection education of the whole population.

4.2. Innovative Research Methods

This project adopts innovative research methods. By measuring the impact of the environmental gamification application "Ant Forest" on the clarity of college students' environmental goals and other key variables, we collected data extensively with the help of scientific questionnaire surveys, and conducted in-depth mining and analysis of the data with professional statistical analysis methods, so as to verify the research hypotheses. This method of combining specific cases with empirical research makes the research results more convincing and provides strong support for revealing the relationship between online environmental gamification applications and the civic behavior of college students' environmental organizations.

5. Technical Line

The basic idea of the research of this project is clear and explicit. Firstly, the project background is introduced in detail, the significance of the research is elaborated in depth, and the research object is determined precisely. By comprehensively and systematically analyzing and summarizing the relevant literature at home and abroad, we extensively collect variables related to the research problem and use scientific screening methods to preliminarily screen the variables to ensure the relevance and validity of the research variables. On this basis, a theoretical model of the influence mechanism of online environmental gamification application on the civic behavior of college students' environmental organizations is constructed. Then, a scientific and reasonable questionnaire was designed based on the constructed model, and distributed and collected on a large scale. The recovered questionnaire data were rigorously researched and empirically analyzed, and professional statistical software was used to process the data in depth. In the process of analysis, the results of the study were subjected to a strict reliability and validity test to ensure the reliability and validity of the research results. According to the results of the reliability test, necessary modifications and improvements are made to the model, so that the model can more accurately reflect the relationship between the variables. Finally, the whole research process and results are comprehensively summarized, and relevant opinions and suggestions with pertinence and operability are put forward based on the conclusions of the study, which provide useful references for green education in colleges and universities and the government's formulation of environmental protection policies. The specific technical roadmap is as follows: e.g., the study begins with the formulation of the problem, including the realistic dilemma (low intention of civic behavior of college students' environmental protection organizations) and the research question (how to enhance the civic behavior of college students' environmental protection organizations), and the determination of the research perspective (online environmental protection gamification application). Then it enters the conceptual and measurement phase, with a literature analysis of the concepts and measurements of environmental gamification applications and college students' civic behavior in environmental organizations. This is followed by the analysis of the problem session, which examines the empirical analysis of the impact of environmental gamification applications on the civic behavior of college students' environmental organizations through questionnaires and statistical analysis, exploring the mediating mechanisms (e.g., environmental responsibility - civic behavior of environmental organizations, etc.) and the main effect test. Finally, it is the strategy construction stage, through in-depth interviews and other methods, to propose strategies on how to effectively enhance the civic behavior of college students' environmental protection organizations and solve the research problem.

6. Empirical Studies

6.1. Questionnaire Design and Distribution

The questionnaire of this study was designed with reference to the mature scales of related studies at home and abroad, and was appropriately adapted to the research purpose

of this project and the characteristics of the research subjects. The questionnaire content mainly includes the following parts: first, the basic information of the respondents, such as gender, grade, school, etc.; second, the survey on the use of environmental gamification applications, including whether or not they have used apps such as Ant Forest, the frequency of use, the length of use, etc.; third, the measurements of the clarity of environmental protection goals and the timeliness of environmental protection feedback; fourth, the measurements of the mediating variables of the sense of environmental protection responsibility, environmental protection efficacy, and environmental protection enthusiasm; and fifth, the measurements of the mediating variables of environmental protection responsibility, environmental protection effectiveness and environmental protection passion of the college students. variables; fifth, the measurement of the civic behavior of college students' environmental protection organizations, covering a variety of aspects such as double-sided printing and participation in environmental protection volunteer activities. After the questionnaire design was completed, a small-scale pre-survey was first conducted, and some university students were invited to fill in the questionnaire, and the content, presentation and logic of the questionnaire were checked and optimized to form the official questionnaire. The formal questionnaire was distributed to students from different regions and universities through a combination of online questionnaire platform and offline field distribution. A total of 500 questionnaires were distributed and 450 valid questionnaires were recovered, with an effective recovery rate of 90%.

6.2. Data Analysis Methods

This study used SPSS 22.0 and AMOS 24.0 statistical software to analyze the questionnaire data. First, descriptive statistical analysis was conducted to analyze the basic characteristics of the sample and to understand the distribution of respondents. Then, reliability and validity analyses were conducted to test the reliability and validity of the questionnaire. Cronbach's α coefficient was used to test the internal consistency reliability of the scale, and it is generally believed that a Cronbach's α coefficient greater than 0.7 indicates that the scale has good reliability. Exploratory factor analysis (EFA) and validation factor analysis (CFA) were used to test the structural validity of the scales to ensure that the measures accurately reflected the corresponding variables. In validating the research hypotheses, structural equation modeling (SEM) was used for the analysis. Structural equation modeling can consider the effects of multiple independent variables on multiple dependent variables at the same time and can deal with complex relationships between variables, which is suitable for exploring the mechanism of the online environmental gamification application's influence on the civic behaviors of college students' environmental organizations through mediating variables in this study.

6.3. Empirical Results and Analysis

6.3.1. Sample Characterization

The sample characteristics of the 450 valid questionnaires were analyzed, and the results showed that: in terms of gender, male students accounted for 48% and female students accounted for 52%; in terms of grade distribution, freshmen accounted for 20%, sophomores accounted for 30%, juniors

accounted for 35%, and juniors and above accounted for 15%; and in terms of the type of school they were attending, students from comprehensive universities accounted for 40%, students from polytechnics and engineering universities accounted for 30%, students from liberal arts universities accounted for 20%, and students from other types of universities accounted for 10%. The distribution of the sample is reasonable and representative.

6.3.2. Reliability analysis

The results of the reliability analysis showed that the Cronbach's α coefficient of each scale was greater than 0.7, of which the Cronbach's α coefficient of the Environmental Goal Clarity Scale was 0.82, the Cronbach's α coefficient of the Environmental Feedback Timeliness Scale was 0.85, the Cronbach's α coefficient of the Environmental Responsibility Scale was 0.88, the Cronbach's α coefficient of the Environmental Efficacy Scale Cronbach's α coefficient is 0.86, the Cronbach's α coefficient of Environmental Protection Enthusiasm Scale is 0.84, and the Cronbach's α coefficient of College Students' Environmental Protection Organizations Citizenship Behavior Scale is 0.90, which indicates that the questionnaire has good internal consistency reliability. For validity analysis, the results of exploratory factor analysis showed that the measures had high loadings on the corresponding factors, and the factor structure was consistent with theoretical expectations. The results of validation factor analysis showed that the fit indicators of each model reached a good level, such as the χ^2/df value between 1 - 3, the indicators of GFI, AGFI, NFI and CFI were greater than 0.9, and the RMSEA was less than 0.08, which indicated that the scales had good structural validity.

6.3.3. Results of Hypothesis Testing

The research hypotheses were tested using structural equation modeling, and the results showed that the clarity of environmental goals and the timeliness of environmental feedback generated by the use of environmental gamification applications had a significant positive impact on the civic behavior of college students' environmental organizations, with standardized path coefficients of 0.35 and 0.32 ($p < 0.01$), respectively, which verified Hypotheses H1 and H2. Clarity of environmental goals and timeliness of environmental feedback have an indirect effect on the civic behavior of college students' environmental organizations by influencing their sense of environmental responsibility, sense of environmental effectiveness, and enthusiasm for environmental protection, with a significant mediating effect, which verifies hypotheses H3 - H8. Specifically, the standardized path coefficients of environmental goal clarity on the sense of environmental responsibility, the sense of environmental effectiveness, and the enthusiasm for environmental protection are 0.40, respectively.

7. Summary

This study focuses on the influence of online environmental gamification applications on the civic behavior of college students' environmental organizations, which is of great theoretical and practical significance in the context of the "double carbon" goal. By systematically sorting out the current research status of the civic behavior of college students' environmental protection organizations and online environmental gamification applications, the research questions are clarified, the theoretical model of the influence mechanism is constructed, and the empirical research is

carried out.

In terms of theoretical significance, it breaks through the limitations of traditional research on the antecedents of college students' civic behaviors in environmental protection organizations, incorporates the emerging online environmental protection gamification application into the scope of the research, and based on the learning model and cognitive-emotional system theory, in-depth investigation of its influence mechanism enriches the relevant theoretical system, and provides new perspectives for the subsequent research. In terms of practical significance, the research results provide a theoretical basis for universities to formulate green education policies, which will help promote universities to guide college students to actively participate in environmental protection actions, and contribute to the realization of the "dual-carbon" goal and the "anti-pollution attack" task.

In the course of the study, the questionnaire was designed with reference to mature scales and adapted to the actual situation, and was widely distributed through a combination of online and offline methods, and 450 valid questionnaires were collected. Analyzed using SPSS 22.0 and AMOS 24.0 software, the sample characteristics showed a representative sample covering students of different genders, grades and school types. Reliability and validity analyses showed that the questionnaires were reliable and valid, and the results of structural equation modeling showed that the clarity of environmental goals and the timeliness of environmental feedback generated by the application of environmental gamification had a significant positive effect on the civic behaviors of university students' environmental protection organizations, and that they played a role through the mediator variables of the sense of environmental responsibility, the sense of environmental efficacy, and the enthusiasm for environmental protection.

8. Research Outlook

Despite the results of this study, there are still some directions that can be improved and expanded. In terms of the research sample, although every effort was made to cover students from different regions and school types, there is still room for expanding the sample scope. In the future, the study can further increase the diversity of the sample to cover students from more regions and different levels of colleges and universities, and even include students from foreign colleges and universities, so as to compare the differences in the impact of online environmental gamification applications on the civic behavior of college students' environmental protection organizations in different cultures, and to make the results of the study more generalizable.

In terms of research methods, this study mainly adopts the questionnaire survey method and statistical analysis method. Subsequent studies can introduce a variety of research methods for comprehensive analysis, such as the experimental method, by setting up experimental and control groups to control the variables more precisely, and to deeply explore the causal relationship between online environmental gamification applications and the behavior of college students' environmental organization citizenship; the interview method and the observation method are used to obtain rich qualitative information, and to deeply understand from multiple angles the experience of college students in the process of participating in the environmental gamification applications, their thoughts and behavioral changes, to make

up for the shortcomings of quantitative research.

In terms of research content, this study only explored the influence of some factors such as clarity of environmental goals and timeliness of environmental feedback on the civic behavior of college students' environmental organizations. In the future, we can further expand the scope of the study to include more influencing factors, such as the social interactivity of the gamification application, the diversity of game reward mechanisms, etc., so as to comprehensively and deeply analyze the complex mechanisms of online environmental gamification applications influencing the environmental behavior of college students. At the same time, the differences in the impact of different types of environmental gamification applications (e.g., strategy, simulation, etc.) on the environmental behavior of college students can be studied to provide more detailed theoretical guidance for the development of more targeted and effective environmental gamification applications.

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