

Article

Perception and Effectiveness of Environmental Education for Tourists under Spatial Perspective: A Case Study of Wuyi Mountain National Park

Mengwei Chi ¹, Cuize Lin ¹, Jiayi Liu ¹, Lingyun Liao ^{1,2}  and Siren Lan ^{1,*}

¹ College of Landscape Architecture and Art, Fujian Agriculture and Forestry University, Fuzhou 350100, China; 2191775008@fafu.edu.cn (M.C.); 22319075001@fafu.edu.cn (C.L.); liaolingyun@fafu.edu.cn (L.L.)

² Wuyishan National Park Research Institute, Fuzhou 350002, China

* Correspondence: lkzx@fafu.edu.cn

Abstract: National parks are important spatial places for environmental education. To improve the perception and effectiveness of environmental education, it is critical to facilitate the public's spatial experience. To explore influencing factors of perception and effectiveness of environmental education from a spatial perspective is of great significance for stimulating the public's pro-environmental behavior and promoting the high-quality development of environmental education in national parks. Educational mode plays an important role in environmental education space, and spatial element is also an important part of it. In this study, Wuyi Mountain National Park was selected as a sample to explore whether educational methods and spatial elements affect the perception and effectiveness of environmental education through questionnaires and statistical methods. The results show that: (1) tourists prefer guided education mode, open space and road with interactive facilities and characteristic paving; (2) both educational modes and spatial elements have positive influence on the perception and effectiveness of environmental education; (3) educational mode and environmental education effectiveness are affected by the demographic characteristics, of which educational background is the main influencing factor. After analysis, it is suggested that when environmental education space is designed, tourists' preference should be considered and personalized environmental education program should be customized, so as to improve the readability of environmental education space, and provide reference and support for strengthening the environmental education function of national parks.

Keywords: environmental education space; environmental education effectiveness; environmental education perception; Wuyi Mountain National Park



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1. Introduction

Environmental education is one of the important functions for achieving the public welfare of national parks [1], which has gradually become the focus of national park research [2]. It can not only provide the public with the opportunity to understand national parks, and get close to and experience nature as a national welfare (including mobilizing the enthusiasm of whole people, stimulating the awareness of nature protection and enhancing their national pride), but also improve the ecosystem service function. It is also a significant cultural service ecological product, and an important path to promote the coordinated development of communities [3]. In addition, national parks are important spatial places for outdoor environmental education [4,5]. In the future, the public will have more opportunities to enter national parks [6]. How to conduct environmental education activities in national parks scientifically and reasonably, and provide environmental education projects with good perceived effect and high experience value for the public are significant contents of high-quality construction and development of national parks [7].

One of significant features of environmental education activities in national parks is outdoor [8], and outdoor environmental education space is an important part of environmental education research in them [9,10]. It plays a vital role in environmental education and provides a unique natural environment that enables the public to directly contact and experience natural ecosystems [11]. This direct contact helps to improve the public's environmental awareness and ecological knowledge, but also promote ecosystem cultural services [4,8,12,13]. In addition, it provides a collaborative platform for researchers and educators to translate the latest scientific findings into educational content, which makes environmental education more scientific and cutting-edge. Environmental education space is a spatial system coupled by environmental education material space and behavior, which can meet the needs of tourists' various self-guided and guided environmental education activities [14]. At present, environmental education in some national parks only focuses on publicity work, or simply regards it as environmental and natural resource interpretation, paying much more attention to the recreational value of environmental education resources [15]; however, it emphasizes less on the spatial representation of environmental education with natural and cultural values of national parks. Among them, the mismatch between environmental education space and public space perception leads to serious problems. For instance, the value of national parks can not be understood by the public and even the perception deviation is thus generated. The public's spatial experience is an important way to enhance the perception and effectiveness of environmental education [16]. Therefore, it is great significance to understand the public's behavioral preferences and spatial components in environmental education space.

From the perspective of behavioral geography, people's outdoor cognition is restricted by spatial elements [17], and relevant studies also confirm that spatial behaviors and elements have a strong correlation. For example, children's natural activities are mostly concentrated in sand pits, water bodies and other spaces, preferring natural soft paving [18]; the public tends to carry out physical activities in belt green space [19]. In addition, an optimally designed space may promote a more effective activity process, and the analysis of subject behavior of restricted space helps to propose targeted spatial optimization strategies [20]. The spatial structure of environmental education has supply and demand elements, that is, subjective and objective perspectives of space. The spatial active perspective of environmental education is mainly considered from the perspective of spatial elements, while its spatial passive perspective starts from the behavior itself. It has important practical and theoretical significance to study the effect of environmental education activities from the perspective of spatial supply and demand.

Wuyi Mountain National Park is the only national park in China that is not only the world cultural and natural heritage, but also the world biosphere reserve with intangible cultural heritage of mankind [Wuyi rock tea (Dahongpao) manufacturing process]. It has rich environmental education resources. Therefore, Wuyi Mountain National Park was selected as the empirical object to understand influencing factors of perception and effectiveness of environmental education from a spatial perspective through questionnaire survey. Statistical analysis methods, such as correlation and regression analyses, were used to reveal the influencing mechanism of environmental education, providing theoretical support for the spatial planning and design of environmental education, and improving the readability of environmental education space.

2. Theoretical Model

2.1. Perception and Effectiveness of Environmental Education

2.1.1. Environmental Education Perception

The knowledge of environmental education are important contents of environmental education perception [21]. Previous studies [22] have mainly evaluated the perception of environmental education from the perspective of knowledge perception. It mainly includes the surface knowledge related to human connotation (understanding ecosystem, protection

object, protection significance, etc.) and the deep knowledge related to environment (environmental issues, laws and regulations, protection behaviors, protection skills, etc.).

2.1.2. Environmental Education Effectiveness

Effective environmental education not only teaches people environmental knowledge, but also cultivates and strengthens people's environmental attitudes, values and skills to prepare for positive environmental actions [23]. Nowadays, the effectiveness of environmental education is assessed through whether there are changes in environmental knowledge, attitude, pro-environmental behavior and attitude after environmental education [24]. Therefore, based on previous research results [22] and environmental education objectives of national parks [25], relevant indicators were set up to evaluate the effects of environmental education from five dimensions: knowledge, behavior, attitude, skill and awareness.

2.2. Influencing Factors

Existing studies have found that educational facilities, educational modes, security systems and educational contents have an influence on the effectiveness of environmental education [26]. In the context of environmental education space, tourists' inner spatial perception is mainly formed through environmental education modes carried out in space, that is, the direct spatial behavior generated by public participation in environmental education activities. At present, there is relatively fewer researches on spatial elements and the perception and effectiveness of environmental education. Previous studies have confirmed that element attributes of natural environment [27], interpretive signs [28] and other spatial elements directly affect the effectiveness of environmental education. Therefore, it is necessary to further explore the effect of spatial elements on the perception and effectiveness of environmental education.

2.2.1. Education Mode

National park Environmental education modes include guided and self-guided education modes [29] (see Table 1 for details). Guided education means conducting environmental education activities through the guidance of environmental education tutors, guides and volunteers, such as interpreting the value of national park resources and introducing natural games. self-guided education means that without the guidance of instructor, environmental education contents of national parks can be independently learned through the self-guided environmental education system that has been built, so as to further understand the national parks and establish a positive relationship with nature. Thus, two research hypotheses were proposed.

H1: Education mode has positive influence on the perception of environmental education.

H2: Education mode has positive influence on the effectiveness of environmental education.

Table 1. Environmental education mode.

Education Mode	Specific Item
Guided mode	Guided interpretation of resource elements, such as guide's interpretation Participatory interactive experiences, such as nature games
Self-guided mode	Self-guided interpretation of resource elements, such as single natural objects, thematic knowledge points, etc. Participatory interactive experiences, such as interactively experiencing outfit: observing telescope, etc.

2.2.2. Spatial Element

Trail space is the main channel for tourists to contact the national park, and the main spatial place for environmental education activities. The environmental education of national parks in the United States has gained valuable experience in management mechanism

and planning system after more than 100 years [30], which can provide reference for determining the evaluation index of spatial elements. The United States Forest Service takes trail experiences, road surface and traffic conditions, obstacle conditions, construction materials and road facilities, and signage and interpretation as the basis for trail classification management [31], and the corresponding spatial elements are space opening conditions, interpretation and interactive experience facilities, and pavement materials of trails. As a result, the spatial element preference survey was mainly conducted from the above three aspects, and two research hypotheses were put forward.

H3: Spatial element preference has positive influence on the perception of environmental education.

H4: Spatial element preference has positive influence on the effectiveness of environmental education.

2.3. Theoretical Model

In this study, Wuyi Mountain National Park was taken as an example. Based on the above discussion, whether education modes and spatial elements have an influence on the perception and effectiveness of environmental education in national parks was explored from the perspective of space. The final theoretical model was shown in Figure 1. Research manuscripts reporting large datasets that are deposited in a publicly available database should specify where the data have been deposited and provide the relevant accession numbers. If the accession numbers have not yet been obtained at the time of submission, please state that they will be provided during review. They must be provided prior to publication.

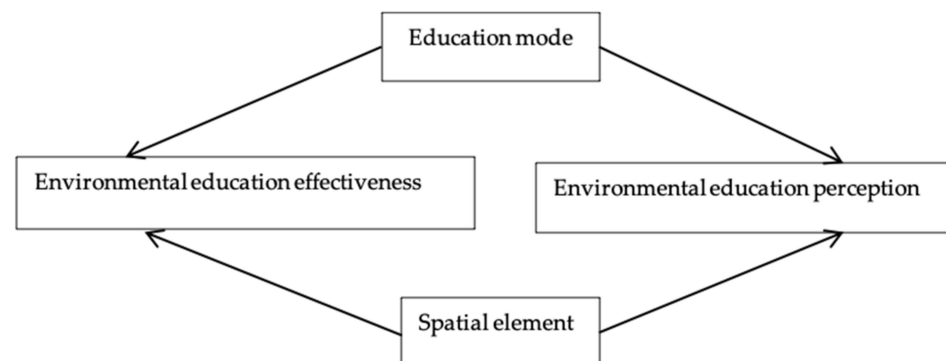


Figure 1. Research model.

3. Methodology

3.1. Study Area

Wuyi Mountain National Park spans Fujian Province and Jiangxi Province. According to the Master Plan of Wuyi Mountain National Park (2022–2030), the total area of Wuyi Mountain National Park is 1280 km², and its location is in the north of Wuyi Mountain Range, with a geographical coordinate of east longitude 117°24′15″~117°59′33″ and north latitude 27°24′15″~28°2′53″. It stretches from Baishigang, Wuyi Mountain Town, Yanshan County, Jiangxi Province in the north, Dakengxian, Shuibei Town, Shaowu City, Fujian Province in the south, Dongshan, Baishi Village, Zhaili Town, Guangze County, Fujian Province in the west, and Tongluoxing, Yingjiang Town, Yanshan County, Jiangxi Province in the east (Figure 2).

Wuyi Mountain National Park preserves the world's most complete, typical and largest subtropical forest ecosystem at the same latitude, which is home to nearly 3000 species of higher plants and over 7000 species of wild animals. It has a profound cultural heritage, with Zhuzi neo-Confucianism culture, Minyue culture, tea culture and other time-honored and splendid culture. In addition, there are comprehensive environmental education

resources, such as Wuyi Mountain National Park Intelligent Management Center, Environmental Education Mission Hall, Natural History Museum, Wuyi Academy, Dongfang Academy, Sangang Science and Technology Building Laboratory and Xianfengling Observatory. Abundant natural, cultural and comprehensive environmental education resources have laid the foundation for environmental education in Wuyi Mountain National Park. Moreover, Wuyi Mountain National Park is rich in environmental education media. In addition to digital media (official website, public account, etc.), paper media (the Drepanidae and Geometridae Record of Wuyi Mountain National Park, the Bird Guide of Wuyi Mountain National Park, the Publicity Album of Wuyi Mountain National Park, and Understanding Wuyi Mountain National Park) have also been published. Wuyi Mountain National Park has set up self-guided education facilities, such as information boards. Furthermore, it has carried out a series of environmental education guided activities focusing on science popularization and education, including “Welcoming the World Heritage Conference and Displaying Wuyi’s Charm” of Cultural and Natural Heritage Day, and “Focusing on Forests and Exploring Wuyi: Natural Education and Research Project of Youth Entering into Forests”.

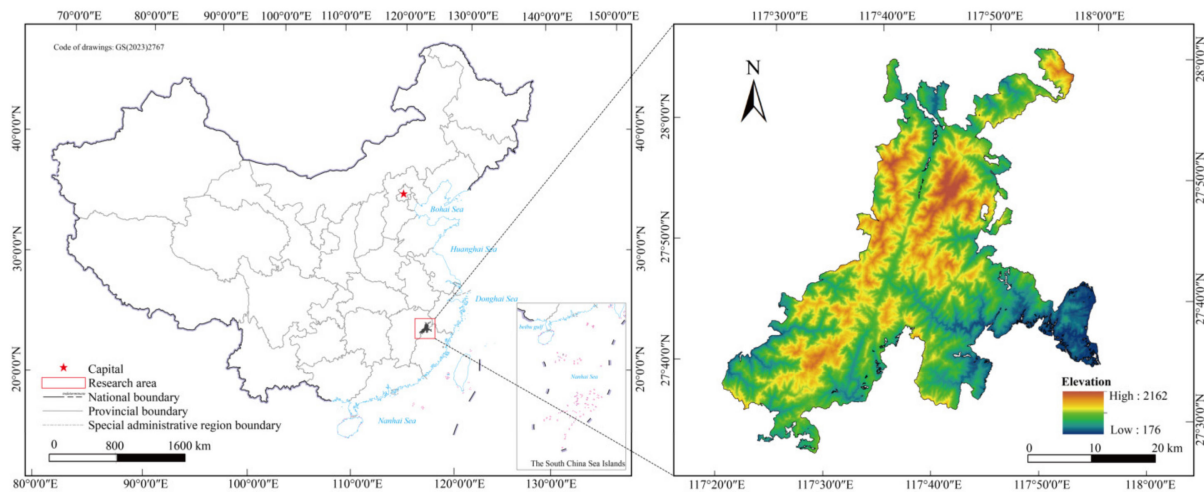


Figure 2. Study area.

From the above mentioned, Wuyi Mountain National Park is rich in environmental education resources, environmental education facilities and media, which is suitable for the study of perception and effectiveness of environmental education.

3.2. Questionnaire Design

The main objects of questionnaire are tourists who have visited Wuyi Mountain National Park, so the frequency and motivation of visits are first investigated. The main part of scale includes (1) basic personal information; (2) environmental education perception scale; (3) environmental education effectiveness scale; (4) educational mode preference scale; (5) spatial element preference scale. These scales are 5-level Likert scales, in which 5 levels of “strongly disagree”, “disagree”, “uncertain”, “agree” and “strongly agree” are recorded as 1, 2, 3, 4 and 5 points respectively. In the 5-level Likert scale, the average score of 1~2.49, 2.50~3.49 and 3.50~5 shows low recognition, neutral and high recognition respectively. Therefore, visitors’ average score can be used to analyze each item. Among them, pictures preferred by spatial elements are the corresponding ones generated by keywords input through the Midjourney software (<https://www.midjourney.com/home>), so as to exclude the interference of tourists’ place attachment emotion in real photos to the research.

3.3. Data Collection

From 31 May to 2 June 2023, the survey was conducted by combining on-site survey and online questionnaire. Due to the relatively good facilities and concentrated tourists

of Wuyi Mountain Scenic Area in the south of Wuyi Mountain National Park, the on-site survey was mainly carried out in the south of Wuyi Mountain National Park. In this study, stratified random sampling was adopted to ensure the representativeness of samples. Statistics obtained from the Wuyishan National Park Administration show that the ratio of male to female visitors to Wuyishan National Park is about 55:45. Furthermore, questionnaires strictly in accordance with this gender proportion were issued and collected, so as to ensure the representativeness of samples in terms of gender proportion. It received a total of 517 questionnaires; after incomplete data were excluded, a total of 469 valid questionnaires were collected, with a questionnaire efficiency of 90.7%.

4. Data Results

The collected data were analyzed by using the statistical product and service software automatically (SPSSAU, <https://spssau.com> (accessed on 29 July 2023), including reliability and validity analysis (measuring the reliability and validity of questionnaire scale), descriptive analysis (specific analysis of demographic situation and frequency of each scale indicator), Pearson correlation analysis (testing the above four sets of theoretical hypotheses), path analysis (measuring the effect of independent variable on the dependent variable that the above hypothesis is established), linear regression analysis (measuring the effect of each basic information on the spatial preference and effectiveness) and analysis of variance (determining the specific effect of basic information on the spatial preference and effectiveness).

4.1. Reliability and Validity Tests of Measurement Results

SPSSAU data analysis platform was used to test the reliability and validity of scale data (Table 2): Cronbach α of reliability of total scale is $0.964 > 0.8$; Kaiser-Meyer-Olkin (KMO) of validity of total scale is $0.946 > 0.8$; Barth spherical value is 29,886.66; and value of degree of freedom (df) is 2211.0, indicating that the scale has high reliability and good effectiveness. Cronbach α and KMO of each scale are >0.7 , indicating that each scale has good reliability and validity.

Table 2. Reliability and validity tests.

	Cronbach α	Number of Items	Sample Size	KMO	Barth Spherical Value	df Value	<i>p</i> Value
Environmental education perception scale	0.959	8	469	0.931	4093.056	28	0
Environmental education effectiveness scale	0.965	21	469	0.946	11,888.3	210	
Educational mode preference scale	0.857	4	469	0.775	887.915	6	
Spatial element preference scale	0.943	13	469	0.949	4494.024	78	

4.2. Descriptive Statistics of Sampling Data

According to demographic statistics, the number of males (55.01%) is slightly more than that of females (44.99%). The proportion of tourists between 19 and 29 years old is the highest, followed by those between 30 and 39 years old, indicating that the national park is dominated by middle-aged and young tourists. It shows a younger trend, which is consistent with the main visitor groups of Wuyi Mountain National Park. Respondents are generally highly educated, of which more than 90% of them have a bachelor's degree or above, 40.54% of them come to Wuyi Mountain National Park again, and 8.1% of them come here 5 times or more, indicating that it has a strong attraction and tourists visit it many times. 66.10% and 66.98% of them choose to visit it mainly because of vacation and beautiful natural ecology; 29.64% of them exercise and participate in environmental education activities (such as nature observation and nature perception) through outdoor activities in national parks; only 26.44% of them are interested in the objects protected by national parks.

The descriptive statistical results (Appendix A) show that the average distribution of observed variables is relatively balanced, and the average value ranges from 3.46 to 4.17.

4.3. Correlation Analysis

Correlation analysis was carried out on tourists' education mode preference, spatial element preference, environmental education perception and effectiveness data. Pearson correlation analysis shows that through pairwise comparison, there is significant positive correlation with positive influence ($p < 0.01$). Therefore, H1 ($r = 0.36$), H2 ($r = 0.47$), H3 ($r = 0.49$), and H4 ($r = 0.52$) hypotheses are valid. The influencing path established by path analysis and regression coefficient is shown in Figure 3. It is found that the effect of educational mode preference on environmental education effectiveness and perception is small, of which the effect on the environmental education effectiveness (0.248) is slightly greater than that on the environmental education perception (0.113); the effect of spatial element preference on the environmental education perception is the largest (0.424), followed by its effect on the environmental education effectiveness (0.368).

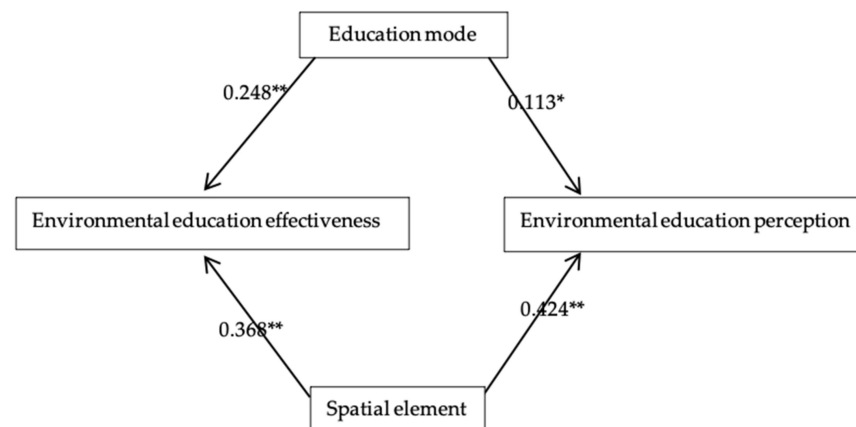


Figure 3. Influencing path (* $p < 0.05$ ** $p < 0.01$).

Regression analysis was used to further analyze the relationship among the four. The environmental education effectiveness was taken as the dependent variable, and the spatial element preference of education modes was controlled to observe the effect on it. As can be seen from Table 3, in education modes, guided and self-guided resource element interpretations have significant positive influence on the environmental education perception; guided and self-guided participatory interactive experiences, and self-guided resource element interpretation have significant positive effect on the environmental education effectiveness. The open space of spatial elements, and cobblestone paved road positively affect the environmental education perception. Open space, artificial road with interpretation facilities and wood paved road have significant positive influence on the environmental education effectiveness. Artificial roads without interpretation facilities has significant negative impact on the environmental education effectiveness.

Table 3. Effect of spatial preference of environmental education on its perception and effectiveness.

	Environmental Education Perception				Environmental Education Effectiveness			
	B	SE	t	p	B	SE	t	p
Educational mode preference constant	1.785	0.205	8.703	0.000 **	2.271	0.165	13.728	0.000 **
XD1	0.159	0.061	2.617	0.009 **	0.086	0.049	1.757	0.08
XD2	0.025	0.062	0.395	0.693	0.113	0.05	2.253	0.025 *
ZD1	0.211	0.057	3.743	0.000 **	0.148	0.046	3.253	0.001 **
ZD2	0.027	0.067	0.404	0.687	0.112	0.054	2.085	0.038 *
R ²	0.144				0.218			
Adjusting R ²	0.136				0.212			
F	F (4,464) = 19.470, $p = 0.000$				F (4,464) = 32.402, $p = 0.000$			
D-W value	1.608				1.85			

Table 3. Cont.

	Environmental Education Perception				Environmental Education Effectiveness			
Spatial element preference constant	0.935	0.207	4.509	0.000 **	1.671	0.165	10.105	0.000 **
YS1	0.222	0.063	3.515	0.000 **	0.214	0.05	4.251	0.000 **
YS2	−0.058	0.069	−0.845	0.399	0.024	0.055	0.441	0.66
YS3	0.041	0.056	0.728	0.467	−0.177	0.045	−3.972	0.000 **
YS4	0.095	0.063	1.507	0.132	0.037	0.05	0.736	0.462
YS5	−0.02	0.078	−0.261	0.794	0.149	0.062	2.391	0.017 *
YS6	0.085	0.07	1.21	0.227	−0.031	0.056	−0.558	0.577
YS7	0.004	0.069	0.063	0.95	−0.031	0.055	−0.56	0.576
YS8	0.038	0.073	0.516	0.606	0.155	0.058	2.653	0.008 **
YS9	0.008	0.082	0.092	0.926	0.118	0.065	1.805	0.072
YS10	−0.028	0.066	−0.422	0.673	−0.023	0.053	−0.427	0.669
YS11	0.072	0.074	0.98	0.328	0.1	0.059	1.697	0.09
YS12	0.189	0.062	3.037	0.003 **	0.069	0.05	1.395	0.164
R ²	0.279				0.357			
Adjusting R ²	0.26				0.34			
F	F (12,456) = 14.711, $p = 0.000$				F (12,456) = 21.072, $p = 0.000$			
D-W value	1.673				1.927			

Note: B represents the regression coefficient; SE represents the standard error; t represents the statistical value; p represents the significance level; the significance test of regression coefficient mainly focus on values t and p (* $p < 0.05$ ** $p < 0.01$); and R^2 represents the interpretation of independent variable to dependent variable.

4.4. Influencing Factor Analysis

Based on demographic characteristics, regression analysis was conducted on the four dimensions (see Table 4 for the results). It is shown that the education mode preference is affected by gender, age and educational background; the environmental education effectiveness is impacted by gender and educational background; and element preference and perception of environmental education are not influenced by demographic characteristics.

Table 4. Regression analysis results of demographic characteristics on four major dimensions (coefficients of independent variables).

Dependent Variable	Gender	Age	Education
Environmental education spatial element preference	0.17	0.79	0.64
Environmental education mode preference	0.001 **	0.037 *	0.004 **
Environmental education perception	0.98	0.31	0.56
Environmental education effectiveness	0.001 **	0.37	0.000 **

* $p < 0.05$ ** $p < 0.01$.

The average scores of gender, age and educational background on educational mode, and gender and educational background on environmental education effectiveness were classified and summarized (see Table 5). Environmental education results best in university education (3.94), but there is little difference with postgraduate education and above (3.91). Men have no obvious preference for educational methods, while women prefer participatory interactive experience activities guided by activity mentors (4.28). The overall average effect of environmental education for women (3.99) was higher than that for men (3.84). Over 60 years old, there is no obvious preference for educational methods. On the whole, guided environmental education activities are favored by all age groups, among which 50–59 years old prefer guided interpretation activities (4.43), and 30–39 years old prefer guided interactive experience activities (4.44).

Table 5. Average scores of demographic characteristics on influencing dimensions.

Demographic Characteristics	Variable	Education Mode					Environmental Education Effectiveness					
		XD1	XD2	ZD1	ZD2	Mean	ZS	TD	YS	XW	JN	Mean
Gender	Male	3.85	3.90	3.91	3.93	3.89	3.52	4.04	3.68	4.06	3.91	3.84
	Female	4.10	4.28	4.00	4.15	4.13	3.50	4.31	3.74	4.31	4.08	3.99
Education	Middle school and below	3.50	3.57	3.79	3.71	3.64	3.06	3.41	3.17	3.34	3.20	3.23
	High school	3.56	3.80	3.68	3.88	3.73	3.58	3.83	3.65	3.94	3.81	3.76
	University and junior college	3.95	4.03	4.01	4.02	4.00	3.55	4.18	3.75	4.18	4.05	3.94
	Postgraduate and above	4.24	4.42	3.78	4.17	4.15	3.42	4.30	3.61	4.35	3.85	3.91
Age	18 years old below	3.68	4.04	3.76	3.88	3.84						
	19–29 years old	3.94	4.01	3.97	4.02	3.98						
	30–39 years old	4.12	4.44	3.76	4.10	4.10						
	40–49 years old	4.07	4.20	4.13	4.00	4.10						
	50–59 years old	4.43	4.36	4.14	4.21	4.29						
	60 years old above	4.33	4.33	4.33	4.33	4.33						

5. Discussion

According to the above analysis, tourists' preference for educational mode is not obvious. Among them, the value of guided mode is slightly higher than that of self-guided mode, which may be due to the fact that China's educational mode is mainly taught in class, and tourists are more familiar with guided educational mode. In the spatial element preference, open space is preferred, mainly because people have genetically formed an evolutionary adaptation mechanism that has an innate positive response to nature's open space [32]. Furthermore, interactive facilities are more popular with tourists, in that it enhances the immersion of tourists and helps increase the environmental education effectiveness. Characteristically paved roads are more popular with the public for they can carry information and enhance interactive functions, which plays an important role in enhancing the environmental education effectiveness.

According to the correlation analysis and influencing path analysis (Figure 2), it can be seen that the preference of educational mode and spatial element have a positive influence on the environmental education perception. The results show that open space and cobblestone paved road improve the environmental education perception. Previous studies have also proved that tourists' effectiveness of receiving interpretation information at different spatial scales is different [33]. In addition, the educational mode positively affects the environmental education perception, and the guided and self-guided resource element interpretations are conducive to it. The daily learning mode is mainly taught by teachers and visual learning, so the interpretation mode of resource element conforms to the daily learning rules of tourists.

Guided and self-guided participatory interactive experiences, and self-guided resource element interpretation have significant positive influence on the environmental education effectiveness. Environmental education activities conducted in open space are conducive to the improvement of environmental education effectiveness, and non-interpretation facilities significantly affect it. This is consistent with the existing research findings that educational facilities and modes have an influence on the environmental education effectiveness [26], and interpretation signs in educational facilities [28] directly affect it.

To further improve the environmental education effectiveness, regression analysis and classification were carried out to understand the influencing factors of educational mode preference and environmental education effectiveness. Table 5 shows that there is a large gap in the data of educational level, with obvious demographic characteristics. Therefore, educational background is the main demographic influencing factor. Overall, the higher the level of education, the more likely to participate in participatory interactive experience

activities. Educational background is a comprehensive influencing factor, but the higher the level of education, the stronger the ability to capture information and the higher the environmental cognitive potential. In addition, gender and age have certain effect, but their difference is not significant.

The above results indicate that there are significant generalizability and representativeness. Both guided and self-help education modes have significant positive influence on the perception and effectiveness of environmental education, which is consistent with other similar studies. It is indicated that different education models have universal applicability in improving the effectiveness of environmental education [34]; moreover, open space and interactive facilities can significantly improve tourists' perception and effectiveness of environmental education. Similar studies have reached similar conclusions in other national parks and nature reserves, that is, spatial design plays important role in environmental education [27]. At the same time, stratified random sampling method was used to ensure the gender representativeness of samples. The male to female ratio in the study is determined to be 55:45, which is consistent with the actual sex ratio of tourists in Wuyi Mountain National Park, thus improving the external validity of the results in previous studies.

Based on the above discussion, the following suggestions were proposed to improve the effectiveness of nature education.

- (1) Improvement of resource element interpretation system. The perception and effectiveness of environmental education are affected by the interpretation of resource element. Therefore, it is necessary to improve the connotation of resource element interpretation system in national parks. First of all, we need to sort out knowledge resources of environmental education in Wuyi Mountain National Park, focus on local knowledge, and systematically plan the environmental education knowledge system in Wuyi Mountain National Park. Secondly, we should improve the usability and convenience of resource element interpretation media to increase the depth of perception and effectiveness of environmental education.
- (2) Design of environmental education space combined with tourists' preference. The planning and design of environmental education space should integrate the characteristics of national parks and tourists' personality perception. As a key element to enhance perception and effectiveness, open space should be considered as the focus of environmental education space design. In addition, the natural texture of wood paved roads and the unique beauty of cobblestone paved roads provide visitors with pleasant environmental educational experience, creating a more organic connection between the natural landscape and educational element. By combining the spatial elements preferred by tourists, an environmental education space integrating perception, learning and interaction can be created to provide more pleasant and meaningful deep educational experience.
- (3) Customization of personalized environmental education program. According to the gender, age and education level of visitors, personalized education courses and spaces are customized to ensure that the environmental education space fully meets the needs of visitors and provides unique and meaningful educational experience. With the content of environmental education resources as the core, environmental education modes are determined according to the characteristics of different tourists, and experience routes are organized through various types of roads. For instance, patrol roads are connected with walking trails to form different educational trails, so as to better satisfy different audiences' educational needs and provide more personalized and differentiated environmental education experiences.

This study has certain theoretical and practical significance for the optimization of environmental education. First of all, according to the existing research, environmental education programs customized to the needs of tourists can significantly improve the effectiveness of environmental education effect [24]. Therefore, by understanding visitors' preferences for different educational modes and spatial elements, managers can design more attractive and effective environmental education programs that optimize environmental education activities in national parks. Then, effective policy support is the

key to the success of environmental education [25]. The research results provide scientific basis for the formulation of national park management policies. Policy makers can use the data of this study to formulate more scientific and rational environmental education policies and promote the improvement of public environmental awareness and behavior.

Different cultural backgrounds may have various influences on the acceptance and effectiveness of environmental education. Future research should focus on the diversity of cultural background and explore how cultural factors affect the effectiveness of environmental education. In addition Environmental risk is an important element of tourist perception and environmental education, and future research needs to take this factor fully into account. Environmental risks, including natural disasters, ecosystem degradation and climate change, not only affect the experience and safety of tourists [35], but are also directly related to the effectiveness and significance of environmental education. Understanding and communicating these risks is critical to increasing public environmental awareness and coping capacity [36].

6. Conclusions

In the environmental education space of Wuyi Mountain National Park, through a questionnaire survey from the subjective and objective perspectives of space, the scientific measurement of tourists' spatial element, behavioral preference, environmental education perception and effectiveness was completed, and the relationship between spatial preference and environmental education perception and effectiveness was explored.

The results show that from the spatial perspective, both education mode and element preference have a positive influence on the perception and effectiveness of environmental education. The specific contents are as follows: Firstly, from the perspective of educational mode preference, guided and self-guided resource element interpretations are important methods of environmental education perception. Both guided and self-guided participation experience activities can improve the environmental education effectiveness. Secondly, in terms of spatial element preference, the perception and effectiveness of environmental education are better in open space. Cobblestone paved roads have a positive influence on the environmental education perception, and wood paved roads can enhance the environmental education effectiveness. Thirdly, educational preference and environmental education effectiveness are affected by demographic characteristics, and educational background is the main influencing factor.

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Appendix A

Table A1. Descriptive analysis.

Variable	Average Score	Item	Sample Distribution of Score/Piece					Mean	Standard Deviation
			1	2	3	4	5		
Environmental education perception (GZ)	3.46	Ecosystem knowledge of national park (GZ1)	19 (4.05%)	64 (13.65%)	173 (36.89%)	137 (29.21%)	76 (16.2%)	3.4	1.04
		Protected object knowledge of national park (GZ2)	13 (2.77%)	66 (14.07%)	169 (36.03%)	140 (29.85%)	81 (17.27%)	3.45	1.02
		Humanistic culture knowledge of national park (GZ3)	13 (2.77%)	53 (11.3%)	169 (36.03%)	148 (31.56%)	86 (18.34%)	3.51	1.01
		Conservation significance of national park (GZ4)	16 (3.41%)	45 (9.59%)	139 (29.64%)	170 (36.25%)	99 (21.11%)	3.62	1.03
		Introduction to environmental issues (GZ5)	20 (4.26%)	53 (11.3%)	197 (42%)	131 (27.93%)	68 (14.5%)	3.37	1.00
		Ecological protection laws and regulations (GZ6)	21 (4.48%)	59 (12.58%)	182 (38.81%)	137 (29.21%)	70 (14.93%)	3.38	1.03
		Environmental protection behaviors (GZ7)	13 (2.77%)	50 (10.66%)	160 (34.12%)	169 (36.03%)	77 (16.42%)	3.53	0.98
		Environmental protection skills (GZ8)	22 (4.69%)	59 (12.58%)	167 (35.61%)	149 (31.77%)	72 (15.35%)	3.41	1.04
Environmental education effectiveness-knowledge (XG-ZS)	3.51	Natural knowledge of national park (ZS1)	13 (2.77%)	28 (5.97%)	191 (40.72%)	181 (38.59%)	56 (11.94%)	3.51	0.88
		Protected object knowledge of national park (ZS2)	11 (2.35%)	38 (8.1%)	183 (39.02%)	175 (37.31%)	62 (13.22%)	3.51	0.91
		Humanistic culture knowledge of national park (ZS3)	10 (2.13%)	29 (6.18%)	174 (37.1%)	192 (40.94%)	64 (13.65%)	3.58	0.88
		Basic concept of national park characteristics (ZS4)	12 (2.56%)	31 (6.61%)	179 (38.17%)	186 (39.66%)	61 (13.01%)	3.54	0.89
		Environmental protection policies and regulations of national park (ZS5)	13 (2.77%)	39 (8.32%)	205 (43.71%)	157 (33.48%)	55 (11.73%)	3.43	0.90

Table A1. Cont.

Variable	Average Score	Item	1	Sample Distribution of Score/Piece				Mean	Standard Deviation
			2	3	4	5			
Environmental education effectiveness-attitude (XG-TD)	4.16	Caring for the natural environment and ecosystem (TD1)	5 (1.07%)	5 (1.07%)	100 (21.32%)	170 (36.25%)	189 (40.3%)	4.14	0.86
		Protecting wildlife and their habitats (TD2)	5 (1.07%)	3 (0.64%)	107 (22.81%)	155 (33.05%)	199 (42.43%)	4.15	0.87
		Minimizing disturbance to wildlife during the tour (TD3)	3 (0.64%)	5 (1.07%)	103 (21.96%)	155 (33.05%)	203 (43.28%)	4.17	0.85
		Not overdrawing the environmental resources of future generations to satisfy themselves (TD4)	4 (0.85%)	4 (0.85%)	106 (22.6%)	144 (30.7%)	211 (44.99%)	4.18	0.87
Environmental education effectiveness-awareness (XG-YS)	3.71	Helping other publics understand national parks (YS1)	9 (1.92%)	17 (3.62%)	168 (35.82%)	204 (43.5%)	71 (15.14%)	3.66	0.85
		Having awareness of active learning for ecological knowledge(YS2)	8 (1.71%)	15 (3.2%)	167 (35.61%)	204 (43.5%)	75 (15.99%)	3.69	0.84
		Having awareness of environmental concern (YS3)	8 (1.71%)	16 (3.41%)	144 (30.7%)	210 (44.78%)	91 (19.4%)	3.77	0.86
Environmental education effectiveness-behavior (XG-XW)	4.17	Throwing garbage into the trash or taking it away during the tour (XW1)	8 (1.71%)	8 (1.71%)	94 (20.04%)	101 (21.54%)	258 (55.01%)	4.26	0.64
		Not feeding or scrambling wildlife during the tour(XW2)	9 (1.92%)	4 (0.85%)	103 (21.96%)	121 (25.8%)	232 (49.47%)	4.2	0.94
		Following the designed route without disturbing wildlife habitats (XW3)	5 (1.07%)	7 (1.49%)	97 (20.68%)	118 (25.16%)	242 (51.6%)	4.25	0.91
		Discouraging or reporting violations against protected objects (XW4)	5 (1.07%)	15 (3.2%)	127 (27.08%)	129 (27.51%)	193 (41.15%)	4.04	0.95
		Actively participating in environmental protection and construction of national park (XW5)	6 (1.28%)	7 (1.49%)	123 (26.23%)	132 (28.14%)	201 (42.86%)	4.1	0.93

Table A1. Cont.

Variable	Average Score	Item	1	Sample Distribution of Score/Piece				Mean	Standard Deviation
			2	3	4	5			
Environmental education effectiveness-skill (XG-JN)	3.98	Having a certain waste disposal ability (JN1)	5 (1.07%)	8 (1.71%)	132 (28.14%)	173 (36.89%)	151 (32.2%)	3.97	0.88
		Having ability to observe protected objects and biodiversity (JN2)	4 (0.85%)	14 (2.99%)	123 (26.23%)	179 (38.17%)	149 (31.77%)	3.97	0.88
		Having ability to select the least environmentally disturbing travel route (JN3)	6 (1.28%)	13 (2.77%)	138 (29.42%)	171 (36.46%)	141 (30.06%)	3.91	0.90
		Having aesthetic ability to appreciate and comprehend ecological beauty (JN4)	4 (0.85%)	4 (0.85%)	115 (24.52%)	178 (37.95%)	168 (35.82%)	4.07	0.84
Education mode preference-guided mode (FD-XD)	4.01	Resource element interpretation (XD1)	8 (1.71%)	16 (3.41%)	137 (29.21%)	133 (28.36%)	175 (37.31%)	3.96	0.98
		Participatory interactive experience (XD2)	3 (0.64%)	16 (3.41%)	118 (25.16%)	140 (29.85)	192 (40.94%)	4.07	0.92
Education mode preference-self-guided mode (FD-ZD)	3.99	Resource element interpretation (ZD1)	3 (0.64%)	12 (2.56%)	157 (33.48%)	131 (27.93%)	166 (35.39%)	3.95	0.92
		Participatory interactive experience (ZD2)	4 (0.85%)	8 (1.71%)	130 (27.72%)	156 (33.26%)	171 (36.46%)	4.03	0.89
Spatial element preference (YS)	3.89	Open space (YS1)	6 (1.28%)	8 (1.71%)	117 (24.95%)	195 (41.58%)	143 (30.49%)	3.98	0.86
		Semi-closed understory space (YS2)	5 (1.07%)	8 (1.71%)	130 (27.72%)	191 (40.72%)	135 (28.78%)	3.95	0.85
		Artificial paved roads without interpretive facilities (YS3)	15 (3.2%)	29 (6.18%)	162 (34.54%)	156 (33.26%)	107 (22.81%)	3.66	1.00
		Artificial paved roads with interpretive facilities (YS4)	11 (2.35%)	22 (4.69%)	139 (29.64%)	176 (37.53%)	121 (25.8%)	3.80	0.96
		Artificial paved roads with interactive facilities (YS5)	4 (0.85%)	7 (1.49%)	130 (27.72%)	190 (40.51%)	138 (29.42%)	3.96	0.84
		Natural roads without interpretive facilities (YS6)	5 (1.07%)	20 (4.26%)	141 (30.06%)	186 (39.66%)	117 (24.95%)	3.83	0.89
		Natural roads with interpretive facilities (YS7)	5 (1.07%)	10 (2.13%)	132 (28.14%)	189 (40.3%)	133 (28.36%)	3.93	0.86
		Natural roads with interactive facilities (YS8)	4 (0.85%)	4 (0.85%)	119 (25.37%)	157 (33.48%)	185 (39.45%)	4.10	0.87

Table A1. Cont.

Variable	Average Score	Item	Sample Distribution of Score/Piece					Mean	Standard Deviation
			1	2	3	4	5		
		Wood paved road (YS9)	3 (0.64%)	11 (2.35%)	127 (27.08%)	200 (42.64%)	128 (27.29%)	3.94	0.83
		Rock block paved road (YS10)	4 (0.85%)	12 (2.56%)	132 (28.14%)	191 (40.72%)	130 (27.72%)	3.92	0.86
		Rock paved road (YS11)	8 (1.71%)	25 (5.33%)	141 (30.06%)	169 (36.03%)	126 (26.87%)	3.81	0.95
		Characteristically paved road (YS12)	4 (0.85%)	3 (0.64%)	125 (26.65%)	207 (44.14%)	130 (27.72%)	3.97	0.80
		Cobblestone paved road (YS13)	6 (1.28%)	11 (2.35%)	143 (30.49%)	172 (36.67%)	137 (29.21%)	3.90	0.89

Note: The variable and item are followed by their symbols in parentheses.

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