Article

The Impact of Cultural Digital Game Characteristics on Generation Z User Satisfaction

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Abstract: ***Background:*** Digital games have become a key cultural medium, and using them to spread cultural heritage while satisfying Gen Z's experiential demands is critical. However, research on how cultural digital game characteristics impact Gen Z's user satisfaction is still inadequate. ***Purpose:*** Taking Dunhuang-themed game *Digital Library Cave* as a case, this study explores how its three core characteristics—interactivity, emotionality and culturality—influence Gen Z's user satisfaction, aiming to fill the theoretical gap and offer practical guidance for the gamified design and digital dissemination of cultural heritage. ***Methods:*** A mixed-methods approach was adopted: a theoretical framework was built via literature review, an in-depth case analysis of the game was conducted, and 303 valid questionnaires from Gen Z users were collected to empirically test the research hypotheses. ***Results:*** All three characteristics positively affect Gen Z's satisfaction, with emotionality being the most influential. The study validates the three-dimensional analytical framework, revealing Gen Z's shift toward spiritual and emotional connections in digital cultural consumption; emotional resonance, not just knowledge transmission, boosts satisfaction. Practically, developers are advised to shift from edutainment to emotional engagement via immersive storytelling. ***Conclusion:*** The study confirms the three characteristics' positive effects on Gen Z's satisfaction, with emotionality exerting the strongest impact ($\beta = 0.256$, $p < 0.001$). It verifies the three-dimensional framework, highlights emotional resonance's central role, and provides theoretical and practical support for cultural heritage's gamified design and digital revitalization.

Keywords: Cultural digital games; Generation Z; User satisfaction; Game characterist ics; Cultural heritage

1. Introduction

1.1 Research Background

Since the late twentieth century, digital games have evolved into a key component of the sociocultural ecosystem, positioning themselves as a core cultural medium on par with literature and film (Cui et al., 2021). As a dominant form of digital entertainment globally, digital games have not only reshaped daily habits but have also become a crucial channel for cultural dissemination (Jiang et al., 2024). Digital games are increasingly conceptualized as cultural products deeply rooted in the cultural soil from which they came, reflecting social values and identities of their contexts of origin (Barwick et al., 2011). Accordingly, digital games not only provide users with unique cultural experiences but also establish emotional connections, enhance aesthetic appreciation, and evoke strong cultural resonance. These characteristics enable digital games to transcend the realm of mere entertainment, exerting a profound influence on the preservation and inheritance of a society's culture (Jiang et al., 2024).

Concurrently, with South Korea's transition into a developed nation, its citizens have placed a greater emphasis on their quality of life. Digital games have evolved beyond simple entertainment to become the primary leisure activity for the South Korean population. According to the 2025 *Game User Survey* published by the Korea Creative Content Agency (KOCCA), the gaming rate among South Koreans has reached 50.2%. In terms of platform distribution, mobile games dominate with 89.1% usage rate, revealing a high dependency on this form of entertainment among the digital native generation. This indicates that gaming has become deeply integrated into the daily lives of the public, making it a prevalent form of cultural consumption.

With the advent of the digital era, the integration of gamification methods with learning has become a dominant mainstream trend. The field of cultural heritage is one of its key application areas (Malegiannaki & Daradoumis, 2017). In recent years, a large number of cultural digital games have appeared in China, playing a vital role in transmitting traditional culture to the younger generation (Liu & Zhang, 2024).

The purpose of cultural digital games is to preserve, represent, and promote public appreciation of cultural heritage through edutainment (Malegiannaki & Daradoumis, 2017). Design strategies enable such games to vividly showcase cultural elements and cultivate specific skills in users while creating a learning environment that is difficult to experience in the real world. Wide participation in these games offers users valuable opportunities for in-depth learning, active knowledge exploration, and critical thinking (Camuñas-García et al., 2023). Globally, numerous successful cases demonstrated this trend. For instance, in a study on the preservation of Indonesian cultural heritage, researchers developed a cultural simulation game called "*DayaBaya*" aimed at introducing and disseminating traditional Indonesian culture to the younger generation (Hasibuan et al., 2011). To evaluate the game's effectiveness, an experimental study was conducted, the results of which showed a significant improvement in participants' cultural knowledge after playing the game, with 98% of the participants stating that the game enhanced their understanding of their national culture. Furthermore, the latest frontiers of global game research have profoundly elucidated the theoretical value underlying this trend. Studies show that the deep integration of local tangible and intangible cultural heritage into digital games not only disrupts the homogenizing tendencies of global commercial gaming experiences but also establishes profound cultural and emotional connections among global audiences by constructing a "pluriverse" digital experience that respects cultural diversity (Eklund et al., 2025). Such emotional design and cultural expression rooted in local heritage are increasingly becoming the core driving factors for evoking resonance among younger generations.

As digital natives, Generation Z (individuals born between 1995 and 2010) were born into an era shaped by the internet; hence, they are also known as the "internet generation" (Çobanoğlu et al., 2024). When engaging with content related to culture, they tend to prefer digital and gamified experiences (Skinner et al., 2018). This makes Generation Z the core target users for cultural digital games.

However, research on how the characteristics of cultural digital games affect the user satisfaction of Generation Z remains insufficient. Against this backdrop, exploring the impact of these characteristics holds significant theoretical and practical value. Therefore, this study aims to analyze the mechanisms through which the characteristics of cultural digital games function in their dissemination among Generation Z users, focusing on their impact on user satisfaction. The goal is to fill the existing theoretical gap and provide practical references and understanding for the digital dissemination and gamified design of cultural heritage.

1.2 Research Objectives

This study aims to examine the mechanisms influencing Generation Z user satisfaction in relation to the characteristics of digital games. A deep empirical study was conducted using the Dunhuang-themed game *Digital Library Cave (Shuzi Cangjingdong)*

as an illustrative case. Specifically, this research is committed to constructing a comprehensive theoretical framework that encompasses the three dimensions of interactivity, emotionality, and culturality, thereby systematically evaluating the complex composition of cultural digital games as an emerging cultural medium. Building on this foundation, the study focuses on Generation Z—the cohort known as digital natives. Through quantitative empirical analysis, it seeks to accurately profile the psychological motivations and behavioral patterns of this core audience when playing cultural digital games. The research further provides an in-depth analysis of how, beyond mere knowledge transmission, emotional resonance and immersive interactive experiences play a decisive role in their satisfaction evaluation systems. Ultimately, this study aims to translate empirical results into concrete application strategies. It aspires not only to provide actionable, practical guidance for the design and development of cultural digital games but also to offer innovative approaches for the digital dissemination of the Dunhuang culture and other exemplary traditional Chinese cultures. In doing so, it seeks to explore a sustainable path for the revitalization of cultural heritage that effectively balances academic rigor with gaming entertainment.

1.3 Research Significance

Based on the aforementioned objectives, this study presents significant academic value and practical relevance in both theoretical construction and real-world applications.

Theoretically, this study enriches the interdisciplinary research perspective regarding digital games and cultural heritage dissemination. While previous academic discussions on digital games have often been limited to implementation paths in computer science, gamified learning effects in education, or addiction mechanisms in psychology, this study adopts a dual perspective of communication studies and user experience. By introducing "culturality" as an independent and critical variable into the user satisfaction evaluation model—placing it on an equal analytical footing with "interactivity" and "emotionality"—this research extends the application boundaries of the *Uses and Gratifications Theory* within the field of digital cultural heritage. Simultaneously, it fills a gap in empirical research regarding the behavioral characteristics of Generation Z when immersed in cultural digital games. Through empirical data, this study corrects the traditional cognitive bias that overemphasizes "knowledge transmission" or "technological special effects." It refines the media consumption behavior theory of digital natives, particularly through the discovery of emotional experience as a core driving force, providing theoretical support for the deepened application of affective computing and emotional design theories in the cultural heritage sector.

Practically, the findings of this study provide actionable strategic guidelines for game developers, the cultural and creative industries, and public cultural institutions. The empirical conclusions clearly indicate Generation Z's high reliance on "emotionality" and "interactivity" variables. This suggests to game developers that product design should not stop at the mere 3D digital reproduction of artifacts; rather, efforts should be dedicated to triggering deep emotional resonance through sophisticated narrative design and atmospheric creation.

1.4 Research Methods

This study employs a mixed-method approach, integrating theoretical analysis with empirical research. First, a literature review method is used to systematically review domestic and international research on digital games, Generation Z, cultural heritage dissemination, and user satisfaction, thereby constructing a theoretical framework and identifying the core characteristic dimensions of cultural digital games. Second, a case study method is adopted to conduct an in-depth analysis of the design philosophy,

functional features, and cultural connotations of the game "*Digital Library Cave*," examining how the game embodies the three core characteristics and evaluating its innovative practices in disseminating Dunhuang culture. Third, a questionnaire survey method is utilized, designing a survey with 20 core measurement items based on established scales and using a 5-point Likert scale to collect authentic feedback from Generation Z users. Finally, statistical software such as SPSS is used for data processing. Reliability and validity tests are conducted to ensure the scientific rigor of the scale, while correlation analysis and regression analysis are employed to test the research hypotheses and reveal the influence paths between variables.

1.5 Research Content

The core content of this study is to systematically investigate the impact mechanism of the intrinsic characteristics of cultural digital games on the user satisfaction of Generation Z. The study first constructs a theoretical analysis framework through a literature review, with interactivity, emotionality, and culturality as the core independent variables and Generation Z user satisfaction as the dependent variable. Using "*Digital Library Cave*" as an illustrative case, it deeply analyzes the specific design and implementation of these three characteristics within the game. To validate this theoretical model, the study further employs empirical methods by collecting 303 valid data samples from Generation Z users who have experienced the game through a questionnaire survey. SPSS software is then used to conduct reliability and validity tests, correlation analysis, and multiple regression analysis. Ultimately, this research aims to quantitatively reveal the specific impact paths and strengths of the three game characteristics on user satisfaction and to elucidate their underlying mechanisms, providing empirically supported theoretical explanations and practical understanding for the gamified design and digital dissemination of cultural heritage.

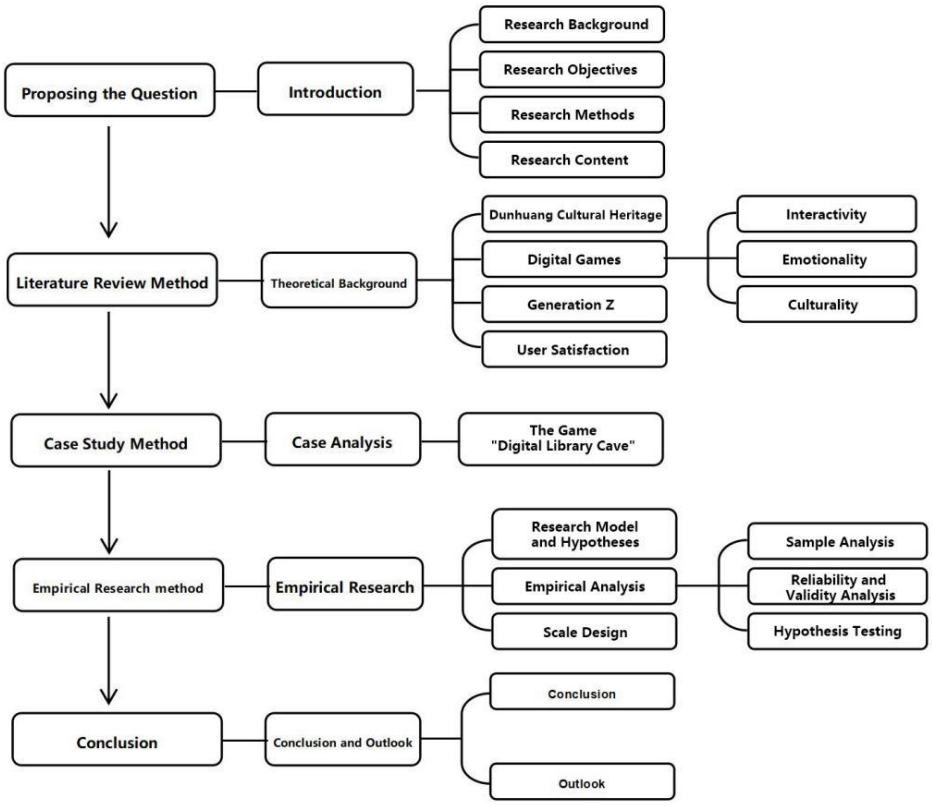

Figure 1. Frame diagram

2. Theoretical Background

2.1 Research and Communication Status of Dunhuang Cultural Heritage

Cultural heritage refers to monuments, groups of buildings, and sites that are of outstanding universal value from the point of view of history, art, or science. This definition originates from the 1972 UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage. Among these, the Dunhuang cultural heritage is a treasure trove of Chinese civilization, representing the crystallization of long-term exchange and integration among various civilizations (Ouyang, 2024). It embodies the wisdom of China's five-thousand-year history and manifests the cultural consciousness and confidence of the Chinese nation (Xiao, 2014). With its long history and profound connotations, Dunhuang culture is a cultural gem of the ancient Silk Road. It encompasses numerous elements of Chinese civilization, reflecting its global and inclusive characteristics (Chong, 2025).

As Dunhuang plays a significant role in advancing the "Belt and Road" initiative (Miao, 2022), its culture radiates new vitality in the new era. It embodies the cultural spirit, cultural inclusivity, and cultural confidence of the Chinese nation, providing spiritual support for upholding and developing socialism with Chinese characteristics in the new era (Xi, 2020). However, the international dissemination and translation of Dunhuang culture still face numerous challenges, such as a scarcity of foreign language communication and promotion platforms, ineffective external discourse methods, and a lack of precision in foreign language expression (Jiang, 2018), which require in-depth academic discussion for their resolution.

2.2 Definition of Generation Z

Generation Z, comprising individuals born between 1995 and 2010, often referred to as the "internet generation," emerged during an era of rapid advancements in digital technology and electronic devices, witnessing the evolution of these technologies firsthand. Consequently, for this young demographic, gaming has become an integral component of their social lives; it serves not only as a means to alleviate stress and cope with the challenges of daily life but also plays a supportive role in the construction of their self-identity (Meriläinen, 2023). In the realm of cultural heritage, Generation Z is more inclined to seek digital and gamified experiences (Yun, 2023). Furthermore, they prefer experience-based learning methods, seeking instant feedback and social interaction (Anastasiadis et al., 2018). Therefore, cultural heritage experiences urgently need to be innovatively reshaped to meet the specific needs of this generation.

2.3 Digital Games

As an entertainment tool, a digital game possesses its own set of rules and contains entertainment content on a digital platform. Within it, users can independently choose their game partners and are not influenced by external factors (Garris et al., 2017). Digital games are widely recognized for providing intrinsically motivating experiences that are enjoyable, and substantial evidence indicates their potential to cultivate and sustain high levels of learning motivation and engagement (Chen et al., 2021). Mobile games, as a globally popular form of entertainment in the digital age, have not only changed people's entertainment habits but have also become a new channel for cultural dissemination (Jiang et al., 2024). In this era, games are considered an aspect of human culture, profoundly influencing individuals' self-perception, worldview, social relationships, and life goals (Peng & Bai, 2025).

As one of the world's largest and most active game markets, China's digital game industry is not only a significant engine for economic growth but is also increasingly becoming a frontier for cultural communication and innovation. According to the *2024 China Game Industry Report* jointly compiled by the Game Publishing Committee of the China Audio-Video and Digital Publishing Association (GPC) and the China Game Industry Research Expert Committee (GPC & China Game Industry Research Expert

Committee, 2024), the actual sales revenue of China's domestic game market reached ¥325.783 billion in 2024, a year-over-year increase of 7.53%, setting a new historical record. The number of game users reached 674 million, a year-over-year increase of 0.94%, also marking a new high (see Figure 2). In terms of platform distribution, mobile games accounted for 73.12% of total revenue, confirming a high dependency on this form of entertainment among the digital native generation. The entire industry exhibits strong growth momentum with market fundamentals continuing to improve. While the domestic market grows steadily, the globalization of China's self-developed games is also accelerating, and "games going overseas" has become an important strategic direction for the industry. At the content level, the deep integration of outstanding traditional Chinese culture with gameplay has become one of the most significant trends in the industry. This is not only a proactive choice by game developers to seek differentiated competition and enhance the cultural connotation of their products but also to precisely meet the cultural consumption demands of young users represented by Generation Z.

Figure 2. 2019–2024 China Game Industry Market Data and User Base
Source: Game Publishing Committee of the China Audio-Video and Digital Publishing Association [GPC] & China Game Industry Research Expert Committee(2024). https://www.jiemian.com/article/12125088.html

2.4 Theoretical Framework Construction

In constructing the characteristic dimensions of cultural digital games, this study cited recent relevant research by Korean scholars. For instance, a study pointed out that when digital natives engage with content in regional cultural digital games, the elements they focus on primarily include emotional perception sparked by visual aesthetics, immersive experiences, and cultural narratives (Teng & Min, 2025). This further substantiates the rationale for using emotionality, interactivity, and culturality as core variables.

1) Interactivity

Interactivity refers to the degree and quality of two-way information exchange between the user and the content, which serves as a core dimension for measuring engagement in a media experience (Lee, 2015).As proposed in the Social Presence Theory (Short et al., 1976), the core value of interactivity lies in establishing psychological connections between people. The theory posits that "social presence" is a psychological state in which a user, communicating through a medium, perceives the other party as "real" and "present" to a certain extent. The interactive components of digital games are often considered a key factor in enhancing self-efficacy, as this process of experiential learning is believed to promote a deeper understanding of complex systems and improve problem-solving abilities (Lee, 2015).

2) Emotionality

According to the classic Uses and Gratifications Theory from the field of communication, audiences are not passive recipients of information but actively select

media content to satisfy their intrinsic psychological needs (Blumler & Katz, 1974). Therefore, emotionality is a crucial dimension of players' emotional experience and affective engagement in digital games. As learning based on digital games gains increasing attention, emotionality is regarded as a valuable medium for fostering emotionally engaging learning experiences (Chen et al., 2021). Cultural digital games fall under the "cultural content industry." According to the definition by Korean scholars, the final product of this industry is not material but "emotion." Consumers purchase not only functionality but also aesthetic satisfaction and emotional resonance. Consequently, "emotionality" is a fundamental and critical indicator when evaluating game satisfaction (Yi & Kim, 2007). Concurrently, digital game environments typically elicit a series of subjective, complex, and unpredictable emotional responses, which are vital for promoting effective learning (Chen et al., 2021). Furthermore, digital games strengthen social connections and symbolic communication by constructing a shared focus and synchronizing behaviors. Such activities are inherently pleasurable and demonstrate adaptive value for human cultural development (Murray, 2006). Thus, emotional factors play a core role in facilitating users' mastery of game knowledge and enhancing their gaming experience (Jiang et al., 2024).

3) Culturality

Culturality refers to the cultural content carried and transmitted within a digital game. The concept of culture in games encompasses four distinct aspects: emotional connection, design aesthetics, perceived fun, and knowledge acquisition (Jiang et al., 2024). Integrating cultural content into games not only attract a broader audience but also promote its global dissemination, achieving the preservation and inheritance of cultural heritage (Jiang et al., 2024). Like traditional games, all types of digital games have an educational function, which stems from social, economic, cultural, ideological, and historical factors (Çobanoğlu et al., 2024). In game-based cultural experiences, emotional connection and knowledge acquisition become the core elements influencing users' cultural identity (Jiang et al., 2024).

4) User Satisfaction

Video game user satisfaction is defined as "the degree of fulfillment a player feels about their experience while engaging in video game activities." The evaluation of game user experience satisfaction covers multiple dimensions, including but not limited to usability (or playability), narrative, creative freedom, audiovisual aesthetics, and personal fulfillment (Espinosa-Curiel et al., 2020), as well as a sense of control, fun, interactivity, feedback mechanisms, and multimodal presentation (Anastasiadis et al., 2018). A well-designed game can guide players into a state of flow or the flow zone, bringing profound pleasure and enjoyment (Chen, 2007). Research shows that a high-quality gaming experience can significantly enhance perceived entertainment value, increasing user satisfaction (Shi et al., 2024).

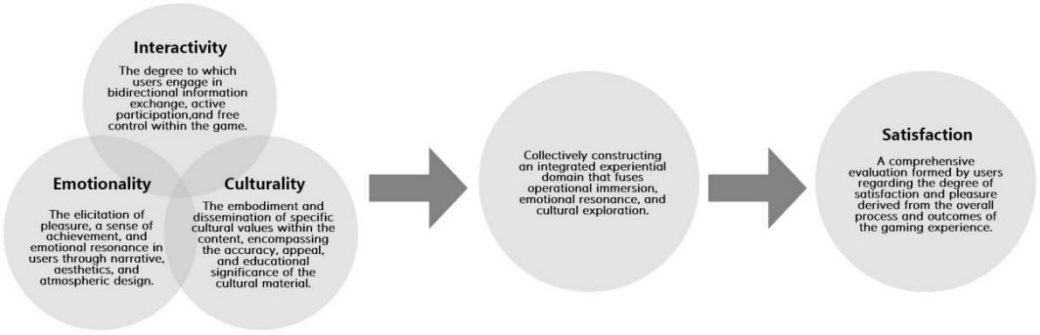

Figure 3. Relationship Model

3. Case Analysis

3.1 Introduction to the Game "Digital Library Cave"

"Digital Library Cave" is a role-playing game (RPG) jointly produced by Tencent and the Dunhuang Academy, which won the Gold Award at the 2023 Effie Awards. Users can directly access the game through the "Cloud Travel Dunhuang" WeChat Mini Program or the "Digital Dunhuang" official website.

The project team meticulously recreated Mogao Caves 16 and 17 and the landmark "Three-Story Building" with millimeter-level accuracy. Leveraging over ten thousand 8K photographs, they built a hyper-realistic digital model of astounding complexity, featuring 900 million polygons to create a high-fidelity digital twin of the physical site. By simulating the natural reflection and refraction of light, the team has imbued the digital caves and artifacts with a deeply authentic ambiance. The richness of detail is so profound that it exceeds what visitors can perceive with the naked eye on-site. This immersive experience is powered by cloud gaming technology, where all rendering is handled on cloud servers. This enables users to stream and enjoy a cinematic, ultra-high-definition experience directly on their devices.

In *"Digital Library Cave,"* users assume the role of a character who travels through historical space and time, with their "game footprint" reaching key historical periods such as the late Tang, Northern Song, and late Qing dynasties. Within the game, users can personally participate in the entire process of cave excavation, the sealing of ten thousand scrolls, their reappearance in the world, the dispersal of cultural relics, and their eventual reunion. The project garnered widespread attention upon its launch.

Figure 4. Game screenshots (1)

3.2 Analysis of Game Characteristics

Based on the theoretical framework of this study, *"Digital Library Cave"* exhibits significant features in the three dimensions of interactivity, emotionality, and culturality, making it an ideal case for studying the impact of cultural digital games on the user satisfaction of Generation Z.

1) Interactivity Analysis of "Digital Library Cave"

The interactivity of *"Digital Library Cave"* is shown as a deeply participatory form of experiential learning. Firstly, role-playing and free exploration grant users a high degree of autonomy. Players can choose different identities and freely walk within the 1:1 scale digital replica of the caves, observe details of the murals, and interact with the environment. This process of exploration is an act of active knowledge seeking. Secondly, players can also interact with non-player characters (NPCs) such as Hong Bian and Daozhen, travel through different historical nodes within the game, and advance the game's plot. This combined design of narrative interaction and cross-temporal interaction integrates a grand historical narrative with a personalized exploratory experience, transforming the user from a passive receiver of knowledge into an "active participant" in history (Ding, 2025). This aligns with the view proposed by Lee (2015) of enhancing self-efficacy through experiential learning.

Figure 5. Game screenshots (2)

2) Emotionality Analysis of "Digital Library Cave"

"Digital Library Cave" successfully evokes complex and profound emotional experiences in players through its unique narrative and aesthetic design. On a technical level, the project team utilized physically based rendering (PBR) technology and global dynamic illumination to accurately restore the light and shadow effects of the Mogao Caves. When a player enters a dimly lit cave and activates the "lantern" mode, and the light illuminates the Buddha statues and murals one by one, a sense of awe and sanctity toward the cultural heritage spontaneously arises. This audiovisual aesthetic experience is a crucial prerequisite for evoking emotional resonance. On a narrative level, the game's plot allows players to "witness" the dispersal of precious cultural relics, thereby triggering complex emotions such as regret and sorrow. This emotional experience is precisely what Chen et al. (2021) emphasized as vital for promoting emotionally engaged learning. The game ultimately allows the national treasures scattered across the world to be reunited in the digital realm, bringing players a sense of comfort and satisfaction from having recovered what was lost. This emotional arc, moving from regret to fulfillment, enhances the player's emotional connection to and cultural identification with Dunhuang culture (Ding, 2025).

Figure 6. Game screenshots (3)

3) Culturality Analysis of "Digital Library Cave"

The core value of "*Digital Library Cave*" lies in its adherence to "cultural fidelity," which makes its cultural characteristics particularly prominent. With academic support from the Dunhuang Academy, all scenes, artifacts, historical figures, and storylines in the game are based on verifiable evidence. The millimeter-level replicated caves, 4K high-definition restored artifacts, and ultra-realistic digital models with 900 million polygons ensure the accurate transmission of cultural information. The game's core positioning is not merely that of a game product but rather a digital museum centered on cultural resources (Ding, 2025). This positions the game as a reliable digital cultural knowledge base, fulfilling the core element of knowledge acquisition within culturality, as proposed by Jiang et al. (2024).

Figure 7. Game screenshots (4)

In summary, through its meticulous design and high degree of integration of interactivity, emotionality, and culturality, *"Digital Library Cave"* provides Generation Z users with an unprecedented way to experience cultural heritage. It is not only a crystallization of technology and art but also a successful practice of cultural dissemination, providing a highly representative sample for this study to explore how the characteristics of cultural digital games affect user satisfaction.

4. Empirical Research

4.1 Research Method

This study employed a questionnaire survey method using the *"Wenjuanxing"* platform for data collection. In the initial phase of the research, key characteristics influencing user satisfaction in cultural digital games were identified through a review of domestic and international literature, leading to the establishment of emotionality, interactivity, and culturality as the core independent variables for this study. Based on this, a research model and hypotheses were constructed with these three characteristics as independent variables and Generation Z user satisfaction as the dependent variable. The questionnaire was designed by adapting established scales and was optimized and adjusted in conjunction with the specific application scenario of the *"Digital Library Cave"* case. To enhance the comprehensibility and applicability of the questionnaire, the research team invited 10 Generation Z users to participate in a pilot survey. Based on their feedback, the wording and item settings of the questionnaire were refined to ensure that respondents could clearly understand and accurately answer the questions. The survey was conducted from September 20 to October 2, 2025, and a total of 309 questionnaires were collected. After excluding 6 invalid responses, 303 valid questionnaires were obtained. Upon completion of data collection, SPSS software was used for statistical analysis to test the research hypotheses, ensuring the scientific validity and reliability of the research conclusions.

4.2 Research Model and Hypotheses

H1: The interactivity of cultural digital games positively affects the user satisfaction of Generation Z.

H2: The emotionality of cultural digital games positively affects the user satisfaction of Generation Z.

H3: The culturality of cultural digital games positively affects the user satisfaction of Generation Z.

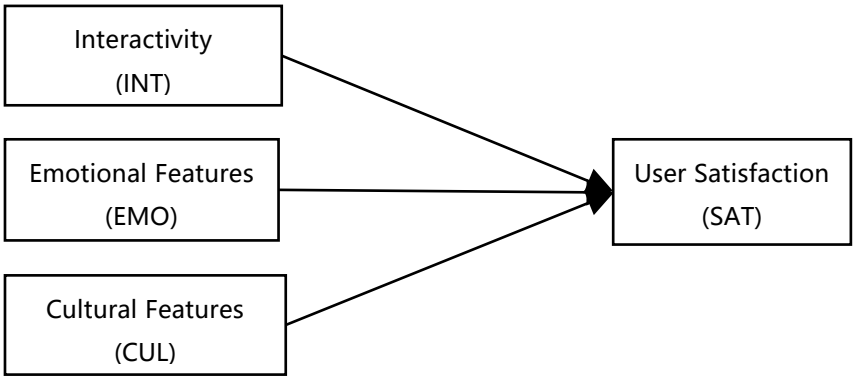

Figure 8. Research Model

4.3 Scale Design

This study aims to analyze the impact of the characteristics of cultural digital games on Generation Z user satisfaction. The research involves four core variables: interactivity, emotionality, culturality, and user satisfaction. The measurement scale was developed based on classic scales in related fields and was appropriately revised in combination with the specific context of the game *"Digital Library Cave"* to ensure the scientific validity and applicability of the measurement tool. All items were measured using a five-point Likert scale (1 = "Strongly Disagree," 5 = "Strongly Agree"). The measurement items for interactivity were adapted from Steuer (1992) and McMillan and Hwang (2002), comprising 5 items (INT1–INT5). The items for emotionality were adapted from Davis et al. (1992) and Sweetser and Wyeth (2005), comprising 5 items (EMO1–EMO5). The items for culturality were adapted from Pine and Gilmore (1999) and Chen and Chen (2010), comprising 5 items (CUL1–CUL5). The items for user satisfaction were adapted from Oliver (1997) and Zeithaml et al. (1996), comprising 5 items (SAT1–SAT5).

Table 1. Measurement scale

Construct	Code	Item	Adaptedfrom
Interactivity	INT1	I can freely control the pace and sequence of the game.	Steuer(1992); McMillan and Hwang(2002).
	INT2	I feel the game responds quickly to my actions.	
	INT3	I can have two-way interaction with the game content.	
	INT4	I feel that I can actively and proactively participate in the game process.	
	INT5	I think the interactive features provided by the game are rich and diverse.	
Emotional Features	EMO1	I felt pleasant while playing this game.	Davis et al. (1992); Sweetser and Wyeth (2005).
	EMO2	I experienced fun during the game.	
	EMO3	I gained a sense of accomplishment when completing tasks in the game.	
	EMO4	I think the atmosphere of this game resonated with me emotionally.	
	EMO5	I felt the excitement of exploration while playing this game.	
Cultural Features	CUL1	I think this game accurately presents the characteristics of Dunhuang culture.	Pine and Gilmore (1999); Chen and Chen (2010).
	CUL2	I think this game has enhanced my understanding of Chinese culture.	
	CUL3	I think this game successfully conveys the value of cultural heritage.	
	CUL4	I find the cultural representation of this game appealing.	
	CUL5	I think this game has stimulated my interest in learning about Dunhuang culture.	
User Satisfaction	SAT1	I am satisfied with the overall game experience of *"Digital Library Cave."*	Oliver (1997); Zeithaml et

	SAT2	I am willing to recommend this game to my friends.	al. (1996).
	SAT3	Compared to my ideal cultural game, the performance of *"Digital Library Cave"* is satisfactory.	
	SAT4	I am willing to continue playing similar digital games with cultural attributes.	
	SAT5	I had a pleasant gaming experience with *"Digital Library Cave."*	

4.4 Empirical Analysis

1) Demographic Characteristics

The demographic characteristics (see Table 2) show a balanced gender distribution in the sample (54.5% male, 45.5% female). The age composition strictly adheres to the definition of Generation Z, with the majority born between 2000–2004 (39.9%) and 1995–1999 (39.3%). The predominant education level is associate/bachelor's degree (70.0%). Regarding gaming behavior, the most common gameplay durations were 30 minutes to 1 hour (36.6%) and 1 to 2 hours (31.7%). Concerning experience with cultural digital games, the majority of users (77.6%) had played other similar games. Overall, the sample structure is reasonable, highly consistent with the target research group, and possesses a certain level of familiarity with the research topic.

Table 2. Demographic characteristics(N=303)

Category	Details	Frequency	Percentage(%)
Year of Birth	2005 and later	63	20.79
	2000–2004	121	39.93
	1995–1999	119	39.27
Gender	Male	165	54.46
	Female	138	45.55
Education Level	High school or below	62	20.46
	College/Bachelor's degree (student or graduate)	212	69.97
	Master's degree or above	29	9.57
Have you played *"Digital Library Cave"*?	Yes, have played	303	100.00
Approximate playtime of *"Digital Library Cave"*	Less than 30 minutes	51	16.83
	30 minutes to 1 hour	111	36.63
	1–2 hours	96	31.68
	2 hours or more	45	14.85
Have you played other cultural digital games?	Never played	68	22.44
	Played 1–2 games	110	36.30
	Played 3–5 games	88	29.04
	Played 6 or more games	37	12.21
Total	/	303	100.00

2) Reliability and Validity Analysis

This study verified measurement quality through reliability and validity tests. As shown in Table 3, the Cronbach's alpha coefficient for each variable was greater than 0.8, indicating good internal consistency of the scale. In the validity test, the KMO value was 0.896 (greater than 0.7), and the Bartlett's test of sphericity yielded an approximate chi-square value of 2847.800 (df = 190, sig. = 0.000), satisfying the conditions for factor analysis. Using principal component analysis, four principal factors were extracted, all with eigenvalues greater than 1, and the cumulative variance explained was 64.05%, meeting the standard criteria. Furthermore, all item factor loadings were above 0.7, and all communalities exceeded 0.5. The results indicate that the scale has satisfactory convergent and discriminant validity, showing reliable measurement quality.

Table 3. Factor analysis results

	Composition				Communality
	1	2	3	4	
Emotional Features 1	0.753				0.625
Emotional Features 2	0.759				0.678
Emotional Features 3	0.775				0.659
Emotional Features 4	0.727				0.590
Emotional Features 5	0.792				0.696
Cultural Features 1		0.780			0.649
Cultural Features 2		0.754			0.612
Cultural Features 3		0.767			0.637
Cultural Features 4		0.781			0.666
Cultural Features 5		0.768			0.659
Interactivity 1			0.760		0.658
Interactivity 2			0.796		0.679
Interactivity 3			0.753		0.635
Interactivity 4			0.760		0.621
Interactivity 5			0.719		0.596
Satisfaction 1				0.719	0.605
Satisfaction 2				0.735	0.591
Satisfaction 3				0.790	0.693
Satisfaction 4				0.755	0.646
Satisfaction 5				0.740	0.613
Variance%	16.235%	16.227%	15.901%	15.682%	-
Cumulative percentage	16.235%	32.462%	48.363%	64.045%	-
Cronbach'alpha	0.864	0.859	0.853	0.848	

KMO=0.896;

Test of Sphericity of Bartlett Approximate Chi-Square to 2847.800;

Degree of freedom 190;

Significance = 0.000.

3) Research Hypothesis Verification

Table 4. Study Hypothesis Verification Results

Serial number	Research hypothesis	Results
H1	The interactivity of cultural digital games positively affects the user satisfaction of Generation Z.	Supported
H2	The emotionality of cultural digital games positively affects the user satisfaction of Generation Z.	Supported
H3	The culturality of cultural digital games positively affects the user satisfaction of Generation Z.	Supported

The results presented in Table 4 confirm that all three research hypotheses are supported. Specifically, the interactivity, emotionality, and culturality of cultural digital games all positively affect Generation Z user satisfaction, providing preliminary support for the proposed hypotheses. However, hypothesis verification based on correlation analysis alone cannot determine the relative contribution of each variable or establish

predictive relationships. Therefore, a multiple linear regression analysis was further conducted to examine the individual and combined effects of these three dimensions on user satisfaction, as presented in Table 5.

Table 5. Linear Regression Analysis

Model	Unnormalized coefficient		Normalized coefficient	t	Significance	Collinearity statistics	
	B	Standard Error	Beta			Tolerance	VIF
(Constant)	0.958	0.233	-	4.105	0.000	-	-
Interactivity	0.256	0.059	0.240	4.361	0.000	0.794	1.259
Emotional Features	0.253	0.056	0.256	4.542	0.000	0.758	1.320
Cultural Features	0.194	0.055	0.192	3.539	0.000	0.820	1.219
$R = 0.528$, $R^2 = 0.279$, Adjusted $R^2 = 0.272$; $F=38.598$, $P<0.001$.							

As shown in Table 5, the overall regression model is significant ($F = 38.598$, $p < 0.001$), with good explanatory power (Adjusted $R^2 = 0.272$). All three independent variables have a significant positive predictive effect on user satisfaction. Among them, emotionality ($\beta = 0.256$, $t = 4.542$, $p < 0.001$) had the largest contribution, followed by interactivity ($\beta = 0.240$, $t = 4.361$, $p < 0.001$) and culturality ($\beta = 0.192$, $t = 3.539$, $p < 0.001$). The collinearity diagnostics indicated that the VIF value for each variable was no higher than 1.32, and the tolerance for each was greater than 0.75, suggesting no multicollinearity issues. In summary, hypotheses H1, H2, and H3 are all supported.

The Adjusted R^2 for this study is 0.272, indicating that the three independent variables—interactivity, emotionality, and culturality—account for 27.2% of the variance in Generation Z user satisfaction. In user satisfaction research, satisfaction is a complex psychological construct influenced by multiple factors, making it difficult for a single category of predictors to provide a complete explanation. Compared to related studies in the field, such as Shi et al. (2024) on mobile game user satisfaction ($R^2 = 0.31$) and Jiang et al. (2024) on cultural identity ($R^2 = 0.28$), the explanatory power of our model falls within a reasonable range. Furthermore, this study focuses on the design characteristics of the game itself, whereas user satisfaction can also be affected by individual and contextual factors. Future research could incorporate these variables to construct a more comprehensive explanatory model.

5. Conclusion

5.1 Research Conclusions and Implications

By integrating a theoretical framework with empirical analysis, this study systematically examined the mechanisms through which the interactivity, emotionality, and culturality of cultural digital games affect the user satisfaction of Generation Z. The data analysis results indicate that interactivity ($\beta = 0.240$, $p < 0.001$), emotionality ($\beta = 0.256$, $p < 0.001$), and culturality ($\beta = 0.192$, $p < 0.001$) all have a significant positive impact on the user satisfaction of Generation Z, and the overall model is supported by the underlying data (Adjusted $R^2 = 0.272$). This demonstrates that the three-dimensional characteristic analysis framework constructed in this study can effectively predict user satisfaction. Among these factors, emotionality has the most prominent impact, followed by interactivity, while the influence of culturality is relatively the smallest. However, all three are key elements constituting user satisfaction for Generation Z.

In terms of theoretical implications, this study first validates that interactivity, emotionality, and culturality constitute an effective analytical framework for evaluating the user experience of cultural digital games, providing a theoretical basis and

measurement tools for subsequent related research. Second, by focusing on the specific group of Generation Z, the research findings deepen the understanding of the behavioral motivations of digital natives in the field of digital cultural consumption. In particular, the emergence of emotionality as the most critical predictive variable reveals that Generation Z users are no longer satisfied with the one-way acquisition of knowledge when experiencing cultural content; instead, they place greater emphasis on emotional resonance and immersive experiences, seeking cultural products that can be spiritually moving.

In terms of practical implications, this study provides empirical evidence for the design and development of cultural digital games and for strategies of digital dissemination of cultural heritage. Given that emotional experience is the primary driver of user satisfaction, developers should shift their focus from merely presenting cultural elements to constructing deep emotional connections. Through sophisticated narratives, immersive atmospheres, and high-quality audiovisual aesthetics, they should guide users to develop a sense of awe and resonance with cultural heritage. The emotional core, as a primary driver, must be supported by meaningful interactive experiences. Designers should move beyond simple operational feedback and provide users greater autonomy in exploration and the ability to substantially impact the game world, thereby transforming users from passive "consumers" to active "participants" in history. All of this should be grounded in innovative cultural expression, which involves skillfully integrating cultural knowledge into exploration and challenges while ensuring the accuracy of the cultural core, avoiding didacticism, and achieving the ideal effect of "edutainment." Ultimately, the organic integration of an emotional core, interactive experience, and cultural expression is the key pathway to enhancing the user satisfaction of Generation Z. It is also crucial for promoting the innovative transformation of outstanding traditional Chinese culture in the digital age.

5.2 Research Limitations and Future Research Directions

Although this study has made progress in theoretical construction and empirical testing, it still has several limitations that need to be addressed and elaborated upon in future research. First, at the sample level, the participants of this study were mainly drawn from Generation Z, with a predominance of university students. This group generally has a high level of acceptance of digital technology and gamified learning. Therefore, the generalizability of the research conclusions to other age groups (such as adolescents or middle-aged groups) or different social backgrounds (such as non-student groups) remains to be tested. Future research should increase the diversity of the groups and conduct cross-group comparisons to explore the perceptual differences in how different user groups experience cultural digital games. Second, in terms of variable selection, this study focused on the three core dimensions of the game itself: interactivity, emotionality, and culturality. However, user satisfaction may also be influenced by individual differences, such as the user's own cultural literacy, gaming experience, and personal interests. Subsequent research could incorporate these individual characteristics as moderating or mediating variables into the model to construct a more comprehensive explanatory framework. Furthermore, during data collection, this study primarily focused on users' emotional perceptions and interactive experiences regarding cultural elements and did not record detailed data on the specific regional distribution of the participants. Users from different geographical regions and cultural backgrounds may exhibit certain differences in aesthetic preferences and cultural identity. Future research could introduce regional variables, expand the coverage and diversity of the sample, and conduct cross-regional comparative studies to explore further the potential impact of geographical factors on in-game cultural experiences. Finally, regarding the research method, this study used a cross-sectional questionnaire survey, which, while effective in revealing correlations between variables, makes it difficult to capture the dynamic evolution of the user experience over time and

does not allow for strict causal inference. Future research could adopt longitudinal tracking or experimental methods, or set up experimental groups with varying levels of interaction and emotion for comparison to more precisely verify the causal effects of various design elements on user satisfaction. Future studies could also conduct multicase comparisons by selecting and analyzing cultural digital games with different cultural themes and game types to test the universality and boundary conditions of the model proposed in this study.

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