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Driving Innovation and Sustainable Development in Cultural Heritage Education Through Digital Transformation: The Role of Interactive Technologies

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Abstract: Integrating cultural heritage education into digital platforms is crucial for advancing the knowledge-based economy, as it introduces innovative methods for information dissemination and economic growth stimulation. This study investigates the synergy between advanced digital technologies and cultural heritage principles, focusing on developing an interactive platform for the Xiannong Altar in China. Utilizing the Applied Games Engagement Model (AGEM), the project created an interactive instructional program on traditional agricultural culture, transforming static cultural resources into dynamic knowledge. We conducted a between-subjects user study involving 100 participants. The findings demonstrate that the platform significantly enhanced participants' understanding of cultural heritage and farming practices, positively influencing their perceptions. This study underscores the potential of digital technology to foster sustainable behaviors and effectively convey information, establishing it as a powerful educational tool for transformative learning. By illustrating how digitizing cultural material can drive innovation and create commercial value, this research contributes valuable insights for governments, cultural organizations, and entrepreneurs to leverage digital advancements to improve accessibility, engagement, and economic opportunities in the cultural and creative industries. Furthermore, it highlights the role of digital transformation in cultural heritage education as a catalyst for innovation and value generation within the knowledge-based economy.

Keywords: digital transformation; cultural heritage education; interactive technologies; serious games; economic value

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Academic Editor: Anderson Sunda-Meya

Received: 19 October 2024
Revised: 16 December 2024
Accepted: 30 December 2024
Published: 3 January 2025

Citation: Zhang, A.; Gong, Y.; Chen, Q.; Jin, X.; Mu, Y.; Lu, Y. Driving Innovation and Sustainable Development in Cultural Heritage Education Through Digital Transformation: The Role of Interactive Technologies. *Sustainability* **2025**, *17*, 314. https://doi.org/10.3390/su17010314

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1. Introduction

Recently, there has been a notable change in the field of education as digital games, game-like applications, and Serious Games (SGs) are increasingly used to address the changing teaching needs in many subjects, such as culture and technology [1,2]. SGs have shown significant advantages in creating realistic and non-realistic learning environments and increasing learner engagement, especially in cultural heritage education. The distinctive attributes of SGs enable immersive experiences that let learners interact with historical artifacts, explore ancient sites, and engage with cultural customs in ways that traditional educational techniques cannot reproduce [3,4]. Since the beginning of the 21st century, cultural heritage has become an important field of study for Serious Games (SGs). Cultural heritage refers to the historical, artistic, and scientific assets generated, kept, and handed down through generations [5,6]. The primary benefit of SGs is their ability to convey

meaning through feedback-driven narratives, gameplay mechanisms, information sharing, decision-making consequences, and immersive content, thereby effectively involving the audience [7]. Incorporating Serious Games (SGs) into cultural heritage education has demonstrated significant flexibility and efficacy, offering a distinct platform for preserving, presenting, and instructing cultural heritage [8,9].

The Xiannong Altar in Beijing, China, is a cultural heritage monument that offers a promising possibility for implementing Serious Games (SGs). This place is of great historical and cultural importance, as emperors used it during the Ming and Qing dynasties for agricultural ceremonies [10]. The main objective of these rites was to offer prayers for abundant harvests, emphasizing the altar's significance as a religious and historical monument and as a crucial reservoir of ancient Chinese agricultural culture and history [11,12]. The architectural design and arrangement of the Xiannong Altar embody the ancient Chinese architectural style and cosmology, symbolizing the significance of agriculture and reverence for the cosmic order and the natural world. Nevertheless, after the Republican era, the Xiannong Altar experienced a progressive decrease in importance or influence [13]. Various entities, such as institutions, schools, sports grounds, residential areas, and unlawful buildings, have encroached upon the altar's interior and outside sections. Modern constructions have caused damage to certain areas, posing a threat to the integrity and historical significance of the monument [14]. At present, there have been some studies on the Xian Nong Tan. For instance, Liu Yuxing has summarized the history of the Qing emperors' ceremonial plowing at the Xian Nong Tan based on imperial archives from the Qing Dynasty [15]. Huang Xiaoxiang and others have conducted a systematic study on the reasons for the "imperial disaster sacrifice rituals" at the Xian Nong Tan during the Ming and Qing periods, the changes in the sacrificial ceremonies, and the cultural significance they embodied [15]. Zhang Lingling and others have comprehensively studied the century-long historical transformation and functional changes of the Xian Nong Tan. However, existing research primarily focuses on the historical and cultural aspects of the Xian Nong Tan itself, with a gap in studies related to its preservation and public education [16]. In light of this situation, it is imperative to investigate novel methods to safeguard and enlighten the general public about the cultural legacy represented by the Xiannong Altar. Utilizing SGs provides an excellent opportunity to tackle this dilemma by rejuvenating the historical site, enlightening the public about agricultural expertise, and enhancing awareness of food conservation [17].

This study aims to explore the capacity of Serious Games (SGs) to safeguard and advance the cultural legacy of the Xiannong Altar. The study aims to investigate the design and implementation of Serious Games (SGs) to produce captivating and interactive learning experiences that effectively convey the historical and cultural importance of Xiannong Altar to a modern audience. By concentrating on this case study, the research aims to enhance the comprehension of how Serious Games (SGs) can be efficiently employed in cultural heritage education and preservation. To this end, we propose the following research questions:

RQ1: How can a serious game be designed to authentically depict the historical and cultural elements of Xian Nong Tan while sustaining learners' attention over an extended period to maintain their long-term interest?

RQ2: Can the developed serious game effectively enhance learners' understanding of the cultural heritage of Xian Nong Tan and its significance in the history of Chinese agriculture?

RQ3: Can a serious game serve as an effective tool for enhancing knowledge and understanding of the importance of cultural heritage sites and the profound cultural concepts embedded within them?

To investigate these questions, we first conducted a thorough literature review in Section 2 to examine existing research and key areas of focus on serious games in the field of education, in order to identify the corresponding design requirements. Then, in Section 3, building upon the literature review, we introduced the Applied Games Engagement Model (AGEM) framework and proposed a serious game design and development methodology based on this framework, which effectively integrates educational content with engaging gameplay. In Section 4, we describe the design and development of the Xian Nong Dreamscape serious game (SGs) prototype system based on the methodology, with a focus on embedding the historical and cultural significance of Xian Nong Tan into an engaging interactive experience while guiding learners' attention. Our system was tested by 100 participants in a user evaluation study in Section 5, using both quantitative and qualitative methods to validate whether the system we designed and developed could enhance learners' knowledge of Xian Nong Tan's cultural heritage and understanding of the importance of preserving cultural heritage sites, as well as advocate for sustainable dietary concepts. The results in Section 6 indicate that the game prototype developed under the guidance of the methodology effectively sparked users' interest in cultural heritage (CH) and significantly improved their understanding of Xian Nong Tan's cultural knowledge and recognition of sustainable dietary concepts. Finally, in Sections 7–9, we discuss, summarize, and address the limitations of this work, as well as propose directions for future research.

Our main contributions are as follows: (1) This study addresses the urgent need to protect and enhance cultural heritage sites, such as Xian Nong Tan, which face threats from modern encroachment, a matter of significant importance in the context of the knowledge economy. By integrating Serious Games (SGs) into cultural heritage education, this study contributes to the expanding body of literature on the innovative use of digital technology to engage learners and preserve cultural narratives [18–20]. (2) The research employs a quantitative approach to develop a serious game that utilizes cutting-edge technologies and historically accurate 3D models of the Xiannong Altar. By assessing the game's efficacy through user studies involving experts and diverse learners, the research underscores the potential of SGs to foster innovation, economic growth, and cultural sustainability, key themes within the knowledge economy.

2. Background and Related Works

2.1. The Role of Serious Games in Enhancing Educational Outcomes Within the Knowledge Economy

Serious Games (SGs) have emerged as a powerful tool in modern education, complementing traditional games, game-like applications, and digital platforms. These educational tools effectively meet the evolving teaching needs in various fields, particularly in culture and technology education [21,22]. The concept of "Serious Games" was first introduced by Abt (1970) [23], highlighting their purpose beyond entertainment to achieve specific educational goals [24]. SGs have revolutionized conventional educational approaches by offering dynamic and interactive learning environments. These simulations facilitate a significant shift from passive learning to active participation, allowing students to engage deeply with simulated scenarios that mirror real-world challenges [25]. The immersive nature of SGs enables learners to develop critical thinking, problem-solving, and decision-making skills within a secure and controlled setting [26,27]. Industry experts have refined the concept of SGs, classifying them as games designed primarily for educational purposes, thus distinguishing them from traditional video games [28,29]. SGs focus on learning outcomes, skill development, and knowledge acquisition while incorporating engaging elements typical of entertainment games. They are crafted to fulfill specific training, teaching, and simulation

objectives, demonstrating their adaptability to various educational contexts and learning goals [30,31].

The educational impact of SGs has been extensively researched, with empirical evidence demonstrating their effectiveness in enhancing learning outcomes. Studies have shown that SGs significantly improve knowledge retention, skill acquisition, and learner motivation [32,33]. Unlike traditional passive learning methods, SGs foster active learning by creating an engaging and interactive environment. They encourage curiosity and exploration, allowing students to test different strategies, evaluate decision outcomes, and learn from successes and failures in a safe space [34]. This active participation promotes cognitive development and instills a sense of ownership over the learning process, motivating students to explore subjects more deeply. Additionally, SGs have proven effective in enhancing cognitive skills, requiring players to analyze complex situations, evaluate options, and make informed decisions [35,36]. Learners refine their problem-solving abilities by addressing challenges in the gaming environment, formulating strategies, and applying knowledge to overcome obstacles. Research indicates that SGs can enhance cognitive capabilities, social skills, communication, and collaboration [37,38]. This comprehensive approach to skill enhancement equips students with the complexities of the modern professional landscape, where adaptability and cooperation are crucial. SGs provide educators valuable tools to improve learning and student performance across various subjects and age groups. They positively impact cognitive functions such as memory, attention, and comprehension [39,40].

SGs also influence students' attitudes and motivations toward learning by creating engaging and enjoyable experiences, leading to improved educational outcomes and perseverance in challenging tasks [41,42]. The adaptability of SGs is evident in their application across diverse fields, including healthcare, education, military training, and ecology [43,44]. In healthcare, SGs train medical professionals, simulate complex procedures, and educate patients on health management. In the military, simulation games provide realistic training scenarios that prepare personnel for various situations while minimizing the risks of live exercises. SGs have demonstrated efficacy in ecology and environmental education by raising awareness of ecological issues and promoting sustainable behaviors. By simulating ecosystems and illustrating the long-term impacts of human actions, these games cultivate a deeper understanding of environmental concerns and encourage proactive conservation attitudes [45]. SGs possess diverse characteristics that effectively address complex societal challenges and foster positive societal change. Developing SGs requires a careful balance between educational content and engaging gameplay. Collaboration between game designers and educators is essential to integrate learning objectives into game mechanics, ensuring player engagement while achieving instructional goals. As technology continues to advance, the potential for SGs in education is expected to grow. Virtual reality (VR) and augmented reality (AR) technologies expand the possibilities for creating highly immersive and interactive learning experiences, enabling more authentic simulations and offering learners experiences that are otherwise unattainable in the physical realm.

2.2. Leveraging Serious Games for Cultural Heritage Education in the Knowledge Economy

Integrating Serious Games (SGs) into cultural heritage education represents a transformative shift in pedagogical strategies, aligning with the broader goals of fostering innovation and knowledge dissemination in a knowledge-driven economy [46]. SGs offer immersive and interactive platforms that enable learners to engage deeply with cultural heritage, providing experiences that traditional educational methods often cannot deliver [47]. This innovative strategy has garnered increasing attention from researchers and educators, recognizing its potential to revolutionize how one engages with and understands our

cultural past [48]. The immersive and interactive nature of SGs offers a unique platform for disseminating cultural heritage knowledge, providing experiences that traditional educational methods often fail to deliver [49]. At the forefront of this educational revolution is the ability of SGs to create engaging, immersive experiences that transport learners into historical and cultural contexts. These digital environments allow users to interact with historical artifacts, explore ancient sites, and engage with cultural practices in previously impossible ways [50]. By doing so, SGs bridge the gap between abstract historical knowledge and tangible, experiential learning, making cultural heritage more accessible and relatable to modern audiences [12]. The efficacy of SGs in cultural heritage education lies in their capacity to present complex historical and cultural narratives in an interactive format. This approach enhances learners' understanding and deepens their appreciation for cultural heritage [51].

Through gameplay, users can explore different historical perspectives, make decisions based on period-specific contexts, and witness the consequences of their choices. This level of engagement transforms the learning process from passive absorption of facts to active participation in historical scenarios, fostering a more profound and lasting connection with cultural heritage [52]. The application of serious games in cultural heritage education is gradually gaining attention in China. With the advancement of the "Digital China" strategy and policy-driven initiatives for cultural heritage protection, an increasing number of digital technologies are being integrated into the education and preservation of cultural heritage. For example, the "Cloud Tour of Dunhuang" project offers the public a virtual interactive experience through the use of serious games. By leveraging 3D scanning and digital reconstruction technologies, the project presents a dynamic virtual reality (VR) tour of Dunhuang's Cave 285. This immersive experience is available both online and offline through VR devices and web platforms. Through a first-person perspective and interactive gameplay, the project animates a cave that is not typically open to the public, providing audiences with a rich sensory experience. This approach narrows the distance between viewers and historical artifacts, enabling them to understand the stories and cultural significance behind the relics. The project not only enhances public awareness and understanding of the Dunhuang caves but also opens up new pathways for cultural heritage education [53]. Similarly, the "Digital Central Axis" project, jointly developed by the Beijing Municipal Administration of Cultural Heritage and Tencent, focuses on the digital exhibition, intellectual property (IP) enhancement, and sustainable development of the Central Axis of Beijing. By utilizing advanced technologies such as high-definition scanning, game engine technology, and cloud gaming, the project offers an immersive experience that engages users through auditory, visual, and tactile interactions. It also innovatively combines "online + offline" mechanisms for the dissemination and inspection of cultural relics, thereby exploring new models for the protection and transmission of cultural heritage [54]. Another notable example is the "Wangfu Yizong" game, which targets young audiences by incorporating location-based service (LBS) technology. This approach allows players to explore different areas of Prince Gong's Mansion using mobile devices, offering insights into the architectural history and cultural context of the site. During the game, players are required to complete a series of tasks and challenges, which stimulates their learning interest and encourages them to engage in hands-on exploration of cultural heritage sites in the real world. Such location-based games enhance the interactivity and enjoyment of learning, catering to the preferences of younger generations in terms of both learning and gameplay. These initiatives exemplify the potential of serious games to foster cultural heritage education by blending education, entertainment, and immersive technology in a way that appeals to modern audiences [55].

Mobile game-based learning has emerged as a particularly promising avenue within the realm of SGs for cultural heritage education. The ubiquity of smartphones and tablets has opened new possibilities for location-based and context-aware learning experiences [56]. These mobile platforms enable learners to interact with cultural heritage assets in situ, blending digital content with real-world environments. This fusion of virtual and physical spaces creates a rich, multisensory learning experience that can significantly enhance the understanding and appreciation of cultural sites and artifacts [57]. Furthermore, mobile SGs in cultural heritage education serve a dual purpose. Beyond their educational value, they are crucial in promoting cultural values and raising awareness about the importance of preserving our shared heritage [58]. By engaging users in virtual reconstructions of historical sites or simulations of conservation efforts, these games can instill a sense of stewardship towards cultural heritage. This aspect is particularly vital in an era where many historical sites and traditions face threats from urbanization, climate change, and changing societal values [59].

Developing location-based games for cultural heritage awareness presents exciting opportunities and unique challenges. These games leverage GPS technology to create site-specific experiences, allowing players to engage with cultural heritage in its original context [60]. However, designing such games for university students requires careful consideration of various factors, including the balance between educational content and entertainment value, the integration of accurate historical information, and the technical limitations of mobile devices [61]. Identifying and implementing fundamental design elements is critical to developing effective location-based SGs for cultural heritage. These may include narrative structures that effectively convey historical information, game mechanics that encourage exploration and discovery, and intuitive and engaging user interfaces [62].

The challenge lies in creating games that are not only educational but also entertaining enough to maintain player interest over extended periods. Despite the promising potential of SGs in cultural heritage education, specific challenges persist. One significant issue is the need for more user engagement over long periods, which can hinder the effective transmission of knowledge [63]. This problem often stems from design deficiencies that fail to strike the right balance between educational content and entertainment value. When players need help to maintain focus on the game, their ability to absorb and understand the cultural heritage knowledge being conveyed is compromised [64]. Recent research has focused on developing more engaging and effective SGs for cultural heritage education to address these challenges. The Applied Games Engagement Model provides a framework for designing games that educate and captivate players [65]. This model emphasizes the importance of creating immersive experiences that align with players' interests and motivations, enhancing engagement and learning outcomes. The application of SGs presents a unique opportunity to protect, learn about, and disseminate the cultural heritage of specific sites, such as the Xiannong Altar in Beijing [66]. By designing a game that deeply integrates with the site's cultural and historical significance, researchers aim to create an engaging educational tool that goes beyond mere information delivery. Such a game could allow players to explore the altar virtually, participate in simulated historical events, and understand the site's importance in Chinese agricultural and imperial history [67].

Developing an SG for the Xiannong Altar would need to carefully balance historical accuracy with engaging gameplay. This might involve creating interactive scenarios that illustrate the altar's role in imperial agricultural rites, simulating the challenges of preserving such a site in modern Beijing, or exploring the altar's significance in Chinese cosmology and architecture [68]. The game could offer a multifaceted learning experience that appeals to diverse learning styles and interests by incorporating problem-solving, storytelling, and

exploration elements. Moreover, such a game could serve as a virtual preservation tool, digitally documenting and recreating aspects of the Xiannong Altar that may be at risk due to urban development or environmental factors. This digital preservation aspect adds another layer of significance to the project, potentially contributing to broader efforts in cultural heritage conservation.

By allowing users to interact with historical artifacts, explore ancient sites, and engage with cultural practices, SGs bridge the gap between abstract historical knowledge and tangible, experiential learning, making cultural heritage more accessible and relatable to modern audiences. This approach enhances understanding and appreciation of cultural heritage, promotes cultural values, and raises awareness about the importance of preservation [69]. Mobile game-based learning, in particular, leverages the ubiquity of smartphones and tablets to create location-based, context-aware experiences, blending digital content with real-world environments [70]. This fusion enriches the learning experience and fosters a sense of stewardship towards cultural heritage, which is crucial in an era where many historical sites face urbanization and climate change threats. Designing effective SGs involves balancing educational content with entertainment value, ensuring sustained user engagement and effective knowledge transmission.

3. Methodology

The Applied Games Engagement Model (AGEM) developed by Kniestedt et al. (2022) [71] provides a comprehensive framework for understanding and designing Serious Games (SGs) that effectively integrate educational content with engaging gameplay. The model emphasizes the complexity of player engagement, which evolves through various stages and is influenced by both in-game elements (diegesis) and external motivations (extra-diegetic purposes). The development of SGs, as outlined by AGEM, involves a systematic process that includes forming multidisciplinary teams, identifying extra-diegetic elements, creating a synergistic narrative system, and engaging in iterative development and evaluation. This approach ensures that SGs are educationally impactful and engaging, balancing entertainment with learning objectives. The cyclical nature of the development process, as depicted in AGEM, highlights the importance of continuous refinement to achieve optimal educational outcomes.

3.1. Applied Games Engagement Model (AGEM)

Serious Games symbolize a highly intricate integration of educational material and game features that goes beyond the simplistic idea of merely adding entertainment to learning–consequently, the understanding of how gaming participation and learning engagement change together must be very subtle. Thus, analysis of game involvement structures must be integrated into the very fabric of the participation process. Indeed, a player's journey through a Serious Game begins with initial engagement before progressing through various stages of participation that may culminate in disengagement and eventually re-engagement at some point. It emerges from the game system and user characteristics, making it multifaceted. Historically, there has been an assumption that participating in games contributes to learning because these two facets have been seen as synonymous.

Kniestedt et al. (2022) [71] have developed an Applied Games Engagement Model (AGEM) to address such complexity. This all-rounded model provides a complex method to build engaging and educationally effective serious games. The narrative elements (diegesis) versus gameplay mechanics (mimesis) are critical for designing immersive learning experiences. AGEM asserts that whether a serious game will be effective depends on its capacity to seamlessly blend edutainment contents within its gameplay structure.

Kniestedt et al. (2022) [71] exercise narratology in analyzing games as text. They differentiate between diegesis and mimesis, which are fundamental forms of narratology. Diegesis deals with storytelling, while mimesis involves direct representation of events. The significant difference is the presence or lack thereof of the narrator in diegetic forms.

Accordingly, serious games are regarded as textual narratives by Kniestetd et al. (2022) [71]. Consequently, intra-diegetic components involve immersive environments, characters, and objects, while extra-diegetic elements represent non-player character actors, external media, and physical environments. Player engagement in Serious Games can thus be conceptualized as occurring at all levels within this diegetic system, requiring attention to the intra-diegetic layer, which can involve temporary disengagement from tasks within the extra-diegetic level. The overlap between these two layers can vary depending on different games' objectives and designs. This variety allows for a range of engagement strategies suitable for education outcomes and specific target groups of individual serious games.

In the AGEM framework, there exists a complex interaction relationship between the player's perspective and the elements of game design. The **Player Frame** and the **Developer Frame** represent these two viewpoints. Within these frames, **Diegetic Systems** and **Extra-Diegetic Purposes** are introduced. Diegetic Systems refer to the in-game elements that shape the player's experience, while Extra-Diegetic Purpose encompasses the external motivations driving their engagement. The overlapping area between the Player Frame and Diegetic Systems signifies the **locus of attention** during gameplay. As seen in training simulations, a substantial overlap indicates a focus on in-game elements. Conversely, a weak overlap suggests focusing on external goals, such as gamification. This framework emphasizes the significance of understanding the relationships among these elements for the design of effective and engaging games [71].

3.2. Design Methodology of Serious Game

Serious Games' development process is a well-organized and well-thought-out learning game design according to the Applied Games Engagement Model (AGEM). It is characterized by several interrelated stages, each contributing to the establishment of an interactive and pedagogically efficient cybernetic learning environment. The first stage involves sketching out full-fledged outlines and forming a multidisciplinary team. This step helps create the foundational structure of the game, taking into consideration its intended size and content intricacies. The makeup of this group should accommodate a varied range of expertise, such as subject matter experts, game designers, pedagogical specialists, technical developers, etc. Secondly, the process proceeds to identify extra-diegetic elements. This refers to aspects external to the story system but necessary for enhancing educational value. Thus, there is a need to have an understanding of diverse features regarding target audience characteristics, motivation factors, and preferences when proceeding with this phase. They can relate to the players through nonplayer characters (NPCs), external media resources, physical environmental considerations, and supplementary educational materials.

Thirdly, a synergistic model is created where the narrative system of games meets with extra-diegetic objectives. In other words, this aspect ensures that narrative engagement with desired learning outcomes goes hand in hand with player engagement. Such synergy can be realized through different approaches, such as refined gameplay mechanics, strategic instruction deliverance, conveyance through narratives, and performance feedback mechanisms. The fourth stage deals with designing the narrative system. This phase needs careful consideration when focusing on players since it requires striking a dynamic balance between getting immersed in a plot and engaging oneself in an extrinsic objective for study purposes. Designers must carefully orchestrate moments of focused narrative engagement

together with those meant for reflection on external learning goals or those that allow both elements to be integrated.

Fifthly, this section covers the technical development stages for games. This phase involves the actualization of a design concept. This process includes game scenario development, user interface design, prop construction, coding functional states, debugging interactive elements, program integration, and scripted event trigger mechanisms. Finally, the game is thoroughly examined. Qualitative research techniques for studying player experience include observational studies or ethnography, questionnaires, and in-depth interviews. The data collected serves as an analysis to identify areas where the game can be improved and guides subsequent iterations and enhancements. This systematic approach to serious game development based on the AGEM framework is a robust means for creating educational games with an optimal balance between engagement and pedagogical goals. Its reasonable aim is to produce serious games that are both entertaining and educationally impactful and aligned with specific learning outcomes by accurately dealing with each stage during the developmental process.

Figure 1 depicts a cyclical model for game development, emphasizing the iterative nature of the process. At the center lies the core of game development, divided into four key phases: defining the extra-diegetic purpose, designing the diegetic systems, developing the game, and evaluating the final product. The process begins with defining the extra-diegetic purpose, which entails identifying the overarching goals or motivations to drive the player's engagement. Once the purpose is established, the diegetic systems, or in-game elements, are designed to align with and support this purpose. Subsequently, the game is developed based on the defined purpose and designed systems. The final stage involves evaluating the game's effectiveness in achieving its intended goals and identifying areas for improvement. The insights gained from this evaluation are then fed back into the process, leading to a new round of planning and development. This cyclical model underscores the importance of continuous assessment and refinement throughout the game development process.

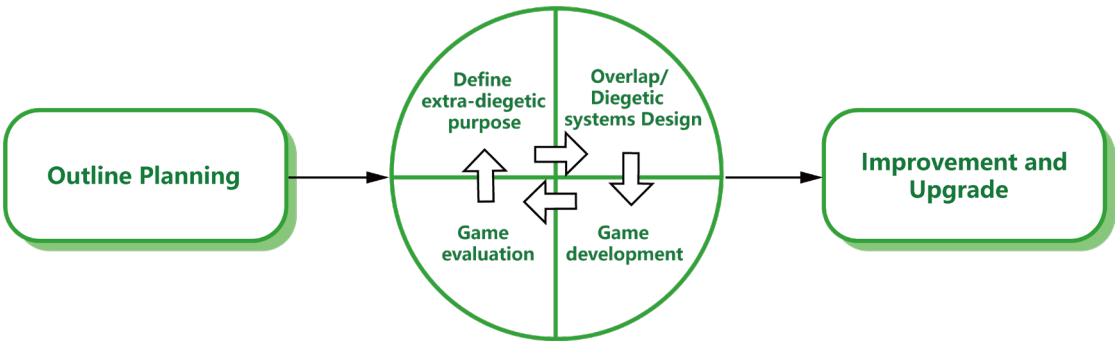


Figure 1. The scrum process.

4. The Developed Serious Game—Xiannong Dreamscape

"Xiannong Dreamscape" is a cutting-edge 3D role-playing game that fully engages players in the historical and cultural importance of Xiannong Altar by providing an absorbing first-person viewpoint. The game commences as players visit the physical Altar, unintentionally triggering its mystical attributes and transporting them to a parallel reality replicating the Temple's surroundings. Within this alternate dimension, participants partake in a diverse range of agricultural trials, encompassing the mastery of sowing methods, the mitigation of natural calamities, the utilization of tools appropriate for the period, and the implementation of efficient crop preservation strategies [72]. The gameplay is intended to instruct gamers about past agricultural techniques while necessitating them to

accomplish specified objectives about crop processing before being able to return to their initial reality. This mechanic functions as a gaming objective and represents the significance of prosperous harvests in ancient Chinese civilization [73].

As players advance in "Xiannong Dreamscape", they eventually realize that their choices in the parallel realm significantly influence the actual reality depicted in the game's storyline. The crops they grow are inherently connected to the ordinary people's harvest, and their endeavors prevent a food crisis, guaranteeing an abundant harvest for the populace. This narrative twist enhances the instructional content by demonstrating the practical importance of agricultural knowledge and practices while cultivating an emotional bond between players and the welfare of the virtual community. "Xiannong Dreamscape" provides a comprehensive learning experience combining gameplay, education, and storytelling. This immersive experience improves players' knowledge of agricultural heritage and fosters a sense of duty toward cultural conservation [74].

4.1. Extra-Diegetic Purpose

"Xiannong Dreamscape" is being created as a non-profit video game. This allows players to engage with the game from home and cater to their interests. A substantial game component focuses on integrating agricultural science and disaster avoidance knowledge, utilizing an experience learning process typified by an "information acquisition—practical operation" approach. This educational content is delivered by agronomy specialists on the development team, guaranteeing precision and pertinence [75]. To enhance players' comprehension of the Xiannong Altar, distinct features are allocated to different temple sections, which are interconnected inside the gaming environment. During gameplay, players must discover these regions to gain knowledge about various aspects of farming, which is crucial for progressing in the game. Therefore, the features outside the storyline mainly include informational resources about agricultural planting procedures, the roles of different places inside Xiannong Altar, and specific in-game animations, including the final animation [76].

The design of "Xiannong Dreamscape" exemplifies certain fundamental principles in producing serious games, specifically in the context of cultural heritage education. Offering the game for download optimizes compatibility with players' existing devices, improving accessibility [51]. The incorporation of agricultural science into the gameplay achieves a harmonious blend of amusement and learning, while the involvement of specialists in the field guarantees the precision of the content. The game's framework promotes proactive exploration, necessitating players to investigate the temple to acquire knowledge about the many stages of farming, thus converting the heritage site into an interactive setting [60]. The game facilitates contextual learning by organizing information into multiple capabilities and utilizing an experiential learning paradigm. This approach connects agricultural activities with the cultural value of the Xiannong Altar. This deliberate strategy encourages gamers to participate actively in educational material and emphasizes the significance of conserving cultural heritage within a non-profit structure [77].

4.2. Guiding Attention Through Design

In "Xiannong Dreamscape", players engage with the historical and cultural significance of Xiannong Altar from a first-person perspective, immersing themselves in an educational experience that combines knowledge acquisition, crop cultivation, and disaster management. The game design ingeniously intertwines its narrative objectives with the gameplay mechanics through a "knowledge acquisition–practical operation" model, where players are continually tasked with gathering information to progress the storyline. This process deepens their understanding of the Xiannong Altar and aligns closely with the

educational content intended for players. However, the repetitive nature of this knowledge-seeking process poses challenges in maintaining player attention over extended periods. To counter this, the game introduces time constraints and unpredictable disasters, providing players with opportunities for forewarning and preparation [76]. This design choice keeps players engaged and adds complexity and excitement to the gameplay, enhancing its entertainment value while allowing players to experience the hardships farmers face. The overarching objective of "Xiannong Dreamscape" extends beyond imparting superficial knowledge; it aims to disseminate the traditional cultural concepts encapsulated within Xiannong Altar. By integrating educational content seamlessly into the gameplay, the game fosters contextual learning that enriches players' appreciation for agricultural heritage. Including challenges, such as managing disasters and adhering to time limits, stimulates players' desire to overcome obstacles, reinforcing their engagement with the gameplay and the educational material. This thoughtful approach enhances the players' understanding of agricultural practices. It cultivates empathy for farmers' struggles, ultimately creating a rich and immersive experience that connects players with the cultural significance of the Xiannong Altar [74].

Figure 2 illustrates the participation process in "Xiannong Dreamscape". Initially, players watch a promotional animation and undergo game tutorials to understand the game's background and mechanics, with their attention entirely focused on the game itself. Upon formally entering the game, the narrative system and objectives external to the narrative work in tandem, as previously described. Ultimately, the success or failure of the game is reflected in different concluding animations, shifting players' attention from the narrative system to these animations. The content of these animations, along with subsequent evaluative questions, guides players to reflect on their gameplay experience, fostering an appreciation for the toils of farming and further understanding the need to respect and revere nature. This approach effectively conveys the cultural significance of the Xiannong Altar to the players.

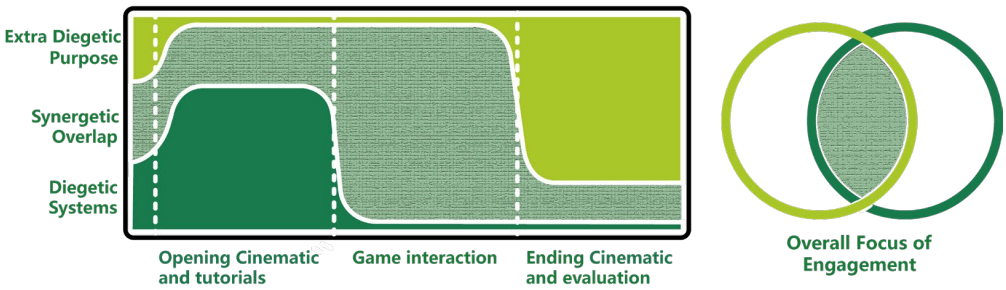


Figure 2. Engagement graphs for the game Xiannong Dreamscape.

4.3. Development and Design of "Xiannong Dreamscape"

Integrating Serious Games (SGs) into cultural heritage education marks a significant shift in pedagogical approaches, aligning with the evolving demands of the knowledge economy by fostering innovation and enhancing knowledge dissemination [78]. SGs provide immersive and interactive platforms that allow learners to deeply engage with cultural heritage, offering experiences that traditional educational methods often cannot deliver. By enabling users to interact with historical artifacts, explore ancient sites, and engage with cultural practices, SGs bridge the gap between abstract historical knowledge and tangible, experiential learning, making cultural heritage more accessible and relatable to modern audiences [79]. This approach enhances understanding and appreciation of cultural heritage, promotes cultural values, and raises awareness about the importance of preservation. Mobile game-based learning, in particular, leverages the ubiquity of smartphones and tablets to create location-based, context-aware experiences, blending

digital content with real-world environments. This fusion enriches the learning experience and fosters a sense of stewardship towards cultural heritage, which is crucial in an era where many historical sites face urbanization and climate change threats. Designing effective SGs involves balancing educational content with entertainment value, ensuring sustained user engagement and effective knowledge transmission [80]. By utilizing advanced technologies such as virtual and augmented reality, SGs can offer highly immersive learning experiences that support cultural heritage conservation and education, contributing to developing a more informed and culturally aware society.

4.3.1. Game Environment Design

One of the unique aspects of "Xiannong Dreamscape" is its environment, which is based on the architectural complex of the Xiannong Altar itself. This approach provides players with an immersive experience of the temple's cultural heritage, making the authenticity and detail of the game environment and models crucial.

1. 3D assets for game environments

The 3D modeling of cultural heritage sites typically employs two advanced techniques rooted in photogrammetric data collection. The first method involves capturing a series of overlapping photographs of the subject, which are subsequently processed to generate a 3D digital model [81]. The second approach utilizes laser scanning technology to measure the object's depth and dimensions, which are then converted into a 3D model [82]. In the case of the Xiannong Altar, its substantial scale necessitates using uncrewed aerial vehicles (UAVs) for comprehensive photogrammetric data acquisition. However, the site's proximity to Beijing's central axis, a designated no-fly zone for drones, precluded this option. Consequently, an alternative methodology was devised, integrating traditional on-site surveying techniques with photogrammetric modeling. The research team conducted extensive on-site investigations, meticulously measuring the architectural elements' dimensions, including length, width, height, rooflines, fenestration, and staircases. This process employed a range of precision instruments, such as laser distance meters, tape measures, and handheld scanners. To ensure accuracy, preliminary measurements and sketches were systematically documented and archived, necessitating multiple site visits to verify and refine the data. Regulatory constraints impeded direct access to certain areas, compelling the researchers to augment their field data with an extensive literature review on the Xiannong Altar and traditional Chinese architecture [83].

Additionally, expert consultations were sought to fill knowledge gaps and validate findings. This multifaceted approach culminated in the acquisition of a comprehensive dataset. Upon completing the data collection phase, the team created detailed computer-aided design (CAD) drawings of the Xiannong Altar. These drawings were the foundation for subsequent 3D modeling efforts, providing a precise digital representation of the site's architectural features and spatial relationships. The architectural modeling of intricate elements, such as dragon ridges and roof beasts, necessitated a collaborative approach with specialized institutions in ancient architecture, enabling access to replicas and analogous models suitable for photogrammetric modeling. A comprehensive photographic survey of these models was conducted to ensure clarity and detail, capturing high-fidelity images that were subsequently processed using ContextCapture v10.19 software to generate initial 3D models. The post-processing phase was executed using Blender 4.0, a sophisticated 3D modeling and rendering software, where the surface complexity of the models was reduced to facilitate seamless integration with the broader architectural model in subsequent phases. Upon completing this stage, the detailed component models were meticulously merged with the primary architectural models derived from CAD drawings, resulting in comprehensive individual structural representations. Through this methodological approach, the

research team completed the modeling of the entire Xiannong Altar architectural complex. This substantial task required the collaborative efforts of the core research team and over thirty undergraduate students. This collaborative model facilitated the completion of a complex project and provided valuable experiential learning opportunities in digital heritage preservation. The successful execution of this project underscores the efficacy of combining advanced digital technologies with traditional architectural knowledge and collaborative research practices, highlighting the potential of such approaches for the accurate digital reconstruction and preservation of complex historical structures, particularly when direct access or conventional documentation methods are constrained.

2. Game Scenario and Functional Design

The design of "Xiannong Dreamscape" intricately integrates game functionalities with the historical and cultural significance of Xiannong Altar, transforming the virtual recreation of the site into an engaging educational experience [77]. Each area within the game serves a specific purpose while imparting knowledge about agricultural practices and the site's historical functions. For instance, Taisui (Jupiter) Hall acts as an educational hub, housing various knowledge books on planting, fertilizing, and disaster prevention, encouraging players to actively seek information akin to the historical role of such halls as repositories of wisdom [84]. Similarly, the Pavilion of Sacrifice introduces players to the importance of livestock in farming, while the Divine Granary emphasizes grain preservation techniques, requiring players to follow guidelines to prevent spoilage. The Divine Kitchen focuses on food processing, teaching players about transforming raw crops into polished rice and enhancing their understanding of agricultural practices.

Moreover, the game's structure fosters exploration and discovery by requiring players to navigate between different areas to progress. The Emperor's Farmland allows players to apply their knowledge in crop cultivation. At the same time, the Deity Altar serves as an exchange point for game items, reflecting historical practices of trade and offerings [85]. Qing Cheng Palace functions as a resting area, providing narrative interludes and encouraging reflection on the learning experience. This multifaceted design motivates players through various gameplay mechanics, such as trading grains for items and acquiring processing manuals, and reinforces the interconnected nature of agricultural activities. By focusing on tasks like planting, harvesting, storing, and processing crops within the context of the Xiannong Altar, the game creates a holistic learning experience that educates players about historical Chinese agricultural practices and highlights agriculture's cultural and ritual significance in the region's history [86] (See Table 1).

Table 1. Functions of the Halls of Xiannong Altar in the game.

Regional Name	**Taisui Hall Complex**			**Pavilion of Sacrifice**	**Storehouse for Preparing Sacrifices**	**Kitchen for Preparing Sacrifices**	**Emperor's Farmland**	**Xiannong Altar**	**Qingcheng Hall Complex**
Regional Function	Storage of Planting Books			Keeping of Farm Animals and Storage of Farming Tools	Storage of Grain	Processed Grain	Farm	Redeem Props	Rest
Items Name	Planting Manual	Fertilizer Manual	Disaster Prevention Manual	Atlas of Farm Animals and Farming Tools	Grain Storage Manual	Machining Tool Atlas	Farmland	Atlas of Props	Resting Area
Items Function	Accelerated Crop Growth	Accelerated Crop Growth	Reduction of Crop Losses	Accelerating the Speed of Farming	Reducing Crop Losses and Increasing Storage Quantities	Processing of Brown Rice Into White Rice	Crops Planted	Redeem Props	Increase Game Realism
Acquisition Pathway	Obtaining Items Through Incense Offerings			Redeem at the Xiannong Altar					

4.3.2. Game Interfaces

1. The game start interface for "Xiannong Dreamscape" demonstrates a thoughtful approach to user engagement and accessibility. Rather than directly representing the Xiannong Altar, the background incorporates related elements to create an imaginative space. This design choice piques players' curiosity and draws their attention, setting the stage for the educational journey ahead. The interface invites players to form their initial impressions using suggestive imagery rather than explicit depictions. It encourages them to explore further to discover the true nature of the Xiannong Altar. The interface's functionality is designed with simplicity and intuitiveness in mind, featuring five clearly labeled buttons: "Start Game", "Level", "Save", "Feedback", and "Exit". This straightforward layout ensures that even players who are not frequent gamers can easily navigate the game's options without feeling overwhelmed. By reducing potential barriers to entry, the interface design maintains players' interest and encourages them to delve into the game's content. This user-friendly approach aligns with best practices in serious game design, emphasizing the importance of creating accessible and engaging experiences that do not deter players from unnecessary complexity in basic operations.
2. Icon Functionality: The interface design of this game demonstrates a minimalist and user-centric approach, featuring a carefully curated selection of icons that prioritize clarity and functionality. Each element serves a specific purpose, contributing to the gameplay experience without overwhelming the player. The countdown timer introduces a sense of urgency, encouraging players to make efficient decisions and manage their time effectively. The tips panel provides contextual guidance, offering relevant prompts based on the player's actions and game progress, aiding learning and decision-making. Health points serve as a critical indicator of the player's success. At the same time, the setup icon consolidates various essential functions, such as personal information modification, sound settings, and game saving, into a single, accessible location. Including a map, the feature assists players in navigating the game world and enhances spatial awareness and strategic planning. The backpack icon provides a convenient storage system for acquired items, supporting inventory management as an integral part of the gameplay. This streamlined interface design effectively guides players to focus on the game's core content, minimizing distractions and unnecessary cognitive load. By reducing the number of interface elements and ensuring that each icon is intuitive and easily understandable, the game creates an immersive experience that allows players to engage more deeply with the educational content and narrative elements. This approach aligns with best practices in serious game design, where the goal is to facilitate learning and engagement by removing barriers to interaction and emphasizing the core educational objectives of the game.

4.3.3. Game Interaction Design

1. Movement: The game's design incorporates a technique of estrangement, a sophisticated artistic method that presents familiar objects or environments in an unfamiliar or strange manner. Setting the game in a fictional alternate world breaks away from the conventional constraints of ground-based movement typically experienced in reality. This innovative approach offers players a fresh perspective, encouraging them to view the virtual world through a new lens. The ability to navigate on the ground and rooftops introduces a unique spatial dynamic rarely experienced in the real world, particularly in historical architecture. Osmose is a pioneering example from the 1990s that integrates art with VR environment design. Its innovation lies in breaking away from the traditional VR model, which is primarily control-driven

and goal-oriented, and instead emphasizing "presence" rather than "action". By navigating through breathing and bodily balance, it allows participants to experience a meditative state within an immersive virtual space. This design guides participants to step away from their habitual daily perceptions and cognitive patterns, offering a new sensory experience. It exemplifies a deep fusion of art and philosophy, providing valuable insights on perception, interaction, and self-awareness for this immersive experience [87]. This design choice serves multiple purposes within the game's educational framework. Firstly, it stimulates players' curiosity and encourages exploration, guiding them to investigate areas of ancient architectural structures that are typically inaccessible or overlooked in real-life scenarios. By allowing players to climb onto and traverse rooftops, the game provides a vantage point that offers insights into the intricacies of ancient Chinese architectural design, such as roof structures, ornamental details, and spatial relationships between buildings. This unconventional perspective not only enhances the players' understanding of historical architecture but also creates a memorable and engaging learning experience that goes beyond traditional methods of architectural study. The estrangement technique thus becomes a powerful tool for education, using the unfamiliarity of rooftop exploration to highlight and elucidate aspects of ancient architecture that might otherwise remain unnoticed or underappreciated.

2. Knowledge Acquisition: The interface design of the Taisui (Jupiter) Hall in this 3D serious game exemplifies a thoughtful integration of educational content with gameplay mechanics, effectively embedding historical, cultural, and agricultural knowledge within the game environment. Upon clicking on the hall, players are presented with a functional interface that includes options such as "Introduction", "Game items", and "Close". This layered structure allows players to navigate through information in a logical sequence, beginning with a general introduction and progressing to specific game items like the "Planting Manual", "Fertilizing Manual", and "Disaster Prevention Manual". By organizing the information according to the sequence of planting activities, the design reinforces practical knowledge and mirrors real-world agricultural processes, enhancing contextual learning and making the educational content more relatable. Furthermore, the interactive nature of the interface encourages players to actively engage with the material, promoting a more immersive learning experience. For instance, selecting the "Planting Manual" reveals a catalog that guides players through various planting tasks, such as soil preparation and using specific tools like "the plow". This task-oriented design directs players to the next steps in their gameplay. It ensures that learning is directly tied to game progression, motivating them to explore the educational content further. Including clear navigation options, such as the ability to click "Close" to exit the interface, provides players with a sense of control over their exploration. Overall, this design effectively balances educational objectives with gameplay elements, creating an engaging and informative experience that enhances players' understanding of agricultural practices within the historical and cultural context of Xiannong Altar.
3. Option Effectiveness: The game mechanics in "Xiannong Dreamscape" are structured around a "knowledge acquisition—practical operation" model, which effectively integrates learning with gameplay. This approach creates a dynamic learning environment where players must actively engage with and apply the information they acquire. The game encourages thorough exploration and comprehension of educational content by requiring players to gather relevant information from specific locations, such as the Tai Sui Hall, before making decisions. Using choice options during practical operations is an immediate assessment tool, testing players' understanding of the acquired knowl-

edge and directly influencing the game's progression. This model is exemplified in the sowing phase, where players must collect information about sowing conditions before making decisions. The "Tips Panel" is a crucial interface element, providing real-time guidance and updates on environmental conditions. Players must critically evaluate this information against their acquired knowledge to determine the appropriate time for sowing. The consequence-based system, where incorrect decisions lead to decreased health points, adds a layer of challenge and reinforces the importance of making informed choices. This immediate feedback mechanism maintains player engagement and simulates the real-world consequences of agricultural decision-making, enhancing the game's educational value. By linking player choices directly to the game's outcome, this design encourages careful consideration of learned information and promotes a deeper understanding of agricultural practices.

4. Game Modes: Incorporating Simple and Difficult modes in "Xiannong Dreamscape" demonstrates a thoughtful approach to game design that caters to a diverse player base with varying skill levels and learning preferences. In Simple Mode, players are afforded a more accessible and less time-intensive experience, with activities such as plowing and sowing requiring shorter duration. This design choice allows players to progress through the game at a more relaxed pace, even under the same overall time constraints. The reduced restrictions in Simple Mode minimize the potential for player errors, creating a more forgiving environment that facilitates more straightforward progression and successful game completion. This approach is particularly beneficial for newcomers to the genre, younger players, or those who prefer a less challenging experience while still engaging with the educational content.
5. Conversely, Difficult Mode offers a more rigorous and authentic simulation of traditional planting methods, presenting players with more challenging conditions that demand greater precision and strategic planning. This model appeals to players seeking a more immersive and historically accurate experience and those who desire a more significant challenge. Complex Mode enhances the game's educational value by emulating the complexities and difficulties of traditional agricultural practices. It provides a deeper appreciation for the skills and knowledge required in historical farming. Including these two distinct modes allows the game to effectively balance accessibility with depth, ensuring that a wide range of players can engage with the educational content while providing options for those who wish to delve deeper into the intricacies of historical agricultural practices.
6. Game Outcome: The game's success or failure mechanism in "Xiannong Dreamscape" is intricately tied to the player's health points, creating a tangible and immediate feedback system. Throughout the gameplay, each incorrect decision reduces health points by a specified percentage, serving as a constant reminder of the consequences of poor agricultural practices. This system not only adds tension and stakes to the gameplay but also reinforces the importance of making informed decisions based on the knowledge acquired during the game. The visual representation of health points turning red upon reaching a critical level provides a clear and intuitive indicator of the player's performance, with the final state of these points at the game's conclusion determining success or failure. The game's outcome is further emphasized through contrasting ending animations and powerful visual narratives illustrating the far-reaching impacts of agricultural success or failure on society. In the case of a successful playthrough, players are rewarded with scenes of abundance: lush rice fields, bountiful harvests, and joyous celebrations. These positive images are accompanied by subtitles describing favorable weather conditions and plentiful yields, reinforcing the connection between skilled agricultural management and societal prosperity.

7. Conversely, a failed outcome presents a stark and sobering scenario: barren fields, widespread poverty, and even starvation. The accompanying subtitles detailing severe disasters and crop failures drive home the devastating consequences of agricultural mismanagement. This dichotomy in endings not only provides a satisfying conclusion to the gameplay experience but also serves as a poignant educational tool, vividly illustrating the critical role of agriculture in sustaining human societies and the dire consequences of its failure.

4.3.4. Game Music Design

The integration of carefully selected sound effects and background music in "Xiannong Dreamscape" demonstrates a sophisticated approach to game design that recognizes the crucial role of audio in enhancing the overall gaming experience. By aligning auditory elements with specific scenarios within the game's storyline, the designers have created a more immersive and emotionally resonant environment for players. For example, the use of heavy rain sounds and intense, fast-paced background music during flood disasters serves to heighten the sense of urgency and danger, effectively conveying the gravity of the situation to players. Conversely, the inclusion of joyful laughter and celebratory music in successful conclusion animations reinforces the positive outcomes of players' efforts, providing a satisfying auditory reward for their achievements. The strategic use of music and sound effects serves not only as an aesthetic enhancement but also as a combination of auditory and visual elements. Beyond providing a singular sensory stimulus, the integration of multiple modalities further strengthens the transmission of information and emotional engagement. For example, the sound of a thunderstorm complements the visual effects of lightning, collectively evoking a sense of tension in the player, while celebratory music and visual depictions of characters enhance the feeling of accomplishment and satisfaction through the synchronization of auditory and emotional cues. Through this multimodal integration, the game amplifies sensory experiences while effectively promoting memory retention and emotional investment, adding an additional layer to the communication of information within the game. The auditory cues work with visual elements to create a multi-sensory experience that more effectively communicates the game's narrative and emotional content. The game creates a more holistic and engaging learning environment by engaging players' auditory senses alongside their visual and cognitive faculties. This approach not only enriches the player's sensory experience but also aids in information retention and emotional engagement with the game's educational content, demonstrating how thoughtful audio design can significantly contribute to the effectiveness of serious games in cultural heritage education.

5. Evaluation

The study investigates the effectiveness of the "Xiannong Dreamscape" game in enhancing knowledge about traditional rice cultivation and promoting sustainable food conservation behaviors. It employs a cross-sectional design, with participants completing pre- and post-game surveys based on the Theory of Planned Behavior (TPB). The research tests two hypotheses: that the game improves understanding of traditional agricultural techniques and the cultural significance of Xiannong Altar (H1) and encourages sustainable food practices (H2). The results demonstrate the game's potential as an educational tool and its ability to influence real-world behaviors.

5.1. Experimental Setup

The study proposes two key hypotheses that aim to evaluate the effectiveness of the "Xiannong Dreamscape" game in achieving its educational and behavioral objectives:

Hypothesis 1 (H1) focuses on the game's ability to impart knowledge about traditional rice cultivation techniques and the historical significance of the Xiannong Altar. This hypothesis posits that players who engage with the game will demonstrate an improved understanding of these topics, as evidenced by their ability to correctly answer knowledge-based questions after playing. This hypothesis is grounded in the educational design of the game, which integrates historical and agricultural information into its gameplay mechanics and narrative structure. The rationale behind H1 is that the immersive and interactive nature of the game will facilitate more effective learning compared to traditional educational methods. By actively engaging with the content through gameplay, players are expected to retain information more readily and develop a deeper understanding of the historical and agricultural concepts presented. This hypothesis aligns with theories of experiential learning and the educational potential of serious games.

Hypothesis 2 (H2) extends beyond knowledge acquisition to address behavioral change, specifically focusing on food conservation practices. This hypothesis suggests that exposure to the game will increase players' intentions to adopt sustainable food consumption behaviors in their real lives. The basis for this hypothesis lies in the game's design, which not only educates players about sustainable agricultural practices but also demonstrates the consequences of these practices on societal well-being. H2 is particularly relevant in the context of current global challenges, including food security issues and the need for more sustainable agricultural practices. By presenting players with scenarios that illustrate the impact of their decisions on food production and societal outcomes, the game aims to foster a sense of responsibility and awareness regarding food conservation. This hypothesis is supported by behavior change theories suggesting that increased knowledge and understanding of an issue and exposure to positive behavioral models can lead to changes in intentions and, ultimately, behavior.

5.2. Study Design

This study employed a cross-sectional research design to assess the effectiveness of a newly developed game in enhancing players' awareness of food preservation, ancient grain cultivation techniques, and knowledge about Xiannong Altar. The methodology involved a two-phase survey process: participants were required to complete an initial survey before engaging with the game, establishing a baseline of their attitudes and understanding of the game's core themes. Following the gameplay experience, participants completed a second survey containing similar questions, allowing researchers to identify changes in attitudes and knowledge about food-related topics. This research design allows for a direct comparison of participants' knowledge and attitudes before and after game exposure, enabling the researchers to evaluate the game's impact on learning outcomes and potential behavioral intentions related to food conservation and cultural heritage appreciation.

5.3. Questionnaire Design

The Theory of Planned Behavior guided the questionnaire design in this study (TPB) framework, a well-established psychological model that posits that behavioral intentions are most effectively predicted when individuals possess positive attitudes toward a behavior, perceive a social endorsement of that behavior (subjective norm) and believe in their capability to execute it (perceived behavioral control). To assess these constructs, the study employed a direct evaluation method through pre- and post-gameplay questionnaires, allowing for a straightforward assessment of changes in players' attitudes, subjective norms, and perceived behavioral control regarding food conservation and traditional agricultural practices. The questionnaires likely included items measuring players' attitudes toward the importance of food preservation, their perceptions of social expectations regarding

these practices, and their confidence in their ability to engage in food conservation behaviors. By comparing the responses before and after gameplay, the study aimed to quantify changes in these TPB constructs, thereby demonstrating the game's effectiveness in influencing players' cognitions and intentions related to food conservation and agricultural knowledge. This approach provides empirical evidence for the impact of the "Xiannong Dreamscape" game. It establishes a theoretically sound basis for understanding how such serious games can promote positive behavioral changes in sustainable practices and cultural heritage appreciation.

5.4. Knowledge Questions

The knowledge-based component of the study was designed to assess participants' understanding of traditional rice cultivation techniques and the cultural significance of the Xiannong Altar. This assessment was conducted through fact-based multiple-choice questions administered before and after gameplay. The pre-game questionnaire included four such questions, establishing a baseline of participants' knowledge before interacting with the game. Following the gameplay experience, participants were presented with four more multiple-choice questions in the post-game questionnaire. This expanded set of questions was crafted to measure the extent of learning during gameplay, allowing researchers to quantify the educational impact of the "Xiannong Dreamscape" game. Researchers could evaluate changes in participants' knowledge levels by comparing responses to the initial four questions with those in the expanded post-game set. This approach enabled a direct assessment of the game's effectiveness in imparting information about traditional agricultural practices and the historical importance of the Xiannong Altar. The specific questions used in both the pre- and post-game questionnaires were carefully designed to cover critical aspects of rice cultivation techniques and the cultural heritage associated with the Xiannong Altar, ensuring a comprehensive evaluation of the game's educational content (detailed questions can be found in Appendix A of the study).

5.5. Behavioural Questions

The questionnaire design for this study demonstrates a comprehensive and structured approach to evaluating the impact of the "Xiannong Dreamscape" game on participants' knowledge, attitudes, and behavioral intentions related to food conservation and traditional agriculture. By maintaining a consistent format across pre- and post-game surveys, the researchers established a reliable basis for comparison, allowing for a clear assessment of changes resulting from gameplay exposure. Using a 5-point Likert scale for the behavioral questions based on the Theory of Planned Behavior (TPB) dimensions provides a nuanced measurement of participants' attitudes, subjective norms, and perceived behavioral control. This approach allows quantitative analysis of subtle shifts in these psychological constructs, which are crucial in predicting behavioral intentions and potential future actions. The inclusion of multiple-choice questions to assess knowledge of food conservation in both surveys serves a dual purpose. Firstly, it directly measures the game's effectiveness in imparting factual information. Secondly, it allows researchers to explore potential correlations between knowledge acquisition and changes in attitudes or behavioral intentions. The questionnaires capture a holistic view of the game's impact by focusing on critical areas such as attitudes toward food cultivation, perceived social expectations regarding food conservation, self-perceived control over food conservation issues, and intentions to adopt sustainable behaviors. This comprehensive assessment evaluates the game's educational efficacy and potential to influence real-world behaviors related to sustainable food practices and cultural heritage appreciation. The detailed breakdown of evaluations for

each TPB component, as provided in Appendix B, further enhances the study's rigor and transparency, allowing for in-depth analysis and potential replication in future research.

6. Results

6.1. Participant Statistics

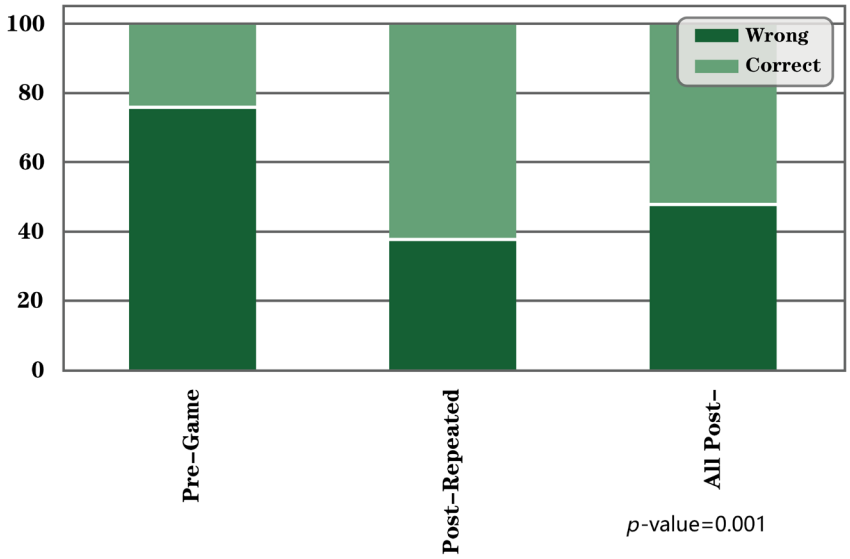
Participant recruitment was conducted through social media platforms and the posting of posters on campus. The recruitment phase lasted for three months, from January to March 2023. A total of 100 participants were recruited, including 58 males and 42 females. Among them, 83% were aged between 18 and 25, 12% were aged between 26 and 30, and 5% were over 30 years old. The participants consisted of 52 undergraduate students, 31 graduate students, 6 doctoral students, and 11 university faculty members, all from local universities. While most faculty members reported not playing digital games, students generally showed a strong interest in them. Regarding weekly gameplay duration, 13% of participants played digital games for 0–1 h, 67% for 1–5 h, 16% for 5–10 h, and only 4% for more than 10 h per week. Notably, 96% of participants indicated that they do not play digital games for learning or training purposes. Only four participants, all from the same academic research group, reported playing a game called "Digital Central Axis"—which focuses on Beijing's ancient architecture—for 0–2 h as part of academic research. In terms of participants' understanding of the cultural heritage of the Xian Nong Tan (Temple of Agriculture), 12% reported having a deep understanding, primarily composed of older faculty members, doctoral students, and members of specific research groups. Another 8% of participants claimed to have a relatively good understanding, 24% had a limited understanding, while the majority, 56%, indicated that they had no prior knowledge of the heritage site.

6.2. Knowledge Questions

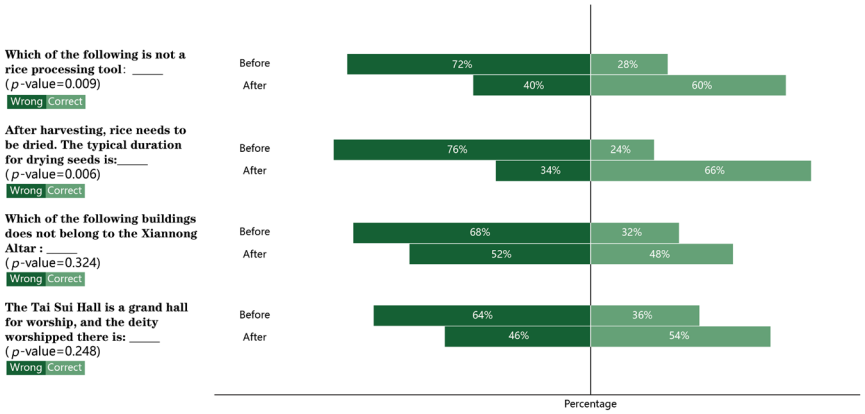
The study results provide compelling support for Hypothesis 1, which posited that participants would demonstrate improved knowledge of agricultural practices and the Xiannong Altar after engaging with the game. Data analysis reveals significant findings, as illustrated in Figure 3a, which shows a marked increase in correct responses to knowledge-based questions following gameplay. This improvement is evident across repeated questions from the pre-game survey and new questions introduced in the post-game assessment. A one-sided, two-sample paired t-test yielded a p-value of 0.001, statistically confirming the game's effectiveness in enhancing participants' understanding of the subject matter. Further examination of the results, as depicted in Figure 3b, highlights the differential improvements in specific knowledge domains. The first two questions, focusing on agricultural practices, reveal a substantial increase in correct responses post-game. This significant enhancement can be attributed to the game's "knowledge acquisition-operation practice" mechanism, which allowed players to experience the planting process in an immersive and hands-on manner.

In contrast, the latter two questions regarding the Xiannong Altar also show improvement, but to a lesser degree. This modest gain may be explained by some participants having prior knowledge of the Xiannong Altar before the study. The disparity in improvement between agricultural and cultural heritage knowledge suggests that while participants generally had less initial knowledge about agricultural practices, the experiential learning approach of the game effectively facilitated greater knowledge retention in this area. Conversely, cultural heritage information was primarily conveyed through text and reflection, indicating potential areas for enhancement in how this knowledge is presented. Overall, the data strongly supports Hypothesis 1, demonstrating the game's

efficacy in improving participants' knowledge across agricultural and cultural heritage domains while highlighting the effectiveness of immersive learning for practical skills.



(**a**) Statistical Chart of Knowledge Quizzes before and after the Game



(**b**) Statistical Chart of Knowledge Quizzes in a Specific Knowledge Domain

Figure 3. Outcomes of the knowledge assessments.

6.3. Behavioural Questions

The study's findings support Hypothesis 2, demonstrating the game's positive influence on participants' behavioral intentions regarding food conservation. Figure 4 illustrates a notable shift in responses to behavioral questions following gameplay, with a general trend towards more favorable attitudes. This shift was particularly pronounced in questions assessing perceived behavioral control, all showing statistically significant improvements ($p < 0.05$). This outcome is especially noteworthy as perceived behavioral control is a key determinant in effecting actual behavioral change according to psychological theories such as the Theory of Planned Behavior. The significant improvements in this area suggest that the game effectively enhanced participants' awareness of food-related issues and strengthened their belief in their ability to engage in food conservation actions. The analysis also revealed significant positive changes in specific topics, such as food-saving behaviors and attitudes toward agricultural practices. For instance, questions like "I find that achieving a bumper grain harvest is a difficult task" ($p = 0.002$) and "I intend to regularly check the expiry dates of food, use food that is about to expire, and avoid waste" ($p = 0.004$) showed marked improvements. These findings indicate that the game increased awareness and potentially influenced intended behaviors crucial for sustainable practices.

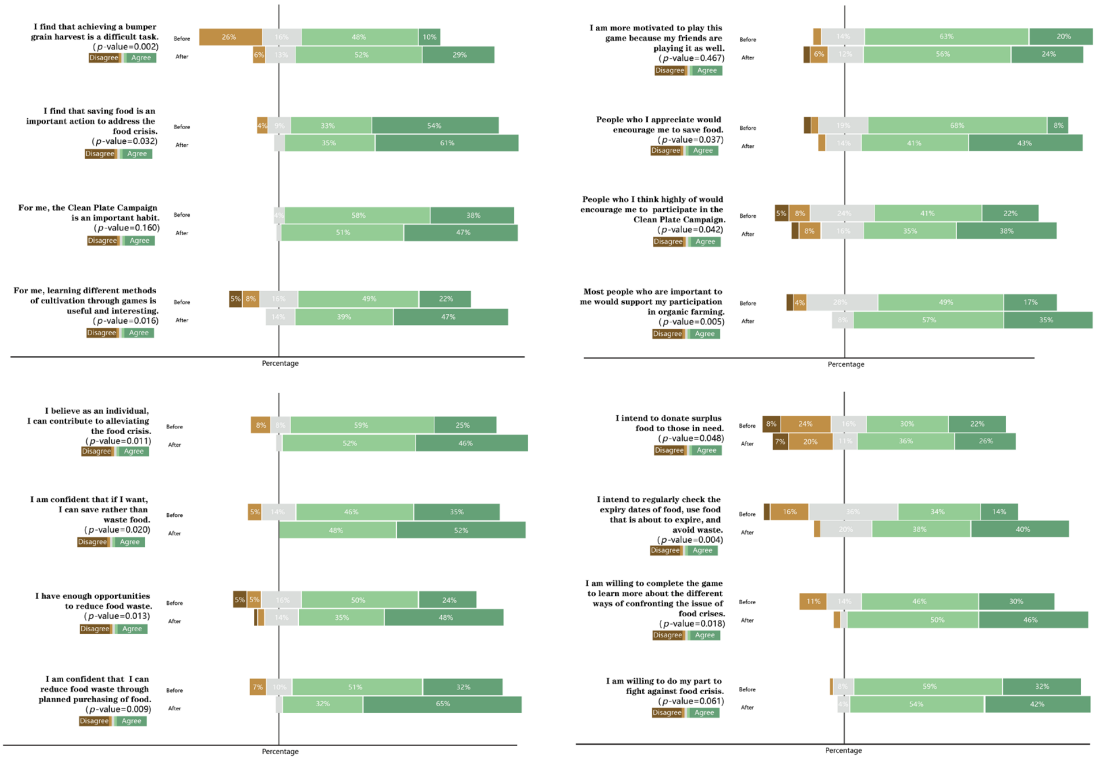


Figure 4. Responses from participants for each behavioral question before and after playing the game.

Additionally, the study found a significant increase in participants' interest in learning cultivation methods through games (p = 0.016), suggesting that the game was engaging and appealing to players. Interestingly, some questions showed no significant differences between pre- and post-game responses, particularly those that had already received widespread agreement before the game. For example, statements like "People who I think highly of would encourage me to participate in the Clean Plate Campaign" (p = 0.042) and "For me, the Clean Plate Campaign is an important habit" (p = 0.160) showed little change, likely due to high initial agreement levels. This suggests that the game either had no significant impact on these pre-existing views or served to reinforce them.

The study demonstrates that the "Xiannong Dreamscape" serious game effectively enhances participants' knowledge of agricultural practices and the Xiannong Altar, with significant improvements in correct responses to knowledge-based questions and a strong influence on behavioral intentions toward food conservation. The game's immersive learning approach, particularly its hands-on experience with agricultural processes, was highly influential in knowledge retention. In contrast, cultural heritage knowledge, conveyed primarily through text, showed more modest gains. Behavioral analysis revealed increased awareness and favorable attitudes towards sustainable practices, particularly in areas related to food conservation, with significant improvements in perceived behavioral control. Feedback from semi-structured interviews confirmed the game's success in engaging participants. It highlighted its potential as a tool for cultural heritage education, though recommendations were made to enhance its educational and entertainment value through features like VR integration and multiplayer options. These findings underscore the game's dual role in education and behavior modification and point to areas for further enhancement.

6.4. Results of Semi-Structured Interviews

A total of 30 participants were interviewed using semi-structured interviews to assess the efficacy and user satisfaction of the "Xiannong Dreamscape" serious game. The feedback

received regarding the game's architectural correctness and ability to give an immersive experience resembling the actual Xiannong Altar was overwhelmingly good. P6 stated: "*I have visited Xian Nong Tan before, and the scenes in the game are truly identical to the real ones, offering an accurate representation. Moreover, there are many details that I overlooked during my visit, which I can now explore more comprehensively and in greater detail through the game*". Participants highlighted that the game format significantly increased their involvement in cultural heritage learning, enabling them to concentrate for extended periods and absorb knowledge more effectively than traditional techniques like visiting sites and reading literature. P21 stated: "*When I visited the site in person, I completely forgot the exhibition text. In the end, all I remembered was the image of the building itself, but it wasn't very clear because ancient Chinese royal architecture looks similar, and the Forbidden City is much more magnificent. As for its historical context, I have no recollection at all*". P23 stated: "*I have a strong interest in ancient Chinese history and architecture, but when reading the books I bought about Xian Nong Tan, I really struggled to get into them. I remember that in one week, I only read six pages. However, this game is different. It successfully captures my attention, and I've learned knowledge through playing*". This response highlights the capacity of serious games to serve as a powerful instrument for cultural heritage education, with the ability to generate captivating and lasting learning encounters.

Although the game was generally well-received, participants pointed out certain aspects that may be improved to boost its educational and entertaining value. The main suggestions include enhancing the game's entertainment features to balance its educational content, particularly for students who frequently play games. P3 stated: "*I think this game is too educational. If given a choice, I wouldn't play it voluntarily. It should incorporate some fun mechanisms, such as multiplayer interaction, team collaboration to complete tasks, and point-based competitions*". P17 stated: "*I think the game's graphics are decent but not stunning; they lack visual impact. I now play VR games, and if VR technology were used, it would be much better*". Therefore, it is recommended to integrate virtual reality (VR) technology to more effectively showcase the grandeur of Xian Nong Tan's architecture and to introduce multiplayer interaction, increasing competitiveness and social elements, thereby enhancing the game's entertainment value. These proposals emphasize the significance of consistently improving serious games to sustain user interest while optimizing their educational influence. The feedback also highlights the changing demands of users in educational gaming, underscoring the importance of achieving a flexible equilibrium between immersive technology, engaging gameplay, and instructional material in future versions of serious cultural heritage games.

7. Discussion

The study of "Xiannong Dreamscape" as a serious game for cultural heritage education provides valuable insights into the effectiveness of gamification in preserving and disseminating cultural knowledge. The results demonstrate that the game successfully achieved its primary objectives, aligning with previous research on the potential of serious games in educational contexts. Mortara et al. (2014) [60] noted that serious games offer immersive experiences that traditional educational methods often lack, a finding strongly supported by the positive reception of "Xiannong Dreamscape" among participants. The game's success in improving participants' knowledge of agricultural practices and the Xiannong Altar's cultural significance corroborates the findings of Anderson et al. (2010) [88], who emphasized the capacity of serious games to engage users with historical and cultural narratives. The significant improvement in agricultural knowledge aligns with the work of Petrucco and Agostini (2016) [89] and Camuñas-García et al. (2023) [1], highlighting the potential of mobile game-based learning in cultural heritage education. The game's ability to simulate agricultural practices and decision-making processes provided a hands-on

learning experience, supporting the notion that experiential learning through games can enhance understanding and retention of cultural knowledge.

Implementing the Applied Games Engagement Model (AGEM) in "Xiannong Dreamscape" proved crucial to its success. This aligns with the research of Kniestedt et al. (2022) [71], who proposed AGEM as a comprehensive framework for designing engaging and educational games. The balance between narrative (diegesis) and gameplay mechanics (mimesis) in "Xiannong Dreamscape" created an immersive learning environment, effectively integrating educational content into gameplay. This approach successfully addressed the challenge of maintaining player engagement while delivering educational content, a common issue in serious game design as identified by various researchers in the field. The study's findings regarding the game's impact on behavioral intentions related to food conservation and sustainable practices are particularly noteworthy. This outcome aligns with the growing body of research on the potential of serious games to influence real-world behaviors, as discussed by Cui and Mousas (2021) [90] and Yun (2023) [91]. The game's ability to impart knowledge and potentially influence attitudes and behaviors underscores the transformative potential of serious games in addressing complex societal issues, such as cultural preservation and sustainable agriculture. However, the study also revealed areas for improvement, particularly in balancing entertainment value with educational content. This challenge is not unique to "Xiannong Dreamscape" and reflects a broader issue in serious game design, as noted by Persico et al. (2019) [92]. Participants suggested increasing the game's entertainment to enhance engagement and incorporating new technologies to elevate the overall experience. The feedback from participants indicates a desire for a more dynamic interaction that could further enrich the educational content. A mixed-methods approach comprehensively evaluated the game's impact by combining quantitative assessments with semi-structured interviews. This methodological approach aligns with best practices in serious game research, as advocated by researchers like Hanes and Stone (2019) [93]. The combination of quantitative data on knowledge acquisition and qualitative insights into user experience offers a nuanced understanding of the game's effectiveness and areas for improvement. One unexpected finding was the differential impact of the game on agricultural knowledge versus cultural heritage knowledge of the Xiannong Altar.

The more significant improvement in agricultural knowledge compared to cultural heritage knowledge suggests that the game's design may have conveyed practical, experiential knowledge more effectively than abstract cultural concepts. This finding highlights the need to carefully consider how different types of knowledge are presented and experienced within serious games. This point has not been extensively explored in the previous literature on cultural heritage games. The study's results also underscore the potential of serious games to address the challenge of preserving and disseminating intangible cultural heritage, a concern highlighted by UNESCO and various cultural heritage scholars. By creating an interactive, engaging platform for learning about traditional agricultural practices and the cultural significance of the Xiannong Altar, "Xiannong Dreamscape" demonstrates how digital technologies can bridge the gap between historical knowledge and contemporary learners. This study points to several directions for future research and development in serious games for cultural heritage education. The suggestion from participants to incorporate multiplayer and competitive elements aligns with emerging trends in educational game design, as discussed by Politopoulos et al. (2019) [94].

Future iterations of the game could explore how collaborative and competitive gameplay mechanics might further enhance engagement and learning outcomes. Additionally, the potential integration of virtual and augmented reality technologies reflects the broader trend of technological advancement in heritage education noted by King et al. (2016) [95]. However, as the study results indicate, it is crucial to maintain a balance between techno-

logical innovation and cultural authenticity. Future research could explore how advanced technologies can be integrated into serious games while ensuring that the cultural narrative remains at the forefront of the user experience. The lessons learned from this study can be applied more broadly to serious game design and cultural heritage education. Recommendations for future development include creating a balance between educational content and entertainment value, possibly through more varied gameplay mechanics and interactive elements. Additionally, exploring the integration of advanced technologies like VR and AR while ensuring that these enhancements support the cultural narrative will be crucial.

By integrating advanced digital technologies with cultural narratives, the game exemplifies how serious games can effectively preserve and disseminate cultural knowledge, offering immersive and interactive platforms that enhance learning experiences. The successful application of the Applied Games Engagement Model (AGEM) highlights the importance of designing educational games that balance narrative and gameplay mechanics to maintain player engagement and deliver educational content effectively [96]. The game's impact on participants' knowledge of agricultural practices and the cultural significance of the Xiannong Altar demonstrates the transformative potential of serious games in engaging users with historical and cultural narratives. Furthermore, the game's ability to influence behavioral intentions related to food conservation and sustainable practices underscores its broader societal benefits [71]. By addressing challenges in preserving intangible cultural heritage and exploring the integration of emerging technologies, the study contributes valuable insights into the potential of serious games to drive innovation and economic value in the cultural and creative industries.

Developing more nuanced approaches to presenting different types of cultural knowledge within the game environment, particularly for abstract or conceptual information, will also be essential. Incorporating multiplayer and collaborative elements to enhance engagement and foster a sense of community around cultural learning will further enrich the player experience. While the study provides valuable insights, it is important to acknowledge its limitations. The research was conducted with a specific demographic group and focused on a single cultural heritage site. Future studies could benefit from a broader, more diverse participant base and the inclusion of multiple cultural heritage contexts to enhance the generalizability of the findings. Additionally, long-term studies could provide insights into the sustained impact of serious games on cultural knowledge retention and behavioral changes beyond the immediate post-game period.

8. Conclusions

The study on "Xiannong Dreamscape" signifies notable progress in utilizing severe games for cultural heritage education. The game provides an immersive learning experience by centering on the Xiannong Altar, a site of significant historical and cultural significance in Chinese agricultural history. This approach surpasses conventional instructional approaches. This approach is consistent with the increasing amount of research that emphasizes the potential of serious games to involve learners in intricate cultural and historical narratives. Research conducted by Mortara et al. (2014) [60] and Anderson et al. (2010) [88] has shown that serious games provide distinct advantages for experiential learning. These games enable players to engage with historical concepts and practices in a manner that surpasses the capabilities of static exhibitions or textbooks. "Xiannong Dreamscape" expands upon these discoveries by offering a platform that allows players to actively participate in agricultural techniques and cultural customs linked to the Xiannong Altar.

The game's concept, which integrates food preservation and agricultural expertise components, tackles current issues by grounding them in a historical framework. This method demonstrates a nuanced comprehension of how cultural heritage can be pertinent

to contemporary audiences, a difficulty acknowledged by scholars such as Cui and Mousas (2021) [90] in their research on safeguarding and promoting Chinese intangible cultural heritage using digital games. "Xiannong Dreamscape" showcases the capacity of serious games to effectively communicate knowledge and shape attitudes and behaviors around sustainable practices and cultural preservation by seamlessly blending educational content with captivating gameplay mechanics. This is consistent with the research conducted by Nadir, H. (2024) [97], which highlights the significance of integrating cultural heritage and gaming experiences to captivate younger generations.

Moreover, the creation and execution of "Xiannong Dreamscape" contribute to the broader discussion on the function of digital technologies in protecting and teaching cultural heritage. According to King et al. (2016) [95], engaging with heritage digitally can provide novel cultural value and enhance comprehension. The game's triumph in enhancing players' understanding and potentially shaping their perspectives on food preservation and cultural legacy highlights the transformative capacity of meticulously crafted educational games. This demonstrates how digital resources can effectively tackle the difficulties of preserving and educating about culture in the modern period. It establishes a model for future projects that connect traditional cultural practices with current learning approaches. This research enhances educational technology and provides new opportunities for investigating the convergence of gaming, cultural studies, and heritage preservation.

This research underscores the transformative potential of serious games in cultural heritage education, aligning with the broader goals of fostering innovation and knowledge dissemination through digital technologies. The game effectively engages learners with complex cultural and historical narratives by offering an immersive learning experience centered on the Xiannong Altar, surpassing conventional instructional methods. This approach is consistent with research emphasizing the advantages of serious games for experiential learning, as they allow players to actively participate in agricultural techniques and cultural customs [98]. The integration of food preservation and agricultural expertise within a historical context demonstrates the relevance of cultural heritage to contemporary audiences, addressing current issues and shaping attitudes toward sustainable practices [99]. Furthermore, the game's success in enhancing players' understanding highlights the role of digital technologies in cultural preservation and education, providing a model for future projects that connect traditional cultural practices with modern learning methodologies [100]. This research contributes to the development of educational technology and opens new avenues for exploring the intersection of gaming, cultural studies, and heritage preservation, ultimately supporting the growth of a more informed and culturally aware society.

9. Limitations and Directions for Future Research

Future research should develop more refined methods for presenting different types of cultural knowledge within game environments, particularly for abstract or conceptual information. The integration of virtual reality (VR) and augmented reality (AR) technologies holds significant potential for creating more realistic and immersive game scenarios, enhancing players' sensory experiences. Incorporating multiplayer and collaborative elements could further strengthen player engagement and foster a sense of community centered around cultural learning, thereby enriching the overall player experience. While this study provides valuable insights, certain limitations must be acknowledged. The research primarily focused on a highly educated population, limited to undergraduate and above, and concentrated on a single cultural heritage site. This narrow scope may affect the generalizability of the findings. Future studies could expand the participant pool to include a more diverse range of demographic groups and investigate multiple cultural heritage

contexts to enhance the robustness and applicability of the results. Moreover, longitudinal studies are recommended to examine the long-term impact of serious games on cultural knowledge retention and behavioral change, moving beyond the assessment of short-term effects observed immediately after gameplay. Such an approach would offer deeper insights into the enduring influence of serious games on cultural learning and engagement.

Author Contributions: A.Z., Writing—original draft; Conceptualization; Supervision; Methodology; Project administration; Visualization. Y.G., Data curation; Writing—original draft; Software; Formal analysis; Investigation; Validation. Q.C., Writing—original draft; Investigation; Data curation; Resources. X.J., Software; Formal analysis; Investigation; Writing—review & editing. Y.M., Resources; Validation; Visualization; Writing—review &editing. Y.L., Project administration; Software; Formal analysis; Writing—review & editing. All authors have read and agreed to the published version of the manuscript.

Funding: This study was supported by the National Natural Science Foundation of China (Grant No. 52278001).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest: The authors declared no potential conflicts of interest with respect to the research, author-ship, and/or publication of this article.

Appendix A. Knowledge Questions

Knowledge Questions
Traditional Rice Cultivation Knowledge
Pre-Post: Which of the following is not a rice processing tool:
- Stone mill
- Blower
- Wooden pestle
- Plough
Post: The first step in rice planting primarily involves:
- Pest control
- Weeding
- Land preparation
- Fertilizing
Pre-Post: After harvesting, rice needs to be dried. The typical duration for drying seeds is:
- 0.5–1 days
- 1–2 days
- 2–3 days
- 3–4 days
Post: The suitable temperature and humidity for rice sowing are:
- Above 5 °C; around 50% humidity
- Above 10 °C; around 60% humidity
- Above 15 °C; around 70% humidity
- Above 20 °C; around 80% humidity

Knowledge of the Xiannong Altar
Pre-Post: Which of the following buildings does not belong to the Xiannong Altar:
- Taisui Hall Complex
- Hall of Supreme Harmony
- Kitchen for Preparing Sacrifices
- Storehouse for Preparing Sacrifices
Post: The function of the Qingcheng Hall Complex is:
- Resting
- Worship
- Processing food
- Storing food
Pre-Post: The Tai Sui Hall is a grand hall for worship, and the deity worshipped there is:
- Xiannong
- Taisui associated with the natural gods of spring, summer, autumn, and winter
- FuXi
- Gnome
Post: The Temple of Agriculture encapsulates a rich ideological content, except:
- A respect for the cosmic order
- A recognition of the importance of agriculture
- Worship of the emperor
- A worship of nature

Appendix B. Behavioral Questions

Behavioral Questions
1. Attitude
I find that achieving a bumper grain harvest is a difficult task.
I find that saving food is an important action to address the food crisis.
For me, the Clean Plate Campaign is an important habit.
For me, learning different methods of cultivation through games is useful and interesting.
2. Subjective Norms
I am more motivated to play this game because my friends are playing it as well.
People who l appreciate would encourage me to save food.
People who l think highly of would encourage me to participate in theClean Plate Campaign.
Most people who are important to me would support my participation in organic farming.
3. Perceived Behavioural Control
I believe as an individual, l can contribute to alleviating the food crisis.
I am confident that if l want, l can save rather than waste food.
I have enough opportunities to reduce food waste.
I am confident that l can reduce food waste through planned purchasing of food.
4. Behavioural Intention
I intend to donate surplus food to those in need.
I intend to regularly check the expiry dates of food, use food that is about to expire, and avolo waste.
I am willing to complete the game to learn more about the different ways of confrontingthe issue of food crises.
I am willing to do my part to fight against food crisis.

References

1. Camuñas-García, D.; Cáceres-Reche, M.P.; Cambil-Hernández, M.D.L.E. Maximizing engagement with cultural heritage through video games. *Sustainability* **2023**, *15*, 2350. [CrossRef]
2. Lobovikov-Katz, A.; Moropoulou, A.; Konstanti, A.; Lampropoulos, K. Heritage Preservation Education for the General Public–The role of Hands-on Education. *Tech. Ann.* **2022**, *1*, 290–308. [CrossRef]
3. Menkshi, E.; Braholli, E.; Çobani, S.; Shehu, D. Assessing youth engagement in the preservation and promotion of culture heritage: A case study in Korça City, Albania. *Quaest. Geogr.* **2021**, *40*, 109–125. [CrossRef]
4. López-Fernández, J.A.; Medina, S.; López, M.J.; García-Morís, R. Perceptions of heritage among students of early childhood and primary education. *Sustainability* **2021**, *13*, 10636. [CrossRef]
5. Shao, Y.; Razali, J.R.; Hassan, H.; Pan, B. A Study on the Influencing Factors of Social Media in the Communication of Cultural Heritage Education: A Systematic Literature. *Stud. Media Commun.* **2023**, *11*, 90–104. [CrossRef]
6. Yannakakis, G.N.; Togelius, J. Experience-driven procedural content generation. *IEEE Trans. Affect. Comput.* **2011**, *2*, 147–161. [CrossRef]
7. Raphael, C.; Bachen, C.; Lynn, K.M.; Baldwin-Philippi, J.; McKee, K.A. Games for civic learning: A conceptual framework and agenda for research and design. *Games Cult.* **2010**, *5*, 199–235. [CrossRef]
8. Camuñas-García, D.; Cáceres-Reche, M.P.; Cambil-Hernández, M.D.L.E.; Lorenzo-Martín, M.E. Digital Game-Based Heritage Education: Analyzing the Potential of Heritage-Based Video Games. *Educ. Sci.* **2024**, *14*, 396. [CrossRef]
9. Du, J.; Zhang, W.Q. Dunhuang Mogao Caves Impact on Adolescent Cultural Heritage Education With New Media–A Case Study On The Deer And The Snitch. *ISPRS Ann. Photogramm. Remote Sens. Spat. Inf. Sci.* **2023**, 71–78. [CrossRef]
10. Santa Cruz, F.G.; López-Guzmán, T.; Gallo, L.S.P.; Rodríguez-Gutiérrez, P. Tourist loyalty and intangible cultural heritage: The case of Popayan, Colombia. *J. Cult. Herit. Manag. Sustain. Dev.* **2019**, *10*, 172–188. [CrossRef]
11. Al Tamimi, W.; Fareed, M.W.; Jamhawi, M. Student-Led Initiatives for cultural heritage awareness: The case of "Meshkat", Jordan. *Events Tour. Rev.* **2023**, *6*, 58–66. [CrossRef]
12. Geraci, R.M.; Recine, N. Enlightening the galaxy: How players experience political philosophy in Star Wars: The Old Republic. *Games Cult.* **2014**, *9*, 255–276. [CrossRef]
13. Jagielska-Burduk, A.; Stec, P. Council of Europe cultural heritage and education policy: Preserving identity and searching for a common core? *Rev. Electrónica Interuniv. De Form. Del Profr.* **2019**, *22*, 1–12. [CrossRef]
14. Jagielska-Burduk, A.; Pszczyński, M.; Stec, P. Cultural heritage education in UNESCO cultural conventions. *Sustainability* **2021**, *13*, 3548. [CrossRef]
15. Huang, X.; Feng, L. Disaster and Ritual: A Study on Imperial Disaster Sacrificial Ceremonies at Beijing's Xian Nong Tan during the Ming and Qing Dynasties. *World Relig. Cult.* **2021**, 168–174.
16. Zhang, L.; Song, M. The Century-long Transformation of Beijing's Xian Nong Tan. *Beijing Arch.* **2023**, 54–56.
17. Lazarinis, F.; Boididis, I.; Kozanidis, L.; Kanellopoulos, D. An adaptable multi-learner serious game for learning cultural heritage. *Adv. Mob. Learn. Educ. Res.* **2022**, *2*, 201–215. [CrossRef]
18. Alexander, B. *The New Digital Storytelling: Creating Narratives with New Media—Revised and Updated Edition*; Bloomsbury Publishing: New York, NY, USA, 2017.
19. Ahmed, I. Paradigms of Engagement: Digital Storytelling as a Pedagogical Strategy in Multilingual Societies. Ph.D. Thesis, Sikkim University, Gangtok, India, 2020.
20. Burgess, J. Hearing ordinary voices: Cultural studies, vernacular creativity and digital storytelling. *Continuum* **2006**, *20*, 201–214. [CrossRef]
21. Fabricius, G.; Büttgen, M. The influence of knowledge on overconfidence: Consequences for management and project planning. *Int. J. Bus. Manag.* **2013**, *8*, 1. [CrossRef]
22. Hoffmann, S. The Euro in Historical Comparison to the Ruble and the Influence of Overconfidence. *Eur. J. Mark. Econ.* **2019**, *2*, 6–16. [CrossRef]
23. Abt, C.C. Reforming Urban Education with Cost-Effectiveness Analysis. *Educ. Technol.* **1970**, *10*, 36–38.
24. Burson, K.A.; Larrick, R.P.; Klayman, J. Skilled or unskilled, but still unaware of it: How perceptions of difficulty drive miscalibration in relative comparisons. *J. Personal. Soc. Psychol.* **2006**, *90*, 60. [CrossRef] [PubMed]
25. Hilton, D.; Regner, I.; Cabantous, L.; Charalambides, L.; Vautier, S. Do positive illusions predict overconfidence in judgment? A test using interval production and probability evaluation measures of miscalibration. *J. Behav. Decis. Mak.* **2011**, *24*, 117–139. [CrossRef]
26. Nouri, P. Decision-making biases in women entrepreneurs: The novices vs. the habitual. *J. Organ. Eff. People Perform.* **2022**, *9*, 675–691. [CrossRef]
27. Malmendier, U.; Tate, G. CEO overconfidence and corporate investment. *J. Financ.* **2005**, *60*, 2661–2700. [CrossRef]
28. Malmendier, U.; Tate, G.; Yan, J. Overconfidence and early-life experiences: The effect of managerial traits on corporate financial policies. *J. Financ.* **2011**, *66*, 1687–1733. [CrossRef]

29. Adebambo, B.N.; Yan, X. Investor overconfidence, firm valuation, and corporate decisions. *Manag. Sci.* **2018**, *64*, 5349–5369. [CrossRef]
30. Zhang, Q.; Wang, Z. Research on the relationship between managerial overconfidence and M&A decision-making-moderating role based on board vigilance. *Appl. Math. Nonlinear Sci.* **2022**, *7*, 1043–1052.
31. Abdalkdoos, H.M.; Hashemi, S.A.; Hamidian, N. The effect of managers' overconfidence on cash holdings in companies listed on the Baghdad stock exchange: Mathematical analysis. *Period. Eng. Nat. Sci.* **2023**, *11*, 85–92. [CrossRef]
32. Chen, G.; Crossland, C.; Luo, S. Making the same mistake all over again: CEO overconfidence and corporate resistance to corrective feedback. *Strateg. Manag. J.* **2015**, *36*, 1513–1535. [CrossRef]
33. Duttle, K. Cognitive skills and confidence: Interrelations with overestimation, overplacement and overprecision. *Bull. Econ. Res.* **2016**, *68* (Suppl. S1), 42–55. [CrossRef]
34. Bukalska, E. Are companies managed by overconfident CEO financially constraint? Investment–cash flow sensitivity approach. *Equilibrium. Q. J. Econ. Econ. Policy* **2020**, *15*, 107–131. [CrossRef]
35. Gervais, S.; Heaton, J.B.; Odean, T. Overconfidence, compensation contracts, and capital budgeting. *J. Financ.* **2011**, *66*, 1735–1777. [CrossRef]
36. Goldberg, C.S.; Graham, C.M.; Ha, J. CEO overconfidence and corporate risk taking: Evidence from pension policy. *J. Corp. Account. Financ.* **2020**, *31*, 135–153. [CrossRef]
37. Barros, L.A.B.D.C.; Di Miceli da Silveira, A. Overconfidence, Managerial Optimism and the Determinants of Capital Structure. 2007. Available online: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=953273 (accessed on 25 February 2007).
38. Jiang, W.; Xiao, M.; You, J. Managerial overconfidence and debt maturity structure of firms: Analysis based on China's listed companies. *China Financ. Rev. Int.* **2011**, *1*, 262–279.
39. Xie, J. CEO career concerns and investment efficiency: Evidence from China. *Emerg. Mark. Rev.* **2015**, *24*, 149–159. [CrossRef]
40. Salehi, M.; DashtBayaz, M.L.; Mohammadi Moghadam, S. The relationship between management characteristics and firm innovation. *Int. J. Product. Perform. Manag.* **2018**, *67*, 1113–1131. [CrossRef]
41. Purhanudin, N.; Zakaria, Z. Managerial overconfidence and debt maturity structure of Malaysian construction and material companies. *Rev. Contemp. Bus. Res.* **2015**, *1*, 32–39. [CrossRef]
42. Reuben, E.; Wiswall, M.; Zafar, B. Preferences and biases in educational choices and labour market expectations: Shrinking the black box of gender. *Econ. J.* **2017**, *127*, 2153–2186. [CrossRef]
43. Ebrahimi, T.; Gupta, J.; Ozkan, A. Supply-side factors, CEO overconfidence, and zero-leverage policy. *Int. J. Financ. Econ.* **2020**, *25*, 547–564. [CrossRef]
44. Chen, Q.; Zeng, H. Is corporate social responsibility constrained by bank credit resource allocation? *Corp. Soc. Responsib. Environ. Manag.* **2020**, *29*, 1560–1577. [CrossRef]
45. Gounopoulos, D.; Loukopoulos, G.; Loukopoulos, P. CEO education and the ability to raise capital. *Corp. Gov. Int. Rev.* **2021**, *29*, 67–99. [CrossRef]
46. Samakhavets, M.; Hrechyshkina, O.; Vemić, M. Development of an Innovative Environment for a Knowledge-Driven Economy in Belarus. *Int. J. Knowl. Syst. Sci. IJKSS* **2022**, *13*, 1–16. [CrossRef]
47. Trunfio, M.; Campana, S. Innovation in knowledge-based destination: Technology-driven vs. social-driven. *Int. J. Knowl.-Based Dev.* **2020**, *11*, 176–199. [CrossRef]
48. Vourvopoulos, A.; Liarokapis, F.; Petridis, P. Brain-controlled serious games for cultural heritage. In Proceedings of the 2012 18th International Conference on Virtual Systems and Multimedia, Milan, Italy, 2–5 September 2012; IEEE: Piscataway, NJ, USA, 2012; pp. 291–298.
49. Lercari, N.; Mortara, M.; Forte, M. Unveiling California history through serious games: Fort Ross virtual warehouse. In *Games and Learning Alliance: Second International Conference, GALA 2013, Paris, France, 23–25 October 2013*; Revised Selected Papers 2; Springer International Publishing: Cham, Switzerland, 2014; pp. 236–251.
50. Remondino, F.; Rizzi, A.; Jimenez, B.; Agugiaro, G.; Baratti, G.; De Amicis, R. The Etruscans in 3D: From space to underground. *Geoinformatics FCE CTU* **2011**, *6*, 283–290. [CrossRef]
51. Bellotti, F.; Berta, R.; De Gloria, A.; D'ursi, A.; Fiore, V. A serious game model for cultural heritage. *J. Comput. Cult. Herit. JOCCH* **2013**, *5*, 1–27. [CrossRef]
52. Remondino, F.; Rizzi, A. Reality-based 3D documentation of natural and cultural heritage sites—Techniques, problems, and examples. *Appl. Geomat.* **2010**, *2*, 85–100. [CrossRef]
53. Gao, J.; Zhong, L.; Wang, Y. Immersive Communication of Digital Museums in the Metaverse: Insights from 'Digital Dunhuang'. *Media Sci. Technol.* **2024**, *10*, 137–141.
54. Cai, X.; Wang, C. Digital Media Reshaping the Cultural Expression of Beijing's Central Axis. *People's Trib.* **2024**, *11*, 107–109.
55. Xu, H.; Chen, Q.; Gong, Y.; Xue, Y.; Zhang, A. Research on Location-Based Service Design for Heritage Education Based on the Perception of Cultural Memes. *Furni Ture Inter. Des.* **2024**, 1–9.

56. Anuar, R.; Abidin, S.Z.; Zakaria, W.Z.W. The design, development and evaluation of tpsack courseware to facilitate the art and design education students artistic skills knowledge. *Asian J. Univ. Educ.* **2019**, *15*, 69–82. [CrossRef]
57. Froschauer, J.; Seidel, I.; Gärtner, M.; Berger, H.; Merkl, D. Design and evaluation of a serious game for immersive cultural training. In Proceedings of the 2010 16th International Conference on Virtual Systems and Multimedia, Seoul, Republic of Korea, 20–23 October 2010; IEEE: Piscataway, NJ, USA; pp. 253–260.
58. Idris, M.Z.; Mustaffa, N.B.; Yusoff, S.O.S. Preservation of intangible cultural heritage using advance digital technology: Issues and challenges. *Harmon. J. Arts Res. Educ.* **2016**, *16*, 1–13. [CrossRef]
59. Orlandi, L.M.; Marsili, G. Digital Humanities and Cultural Heritage Preservation. *Stud. Digit. Herit.* **2019**, *3*, 144–155.
60. Mortara, M.; Catalano, C.E.; Bellotti, F.; Fiucci, G.; Houry-Panchetti, M.; Petridis, P. Learning cultural heritage by serious games. *J. Cult. Herit.* **2014**, *15*, 318–325. [CrossRef]
61. Manikowska, E. The Challenge of the Heritage of Protest Movements: Collecting, Documenting and Preserving the "Women's Rebellion". *Cult. Unbound* **2022**, *14*, 179–201. [CrossRef]
62. Măruţoiu, C.; Bratu, I.; Ţiplic, M.I.; Măruţoiu, V.C.; Nemeş, O.F.; Neamţu, C.; Hernanz, A. FTIR analysis and 3D restoration of Transylvanian popular pottery from the XVI-XVIII centuries. *J. Archaeol. Sci. Rep.* **2018**, *19*, 148–154. [CrossRef]
63. Lee, H.J. Collaboration in cultural heritage digitisation in East Asia. *Program* **2010**, *44*, 357–373. [CrossRef]
64. Jeraman, P. Application of the AHP Method in the Study of Archaeological Resources Management Based on Indigenous Community in Central Sumba Regency. In Proceedings of the 3rd International Conference on Linguistics and Cultural (ICLC 2022); Springer Nature: Cham, Switzerland, 2023; Volume 756, p. 370.
65. Yanti, C.P.; Sudipa, I.G.I.; Aditama, P.W. Design Thinking Testing of AR/VR Application for Bali's Lontar Prasi Preservation. *J. Multidisiplin Madani* **2023**, *3*, 1956–1963. [CrossRef]
66. Isa, W.M.W.; Zin, N.A.M.; Rosdi, F.; Sarim, H.M. Digital preservation of intangible cultural heritage. *Indones. J. Electr. Eng. Comput. Sci.* **2018**, *12*, 1373–1379.
67. Froschauer, J.; Merkl, D.; Arends, M.; Goldfarb, D. Art history concepts at play with ThIATRO. *J. Comput. Cult. Herit. JOCCH* **2013**, *6*, 1–15. [CrossRef]
68. Gorbul, T.; Rusakov, S. Cultural heritage in the context of digital transformation practices: Experience of Ukraine and the Baltic States. *Balt. J. Econ. Stud.* **2022**, *8*, 58–69. [CrossRef]
69. Li, Y.; Hunter, C. Community involvement for sustainable heritage tourism: A conceptual model. *J. Cult. Herit. Manag. Sustain. Dev.* **2015**, *5*, 248–262. [CrossRef]
70. Giannakas, F.; Kambourakis, G.; Papasalouros, A.; Gritzalis, S. A critical review of 13 years of mobile game-based learning. *Educ. Technol. Res. Dev.* **2018**, *66*, 341–384. [CrossRef]
71. Kniestedt, I.; Lefter, I.; Lukosch, S.; Brazier, F.M. Re-framing engagement for applied games: A conceptual framework. *Entertain. Comput.* **2022**, *41*, 100475. [CrossRef]
72. Cheng, M.T.; She, H.C.; Annetta, L.A. Game immersion experience: Its hierarchical structure and impact on game-based science learning. *J. Comput. Assist. Learn.* **2015**, *31*, 232–253. [CrossRef]
73. Urgo, M.; Terkaj, W.; Mondellini, M.; Colombo, G. Design of serious games in engineering education: An application to the configuration and analysis of manufacturing systems. *CIRP J. Manuf. Sci. Technol.* **2022**, *36*, 172–184. [CrossRef]
74. Garcia, G.; Jung, I. Understanding immersion in 2D platform-based online collaborative learning environments. *Australas. J. Educ. Technol.* **2021**, *37*, 57–67. [CrossRef]
75. Bulduklu, Y. Mobile games on the basis of uses and gratifications approach: A comparison of the mobile game habits of university and high school students. *Convergence* **2019**, *25*, 901–917. [CrossRef]
76. Girard, C.; Ecalle, J.; Magnan, A. Serious games as new educational tools: How effective are they? A meta-analysis of recent studies. *J. Comput. Assist. Learn.* **2013**, *29*, 207–219. [CrossRef]
77. Dankov, Y.; Dankova, A. Educational video games as tools for raising awareness of the protection and preservation of cultural heritage. *Digit. Present. Preserv. Cult. Sci. Herit.* **2023**, *13*, 219–228. [CrossRef]
78. Baptista, R.; Coelho, A.; Vaz de Carvalho, C. Training and Certification of Competences through Serious Games. *Computers* **2024**, *13*, 201. [CrossRef]
79. Perna, S. The Design of Serious Games for Competency-Based Education. Ph.D. Thesis, Department of Engineering, University of Palermo, Palermo, Italy, 2022.
80. Novoa, M. Innovating Industrial Design Curriculum in a Knowledge-Based, Participatory and Digital Era. *Des. Technol. Educ.* **2018**, *23*, 154–204.
81. Themistocleous, C. Digital code-switching between Cypriot and Standard Greek: Performance and identity play online. *Int. J. Biling.* **2015**, *19*, 282–297. [CrossRef]
82. Evgenikou, V. *Investigating 3D Reconstruction Methods for Small Artifacts*; National University of Technology of Athens: Zografou, Greece, 2015; pp. 101–108.

83. Fairbank, W. *A Pictorial History of Chinese Architecture: A Study of the Development of Its Structural System and the Evolution of Its Types*; MIT Press: Cambridge, MA, USA, 1984.
84. Ikonomi, J.; Papa, D. Post-Pandemic Heritage Game Design Tools For An Engaging Experience. In *Post-Pandemic Heritage Game Design Tools for an Engaging Experience*; Tirana Design Week (TDW): Waldorpstraat, CA, USA, 2021; p. 57.
85. Calisi, D.; Botta, S. Virtual reality and captured reality for cultural landscape communication. *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.* **2022**, *XLVI-2/W1-2022*, 113–120. [CrossRef]
86. Rizvić, S.; Bošković, D.; Okanović, V.; Kihić, I.I.; Prazina, I.; Mijatović, B. Time travel to the past of bosnia and herzegovina through virtual and augmented reality. *Appl. Sci.* **2021**, *11*, 3711. [CrossRef]
87. Davies, C.; John, H. Osmose: Towards broadening the aesthetics of virtual reality. *ACM SIGGRAPH Comput. Graph.* **1996**, *30*, 25–28. [CrossRef]
88. Anderson, E.F.; McLoughlin, L.; Liarokapis, F.; Peters, C.; Petridis, P.; De Freitas, S. Developing serious games for cultural heritage: A state-of-the-art review. *Virtual Real.* **2010**, *14*, 255–275. [CrossRef]
89. Petrucco, C.; Agostini, D. Augmented reality learning: Pedagogical aspects and technologies for a future methodological framework. In *Virtual Worlds: The Virtual Reality and Augmented Reality Intersections*; Brill: Leiden, The Netherlands, 2016; pp. 57–66.
90. Cui, D.; Mousas, C. Evaluating wearable tactile feedback patterns during a virtual reality fighting game. In Proceedings of the 2021 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct), Bari, Italy, 4–8 October 2021; IEEE: Piscataway, NJ, USA; pp. 328–333.
91. Yun, H. Combining Cultural Heritage and Gaming Experiences: Enhancing Location-Based Games for Generation Z. *Sustainability* **2023**, *15*, 13777. [CrossRef]
92. Persico, D.; Passarelli, M.; Pozzi, F.; Earp, J.; Dagnino, F.M.; Manganello, F. Meeting players where they are: Digital games and learning ecologies. *Br. J. Educ. Technol.* **2019**, *50*, 1687–1712. [CrossRef]
93. Hanes, L.; Stone, R. A model of heritage content to support the design and analysis of video games for history education. *J. Comput. Educ.* **2019**, *6*, 587–612. [CrossRef]
94. Politopoulos, A.; Ariese, C.; Boom, K.; Mol, A. Romans and rollercoasters: Scholarship in the digital playground. *J. Comput. Appl. Archaeol.* **2019**, *2*, 163–175. [CrossRef]
95. King, L.; Stark, J.F.; Cooke, P. Experiencing the digital world: The cultural value of digital engagement with heritage. *Herit. Soc.* **2016**, *9*, 76–101. [CrossRef]
96. Bellotti, F.; Berta, R.; De Gloria, A. Designing effective serious games: Opportunities and challenges for research. *Int. J. Emerg. Technol. Learn. iJET* **2010**, *5*, 22. [CrossRef]
97. Nadir, H. Learning game design while playing games: A Game Design Crash Course. *J. Technol. Integr. Lessons Teach.* **2024**, *3*, 3–20. [CrossRef]
98. Boyle, E.A.; Hainey, T.; Connolly, T.M.; Gray, G.; Earp, J.; Ott, M.; Pereira, J. An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games. *Comput. Educ.* **2016**, *94*, 178–192. [CrossRef]
99. Morganti, L.; Pallavicini, F.; Cadel, E.; Candelieri, A.; Archetti, F.; Mantovani, F. Gaming for Earth: Serious games and gamification to engage consumers in pro-environmental behaviours for energy efficiency. *Energy Res. Soc. Sci.* **2017**, *29*, 95–102. [CrossRef]
100. Malegiannaki, I.; Daradoumis, T. Analyzing the educational design, use and effect of spatial games for cultural heritage: A literature review. *Comput. Educ.* **2017**, *108*, 1–10. [CrossRef]

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