Ant Forest through the Haze: A Case Study of Gamified Participatory Pro-Environmental Communication in China

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Abstract: Increasing energy consumption and growing pollutant emissions speak volumes about the environmental challenges in various countries and regions. As one of the fastest-developing countries, China has been facing a serious environmental crisis, with many parts of the country constantly shrouded in a heavy haze. In order to improve the public's pro-environmental awareness and encourage people to take action to contribute to energy conservation and emissions reduction, Ant Forest, a gamified participatory communication program, was launched on the top mobile payment service Alipay. This innovative approach links people's low-carbon lifestyles with afforestation and haze control in the real world through virtual gaming experiences. This case study explains the working mechanism of Ant Forest in pro-environmental communication and investigates its effectiveness in motivating the public to engage in pro-environmental activities. Focus groups and interviews were adopted in this study to collect qualitative data. The results indicate that Ant Forest plays an encouraging role in Chinese users' pro-environmental awareness and behaviors, but improvements in user experiences are still needed in some aspects. By introducing the haze problem in China and the practice of gamified participatory pro-environmental communication, this paper is expected to provide inspiration and reference for future efforts to promote public participation in environmental protection.

Keywords: haze; game; participatory; pro-environment; communication; China

1. Introduction

News about air pollution, population growth, large-scale rainforest destruction, and climate change these days continues to remind us that the human impact on the environment has become an indisputable fact. Scientists suggest that we declare the beginning of a new geological period, the "human age" [1]. "Anthropocene," the proposed term for this period, refers to the recent history of the Earth, and highlights the influence of humans on the planet; that is, they have become a geological force influencing the global topography and evolution of the Earth [2–5]. With the continuous increase of energy consumption per capita in recent years, the pressure of the environmental crisis on the global village is mounting. The omen of a polluted future looms particularly large in China, an ancient land where people have been living and thriving for generations, with a current population of 1.4 billion. While enjoying the dividends of social and economic development, China is facing severe challenges in climate-related environmental issues [6]. Over the past decade, the world's most populous country has been plagued by a formidable haze challenge. In the central, western, and northern regions of China, where air is constantly polluted and smog levels occasionally run off the charts, people are increasingly finding it difficult to breathe without worrying about the consequences [7,8].

Leveraging the power of the public to protect the environment, save energy, and reduce emissions may well be the most inclusive and cost-effective approach to mitigating haze and other environmental problems. Against the backdrop of the highly developed mobile Internet, gamified participatory pro-environmental programs based on mobile payment apps have emerged in China. Ant Forest, an environmental protection scheme featured on Alipay, China's top mobile-payment platform, disseminates the concept of a low-carbon lifestyle by encouraging environment-friendly behaviors in the form of a tree planting game. By July 2019, the program had already involved 500 million participants and carbon emissions had been reduced by 7.92 million tons [9]. According to estimates, this is equivalent to 3.4 billion liters less gasoline being burned, which could fill half of the country's gas stations. Meanwhile, 122 million real trees have been planted in Alashan, Ordos, and other parts of the country, and desert control has been carried out in an area that totals over 1 million mu (1 mu = 0.0667 hectares) [9].

As shown in this case study of Ant Forest, which has benefited from social and economic development and advanced mobile networks in China, using mobile media as a means of encouraging participatory attention to the environment may be a new approach to perceiving pro-environmental activities. The purpose of this paper is to explore and demonstrate insights on the environmental problem in China and the practice of gamified participatory pro-environmental communication in the country. This study investigates the user experience and persuasion effects of the game and argues for the possibility of combining mobile media technology with the power of the public to make meaningful contributions to improving the environment. The significance of this study is that it will help to get a better understanding of the relationships among humans, the environment, and mobile internet technology, and calls for further explorations on engaging the public through technology in order to advance the interactions between humans and the environment. We conclude the paper with reflections on the adoption of gamified participatory pro-environmental communication and its influence on users' pro-environmental awareness and behavior. The possibility of integrating pro-environmental communication, public participation, and Internet technology in the future is discussed as well.

2. Literature Review

2.1. The Inconvenient Truth about Haze in China

The prosperity and development of human civilization have always been accompanied by a marked impact on the environment and the climate. Since the Industrial Revolution, there has been a sharp contradiction between economic development and environmental protection. China has been rapidly developing its manufacturing industry and playing the role of "world factory" in the international industrial chain. As it lacked capital and technology but had abundant labor, manufacturing was heavily promoted when economic growth was getting started. The "world factory" development model and the rapid economic growth, however, came at the cost of environmental damage. With a sprawling manufacturing industry approaching its limits and per capita gross domestic product (GDP) reaching a moderately developed level of US$5000, environmental pressure has peaked in China [10,11].

Haze, a combination of a large amount of fog and particles that cannot be distinguished by the naked eye in the air, is one of the most undesirable weather phenomena in China. In 2013, severe air pollution in many parts of the country made "haze" a buzzword [12,13]. In January 2019, four haze events affected most of the provinces (districts and municipalities). In Beijing, the air was free of pollution on only five days. The economic and social activities of highly dense populations inevitably emit a great number of fine particles (particulate matter, PM 2.5) [14]. Compounded by air stagnation and other factors, the particles will be trapped, producing significant haze in the air. Results from scientific research prove that atmospheric fine particles can absorb a large number of carcinogens and genotoxic mutagens, and bring undeniable negative effects on human health, including increasing mortality and aggravating chronic diseases [15]. They can worsen respiratory and cardiac diseases,

change the function and structure of the lung, affect reproductive ability, and change the immune structure of the human body [16].

Haze is usually a result of manmade environmental pollution coupled with low temperature, light wind, and other natural conditions causing pollutants to diffuse [17]. Generally, two main causes lie behind the formation of haze: one is the discharge of pollutants, including dust from construction sites, coal-fired exhaust emissions from heating power plants, automobile exhaust emissions, industrial spraying emissions, factory production process emissions, and so on; and the other is climate anomalies, especially atmospheric circulation anomalies, which result in increased ventilation problems and diffusion of pollutants [18].

2.2. Haze Control, Low-Carbon Lifestyle and Afforestation

Curbing haze is not an easy task. A major way to control haze is to reduce emissions from the use of fossil energy, which is the main cause of smoggy weather [8]. Machinery such as automobiles and ships need fuel, and power generation requires burning coal. Besides taking measures such as reducing coal combustion, improving energy efficiency, or even adjusting the industrial structure, pooling the power of the public to adopt a low-carbon lifestyle is one of the most inclusive and cost-effective measures for reducing the fine particles created by energy use [19,20]. However, the popularity of a low-carbon lifestyle in China is limited. A sample survey conducted by the Chinese Society of Environmental Sciences at the end of 2016 showed that fewer than 9 out of every 100 respondents aged 15–69 had a basic mastery of concepts, knowledge, and skills related to a low-carbon lifestyle. The situation has improved since there has been promotion through mass media communication, but compared with their counterparts in developed countries and regions such as Europe, the United States, and Japan, the Chinese are not as well educated and conscientious about saving energy and reducing emissions.

Afforestation is another practicable solution to reduce haze, as forests play a critical role in the environment, the climate, and the whole ecosystem [21]. Forests have a significant bearing on the survival of humans: We breathe out carbon dioxide and breathe in oxygen, while forests complementarily absorb carbon dioxide and release oxygen. Vigorous tree planting and forest cultivation programs can not only control haze, but also improve air quality and the overall environment. Abundant fine hairs and mucus on leaves can absorb harmful particles such as carbon and sulfide in smoke and dust, as well as harmful substances such as bacteria and viruses, and can also reduce dust in the air. In addition, the leaves and trunks of trees can reduce solar radiation and reduce wind speed. According to statistics, a mu of forest can absorb 20,000 to 60,000 kilograms of dust a year, 4 kilograms of sulfur dioxide a month, and 67 kilograms of carbon dioxide a day, and release 48 kilograms of oxygen a day [22]. Afforestation is beneficial to the environment, but it is not an easy task in China, where large amounts of agricultural and industrial lands were needed to support the large population.

2.3. The Discourse of Pro-Environmental Communication

With environmental issues having emerged in many fields and at many levels, discussions about the environment and climate change are growing in volume worldwide. Covering a wide range of topics, pro-environmental communication has become a comprehensive interdisciplinary field. The connotation of pro-environmental communication can be perceived in terms of its practicability and constructiveness. The former means that pro-environmental communication acts as a symbolic medium, through which information about environmental problems and solutions can be disseminated. The latter emphasizes more the deep meaning system behind environmental problems, which constructs our values and reflections in understanding the environment and nature. These two aspects form a complete process of pro-environmental communication from discourse to action.

Chinese mainstream media has made it a priority to manage and address environmental problems and invested a large amount of media resources in this. In February 2015, a documentary named *ChaiJing Investigation: Under the Dome* caused a sensation in Chinese society. It was an in-depth

investigation of air pollution directed and narrated by the famous news hostess Chai Jing. This project opened a window that raised public awareness of the haze problem by answering three questions: What is haze? Where does it come from? What should we do? Realizing that an environmental crisis was unfolding, media organizations and individuals picked up on the science of haze and joined in the chorus of a strong appeal for haze treatment. Mainstream media can promote the dissemination of ecological information and enhance public environmental awareness by setting the agenda in the form of news reports, columns, or special topics. However, the effect of this communication is limited due to a lack of connection between awareness of environmental protection and low-carbon practices. Recent studies on behavioral psychology have provided empirical support for the argument that an updated sustainable discourse model of environmental communication needs to be put forward in the context of media integration [23–25].

With the development of new media technology and the growth of the audience, the discourse around environmental protection, which used to be dominated by traditional media, has embraced new media forms with an interactive nature. As far as the form of media discourse is concerned, with the development of new forms represented by the Internet and mobile phones, environmental issues are increasingly falling under the control of these new modes of communication. The way that information is disseminated among and received by the public has been gradually changed. This evolution has not only shaped environmental issues through a variety of expressions of this topic, but also serves as a bridge to connect other action subjects, such as improving and adjusting the government's management and raising public pro-environmental participation.

2.4. Gamification and New Media in Environmental Communication

Mass media has undergone a change from uniformity to noise, which makes the field of pro-environmental communication more complex [26]. With the development of media technology, gamification has become more involved in environmental communication. Using game elements in non-game contexts, studies were conducted on how gamification was introduced to engage and motivate people to participate in pro-environmental activities. Based on evidence from a dictator game, Ibanez et al. investigated how incidental emotions (one of the significant game features) impact pro-environmental behavior and found that certain emotional states (such as "awe") could increase participants' pro-environmental donation behavior [27]. More empirical studies were presented to examine the effectiveness of applying gamification in this field [28–30]. Morganti et al. conducted a literature review on utilizing serious games and gamification in environmental education, consumption awareness, and pro-environmental behavior promotion [31]. Their analysis indicated that both serious games and gamification can foster energy saving, but the effects varied according to different game types and features [31]. Although these studies explored the implementation of gamification in promoting pro-environmental behavior, there was little perception of gamification from the perspective of environmental communication. Technically, considering interactive features and motivational functions, gamification could be considered in developing communication characteristics as new media forms.

Participatory new media has gradually become an important channel for public opinion expression and public participation concerning pro-environmental communication. Pro-environmental communication practice in new media often involves interactive activities in various subjects. Ownership of the discourse has become an important mobilizing force and characteristic of public environmental events. At the same time, the discourse space of public opinion is quickly being decomposed and reconstructed. Participants in pro-environmental communication have multiple characteristics, with different parties to the discourse representing different interests and value orientations, and the result can be peaceful dialogue or confrontation. In non-interactive discourse, pro-environmental communication largely depends on the will of communicators, such as governments, experts, environmental non-governmental organizations (NGOs), and other social forces. Nowadays, those who display pro-environmental behavior, namely the audiences, are also making their voices

heard in the discourse. The pro-environmental communication process needs to pay attention to the participants in the discourse space of new media (audiences in the sense of traditional media) in many aspects, such as content, mode, method, and persuasion strategy. In gamification design, discourse narrative was non-linear and players had more opportunities to express or make decisions, which shows characteristics of participatory new media.

3. The Case of Ant Forest

As mentioned above, a low-carbon lifestyle and afforestation are playing significant roles in haze control and environmental protection. It is a meaningful practice to utilize new media forms to disseminate relevant information among the public to promote their engagement and participation in these fields. In August 2016, Ant Forest, a gamified interactive pro-environmental program, was launched on Alipay, a mobile payment platform under China's Internet giant Alibaba. Ant Forest is an innovative scheme that features the dissemination of environment-friendly concepts and a low-carbon lifestyle. This is the working mechanism between Alipay and Ant Forest: Users convert their real-life low-carbon behaviors conducted on Alipay into green "energy" points, which can be used for virtual tree planting in the Ant Forest game. Users can accumulate points by doing things like purchasing performance tickets, paying utility fees online, using electronic invoices and environment-friendly packages, making online hospital registration, and paying for low-carbon travel options (such as renting shared bicycles and buying public transportation tickets) through Alipay. It is noteworthy that the number of steps recorded on users' smartphones can also be converted to energy points within the Alipay app. As presented in Figure 1, users can open online carbon accounts in Ant Forest and manage their "energy" points and plant virtual trees. The design is similar to that of animal-raising games, but Ant Forest combines the virtual tree-nurturing experience with real-life activities through a mobile payment device, encouraging users to contribute to the reduction of carbon emissions by demonstrating the link between personal behavior and the cause of environmental protection in the course of the game. During the game-playing experience, users are expected to understand what activities are more environmentally friendly as they are rewarded with "energy" points for conducting specific behaviors. In this way, more information about a low-carbon lifestyle is introduced. Meanwhile, more opportunities to conduct those pro-environmental behaviors are provided as users get to complete those activities easily through the online payment platform.

Moreover, Ant Forest brings the interactive attribute of social networking into play. The collective strength of social relationships among users could be enhanced in settings such as "co-planting". One of the most widely discussed designs of Ant Forest is its "stealing energy" setting. Users can steal "green energy" from their friends, which adds unexpected fun to social interactions. Corresponding to "stealing and loss," users can also "water" their friends' trees and give them their "energy." This setting shows the mutual care and friendship in social relations in a vivid and appropriate way. The game has a dynamic dashboard that shows users which friends are stealing energy and lists their friends' energy points. By clicking on a friend's home page, a user can see detailed information: how they and their friend's energy accumulations compare in the current week, and if either of them is stealing energy from or watering the trees of the other. Ant Forest expresses social connections between users and their friends. It brings users opportunities for social interaction and the pleasure of interpersonal communication. The sense of comparison and competition from the interactive experience makes users more interested in and more likely to pursue a low-carbon lifestyle that contributes to the reduction of carbon emissions and indirect afforestation.
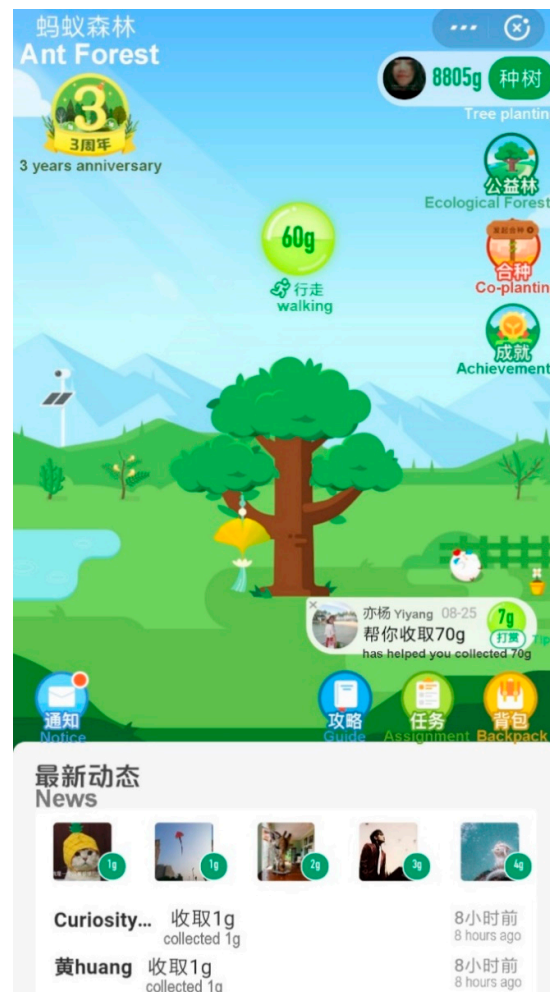
Figure 1. Screenshot of a user's homepage. In this case, the user gains "60 g" by walking and "70 g" from a friend. Upper right corner shows that this account has "8805 g" available for tree planting.

Another special feature of Ant Forest is that when a tree online grows big enough, a real tree will be planted somewhere in China by Ant Financial and other co-investors from the social welfare sector. Each real tree planted has an ID corresponding to its virtual representation. Gamification feedback mechanics are used to motivate users' engagement, so that they can "see" the solid results of their pro-environmental efforts. Meanwhile, users can also get a sense of ownership of a real tree, which is also a significant motivational gamification element. Then, the user experience of contributing to afforestation through self-efforts is further strengthened. By contrast with a reliance on stimuli from virtual game elements, such as points, badges, and leaderboards, by constantly providing positive reinforcement from the real world this innovative design enhances the ability to influence people's actual actions. This conversion between virtual and real objects in gamification systems provides inspiration for using game mechanisms in human behavior modification. Figure 2 shows two pictures taken before and after a tree-planting program in Alashan District of the Inner Mongolia Autonomous Region, where there are three large deserts totaling 80,000 square kilometers. To prevent them from merging, Ant Forest decided to plant Haloxylon ammodendron trees between the deserts, as the root systems of these trees are well developed and able to penetrate soil and reach several meters underneath, effectively controlling the growth of the deserts. Because of the trees, the number of sandstorms and the amount of sand in the area decreased significantly, and the risk of sandstorms in many other parts of northern China has also been reduced [32]. After two years of hard work, a considerable number of trees have been planted.
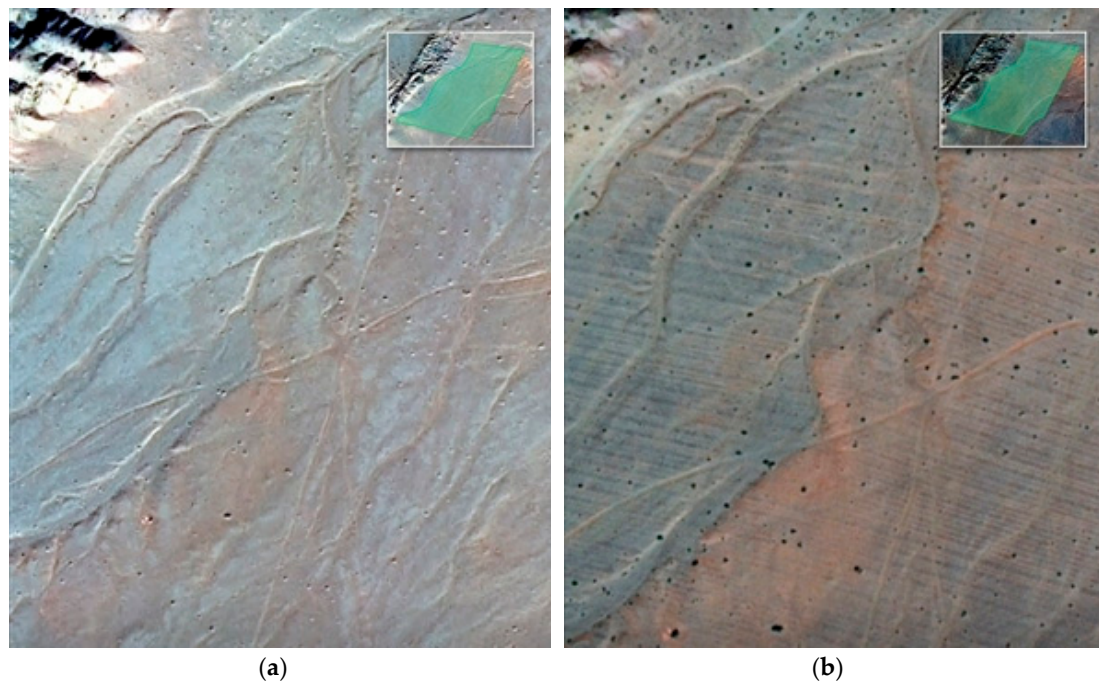
(**a**)　　　　　　　　　　　　　　　　(**b**)

Figure 2. Pictures taken before and after trees were planted show a notable contrast [33]. (**a**) Desertified area before planting: an image provided by China's self-developed high-resolution-2 satellite in October 2015 shows desolate Alashan area before Ant Forest planted trees. (**b**) Same area after trees were planted: a WorldView-2 satellite image from 774 kilometers above the Earth in August 2017 shows lines of Haloxylon ammodendron trees (90,000 trees on a 1800 mu plot of land) planted by Ant Forest.

4. Methods

In order to gain a thorough and in-depth understanding of the user experience and perceptions of the gamified participatory pro-environmental communication practice in Ant Forest, focus groups and interviews were adopted in the present study as a triangulation method. Participants were selected with the criterion sampling strategy. First of all, they had to be Ant Forest users. Then, we recruited participants at 3 levels: (a) beginners, whose cumulative playing time was about 1–24 h and who had not yet planted a tree; (b) intermediate players, whose cumulative playing time was about 25–50 h and who had planted at least 1 tree; and (c) advanced players, whose cumulative playing time was above 50 h and who had planted at least 3 trees. All volunteering participants were recruited from students at a university located in South China, and each received 50 RMB as compensation after participating in the study. The data collection was from 20 March to 12 May 2019.

4.1. Focus Groups

Focus groups were used in this study to collect quick and rich data on Ant Forest's user experience. In multiple focus group sessions, through structured questions by moderators, participants were asked about their experience, including their understanding, likes/dislikes, and comments about Ant Forest and its pro-environmental-related game settings. Each focus group session was held by 2 moderators: one asked the structured questions and the other observed and took notes. All focus group sessions were recorded with video recorders and each session lasted about 30 min. When the discussions of the focus group ended, participants were asked to complete a short questionnaire concerning their demographic information and Ant Forest usage.

Over a period of 2 days, we conducted 4 focus groups with 24 participants, including 12 beginners and 12 intermediate players. Among them, 10 were female participants and 14 were male participants. The age range was from 17 to 25 years. Their majors were computer science (N = 3), material science (N = 4), English (N = 2), biology (N = 3), civil engineering (N = 4), business and management (N = 4),

and mechanical engineering (N = 4). All participants were split about equally among degrees of usage, gender, age, and major. In the third and fourth sessions, the data were apparently becoming saturated, as repeated answers reflecting previously collected information were showing up.

4.2. Individual Interviews

Individual interviews were conducted to collect data from advanced players to get more in-depth insights, as advanced players were expected to have more informative opinions. In the 4 individual interview sessions, a semistructured schedule was adopted. The questions used in interviews were parallel to those used in the previous focus groups sessions. As we did in focus groups, all interviews were video recorded and transcribed. The 4 interviews lasted about 30 min each and were conducted on 4 different days.

Four qualified advanced players participated in the interviews, 2 female and 2 male, and their age range was 20 to 26 years. They came from civil engineering, computer science, material science, and liberal arts majors.

4.3. Data Analysis

The interpretive paradigm was adopted in the present study for data analysis. According to the fundamental tenets of the interpretive paradigm, reality is constructed intersubjectively [34]. The objective of this study was to reach an in-depth understanding of the realities that people construct based on their perceptions and experiences [34]. To achieve that research objective, a thematic analysis procedure was used to analyze the qualitative data we collected from the focus groups and individual interviews [35].

We analyzed the data in the following 4 steps. First, the audio recordings were transcribed into text; then, by highlighting recurring ideas related to our research goals, we identified initial codes; after that, potential themes were developed by grouping different but relevant codes; and finally, the merged themes were reviewed and refined through repeated examination to determine whether any should be modified. Proposed themes were discarded or combined if the data within themes were not meaningfully coherent or differences between themes were not identifiable [35]. After analyzing the collected data, we found that the opinions of users at different levels showed significant consistency. Therefore, we organized their insights into the same main themes, presented in the following section.

5. Research Results

Four major themes about the Ant Forest user experience emerged from the four-step thematic analysis. We present themes that discuss the idea of Ant Forest in gaming experience (theme 1), pro-environmental behaviors (theme 2), afforestation (theme 3), and user experience limitations (theme 4) in this section.

5.1. Gaming Experience Enhances Interests in Low-Carbon Lifestyle Adoption

A major theme that emerged was a sense of encouragement to adopt a low-carbon lifestyle from the gaming experience. Users reported feeling that Ant Forest differentiates itself because it successfully disseminates the message of a green and low-carbon way of life in the interesting form of participatory games. From the game playing, users felt motivated to adopt pro-environmental behaviors such as walking and taking public transportation by the game mechanism of points, badges, leaderboards, and so on. Advanced players emphasized that the social interactions of the gaming experience provided strong motivation to join pro-environmental activities. One interview participant expressed appreciation for the sense of fun that he gained from walking and always ranking at the top among his friends in Ant Forest. One participant in focus group 2 indicated that the shared game experience of planting virtual trees in Ant Forest with her best friend helped them remind each other to reduce their use of takeaway tableware when they were eating together.

5.2. Mobile Payment Platform Makes Pro-Environmental Participation More Convenient

Ant Forest was seen as a special existence as it is embedded in users' mobile payment–based daily life, according to focus group discussions and interviews. It not only helps make people's lives more convenient and efficient through the mobile online payment function, but also provides a platform for implementing pro-environmental behaviors, which was less easy to do without this technological support. Participants expressed the belief that Ant Forest had given them more information about what a low-carbon lifestyle is and more opportunities to conduct pro-environmental behaviors. For example, several participants mentioned that they were very impressed by the setting that allowed them easy access to shared bicycles with a mobile payment device, and they were able to support low-carbon travel. "Without Alipay, I wouldn't use the shared bicycles for sure; can't imagine how it would work without the mobile payment system," a participant said. Similarly, many participants described the joyful experience of gaining reward points in the game when they bought tickets by mobile payment on the bus. Some participants also commented on gaining rewards by ordering online products with green packages: "I enjoyed being engaged in environment protection through refusing excessive packaging with just one click on my phone," one participant said. The convenience provided by the mobile payment platform helps to reduce the cost of participating in pro-environmental activities and improves the possibility of implementing behaviors.

5.3. Afforestation Closes the Distance Between Virtual and Reality

A majority of participants expressed concern about the afforestation system in Ant Forest. They argued that, unlike traditional environmental awareness campaigns that advocate for a low-carbon lifestyle organized by environment-friendly groups and other organizations in the social welfare sector, Ant Forest creates a participatory experience for users to contribute to fixing real environmental issues by enjoying a virtual game world. Although users were just accumulating "energy" points for virtual tree planning in a game, they had the opportunity to experience participating in afforestation, since their virtual trees would eventually be transferred to a real ones planted in the desert. The participatory experience of contributing to environmental protection was enhanced. Participants indicated that although the government, media, businesses, and NGOs have made great efforts to advocate emission reduction, delivery of the information remains didactic one-way communication. With news reports, community announcements, and information boards as the main channels communicating the benefits of a low-carbon lifestyle, the public is merely a passive audience for these messages and can hardly be motivated to make green efforts that can change the world for the better. Moreover, some participants mentioned that there was a great degree of uncertainty when it came to the results of implementing green actions. "But Ant Forest has brought us a participatory experience and changed our roles from passive audiences to active contributors," an advanced player said, emphasizing the fulfillment she gained by planting real trees in the desert owing to her contribution.

5.4. Various but Still Limited Applied Range

Despite the fact that multiple options were available, participants, especially advanced players, addressed the issue of limited pro-environmental behaviors in the game. According to participants in focus groups and interviews, the most commonly used functions include walking, offline payment through Alipay, online movie/performance/transportation ticket purchasing, green package ordering, and shared bicycle renting. Many participants reported that they would like to have more choices in Ant Forest. One participant said, "I like to contribute to environmental protection in a fun way anytime, anywhere." A typical complaint among participants was that refuse classification and waste recycling were not included in the Ant Forest reward list, while these are popular concepts in current Chinese society. Additionally, participants suggested that new game mechanisms be constantly integrated into the up-to-date dynamic low-carbon lifestyle system. One participant commented, "Hopefully, Ant

Forest won't bore me, because I know from the bottom of my heart that pro-environment behavior is a good thing. Sometimes, I just need one more reason to do it."

6. Discussion

First, game-based incentives are helpful for encouraging and cultivating environment-friendly behavior. The research findings are consistent with previous studies on promoting pro-environment activities through games from different perspectives, such as using clean and green energy, participating in environmental organizations and activities, using low-carbon home heating, and choosing green travel by public transportation [31,36]. With incentives like game components (such as roles and badges), game mechanisms (such as challenges and competitions), game drivers (such as emotions and social interactions), and other elements, the game-oriented approach has a positive impact on the intrinsic motivation behind environmentally friendly behavior to varying degrees. Game-based pro-environmental communication in the environment of smart media with Chinese characteristics brings pleasant experiences and provides special dependent variables for the occurrence and implementation of environmentally friendly behavior. According to the integrated model of media entertainment [37], there are two main goals that people pursue with media usage from the perspective of the audience's psychological mechanisms: emotional regulation and self-realization. Ant Forest uses game design to encourage individuals to actively participate in low-carbon activities and communication. Through incentive mechanisms (such as energy accumulation, ranking, etc.), users not only get pleasant experiences of emotional regulation in the process of the game, but also feel accomplished as a result of their contribution to the cause of environmental protection, meeting the motivation of self-realization. The use of the game interaction strategy caters to people's entertainment needs and motivates public participation. This means that awareness programs on a low-carbon lifestyle are no longer confined to information dissemination but have become society-wide efforts that improve citizens' environmental literacy and encourage green habits.

Second, although being part of a financial app makes it seem irrelevant to the field of communication, Ant Forest plays a powerful and indispensable part in disseminating green messages and motivating people to adopt a more sustainable lifestyle through mobile Internet technology. Virtual and real worlds are connected through people's usage of the app: adventures in the online game space motivate users to take pro-environmental actions in real life, with offerings such as the opportunity to contribute to afforestation somewhere far away from the real action. Owing to technology, the physical environment of reality and the virtual gaming environment are not as distinct as they used to be. For example, Pokémon Go, a game that went viral all over the world in 2016, combines the two worlds using augmented reality, or AR, technology. The link between the real and the virtual brings new and exciting experiences for game lovers. In a game-based model, games in the virtual world run parallel with meaningful real-life activities. Ant Forest has gone further than that. In this win–win system, with the assistance of electronic devices and the mobile payment app on smartphones, a low-carbon lifestyle and environmental protection efforts have become part of the virtual gaming experience, giving users a stronger impetus to live and work in a low-carbon manner in reality. Meanwhile, by planting and nurturing trees in the virtual world, Ant Forest has broken the physical limits of this meaningful green activity for city-dwelling users, for whom tree planting was not a practical solution to making a green contribution. The implementation of pro-environment behavior can become easier, more convenient, and more achievable.

In general, the new communication practice such as what is offered by Ant Forest tries to fix two urgent problems in turning people's understanding of the environmental crisis into pro-environmental behavior. The first one relates to incentive mechanisms: The lack of effective incentives makes it difficult to transform willingness into actual behavior, form pro-environment habits, and achieve a series of other environmental actions based on spillover effects [38,39]. The second problem is about behavior implementation: Even if people are aware of the environmental crisis and have a sense of responsibility, due to factors such as perceived behavior control, environmental behavior is still

difficult to implement [40,41]. With the development of media technology, intelligent, interactive, and decentralized modes of pro-environmental communication may provide new approaches for people to actually adopt behaviors that contribute to preserving the environment.

Ant Forest's mode of Internet + games + social welfare has achieved success to some extent, in terms of gaming and participatory experiences; however, some issues still need to be further addressed. First, keeping an innovative edge in both content and form and maintaining users' loyalty and consistency will be high on the agenda of all such endeavors. The scheme should allow more activities to be converted into energy points, giving users more opportunities to live green and healthy lives while contributing to the greater good. Apart from things on the current list such as walking, using public transport, working green, and making online purchases, a broader array of low-carbon efforts should be recognized to form a more complete green picture. Furthermore, it is important to take into account the risk that the social welfare objectives behind games can be overlooked in the long run, as users may be too involved in the fun to embrace the mission in the real world. Striking the right balance between what is entertaining and what is admirable is something that Ant Forest and other social welfare programs need to make more efforts to achieve in the future.

The limitations of this study are mainly related to sampling. Although our participants represent a wide variety of people at different levels of using the program, the sampling pool of this study is college students. Owing to their specific perspectives, understanding of gaming, pro-environmental behaviors, and low-carbon lifestyle, they might have special features compared with the whole population. For example, they might not have as much experience with household energy usage as those who pay utility bills. Therefore, their opinions might be limited in richness and depth. Further studies may consider broadening the sample size by involving participants with various backgrounds and social statuses.

7. Conclusions

Translating the public's green and low-carbon awareness into real action used to be a global challenge. Ant Forest serves as an inspiring example for applying gamification in the pro-environmental communication field. Facilitated by the developed mobile Internet in China, it has taught us a meaningful lesson in promoting pro-environment information with an ingenious piece of design that encourages doing good with a touch of fun. On the low-carbon platform created via mobile Internet, everyone has easy access to the opportunity to participate in protecting the environment. Ant Forest not only presents how typical gamification design mechanics such as point rewards and social interactions ("energy" points and "stealing"/"watering") can be adopted for promoting pro-environmental knowledge and behavior, but also indicates the possibility of integrating mobile Internet technology to create better participatory experiences (transferring virtual trees into real ones). As green and low-carbon development has become a universal trend, the significant value of developing gamification designs in the field of pro-environmental communication lies in assembling individuals' efforts to act green and make a positive contribution to the effective protection of the environment.

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