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A grounded theory-based model of information communication in cultural heritage digital reading on the social media from the perspective of the embodied theory

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Abstract

New media technologies have opened up new possibilities for the communication of cultural heritage, and digital reading aligns with the participatory shift in museums, becoming an indispensable part of information communication. Currently, there exists a certain contradiction between the professional content of cultural heritage and the non-linear and immersive narrative style of new media. In order to find a balance between form and content, and explore the information communication pattern of cultural heritage in the era of mobile media, starting from practical issues, this article introduces the theory of embodied cognition, combines it with relevant theories in communication studies, and systematically explores the impact of embodied factors on audience reading behavior by using semi-structured interviews and grounded theory. The research reveals that embodied cognition, situational cognition, and interactive cognition have a significant impact on the digital reading information communication of cultural heritage on social media, which includes six factors: functional experience, sensory experience, interactive experience, scene simulation, emotional elevation and social experience. This study further constructed a theoretical model of the factors influencing the effectiveness of information communication in cultural heritage digital reading on the social media platform under the influence of embodied cognition theory, which confirms that these six factors play a significant role in the process of museum content generation, audience understanding, as well as the emergence of and the feedback loop of new meanings.

Keywords Digital reading, Cultural heritage, Social media, Theoretical model, Grounded theory

Introduction

Museums, representative of numerous cultural heritage institutions, have undergone a transformative shift from emphasizing collection to prioritizing exhibition. Freeman Tilden, in *Interpreting our Heritage* (1957), explicitly stated that cultural heritage institutions should not only collect and preserve material and immaterial culture but also disseminate knowledge in a captivating way [1]. ICOMOS has reiterated over the past fifty years that the communication of information on cultural heritage is fundamental to positive conservation outcomes. As public cultural service and information communication entities, cultural heritage institutions, exemplified by museums, have embraced a people-centric development philosophy through information communication. The twenty-first century has witnessed several fundamental shifts in production methods and the nature of art, leading to an expansion in the ways culture is preserved, visited, experienced, and consumed, driven by the development of new media [2]. In this process, audiences have

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transitioned from passive information receivers to active content creators. The communication of cultural heritage has thus evolved into a nonlinear, scalable, immersive, and collaborative endeavor, showcasing a new trend of cross-media storytelling that connects diverse cultures and a broader public. As of July 2023, the global social media user count stands at 4.76 billion, equivalent to just under 60 % of the world's total population. The average daily social media usage for a typical social media user is 2 h and 31 min, almost 4 in every 10 min spent online now attributable to social media activities [3]. In this era, cultural heritage institutions, led by museums, actively adapt to the development of digital technology and new media. They integrate VR, AR, and other digital technologies into the construction and interpretation of virtual heritage [4]. Additionally, they utilize social media platforms such as Facebook, YouTube, Bblogs, as well as WeChat and Weibo, to establish new modes of information communication and interaction, offering audiences, especially the younger demographic, novel ways of engagement.

Leveraging social media, digital reading has emerged as a ubiquitous avenue for societal information communication. Its key characteristic lies in the integrated use of various forms, including text, image, audio, and video. Delivering a reading experience distinct from traditional books, digital reading employs concise content and robust social functionality, offering audiences diversity in time, space, and form. Its content presentation features interactivity, sociability, and fragmentation, aligning with the current trends of digital networks and the shift towards a people-centric approach to cultural heritage. However, in the process of disseminating cultural heritage information, the specialized and serious nature of the content poses challenges for integration into the fast-paced, entertainment-oriented environment of social media reading. This significantly impacts the effectiveness of cultural heritage information communication. Relying solely on enhancing exposure through form while neglecting content comes at the cost of communication quality and effectiveness [5]. This not only contradicts the essence of information communication but also runs counter to the original intent of cultural heritage information communication. How can we explore the information communication paradigm of cultural heritage on social media in the era of mobile media? How can we balance the relationship between content and form, ensuring both public experience and the effectiveness and quality of communication?

With the advent of the second cognitive revolution, the embodied cognitive model has gradually replaced the outdated disembodied cognitive model and becoming mainstream [6]. Taking into account the high compatibility between the emphasized features of embodied cognition, interactive cognition, and situational cognition in embodied cognitive theory and cultural heritage on social media digital reading, this article introduces embodied communication theory in a creative manner. The aim is to offer a new conceptual framework for the information communication of cultural heritage on social media. Originating from practical issues and integrating embodied communication theory, this article explores the role and principles of embodied elements in the process of digital reading on social media. To achieve the research objectives mentioned above, original data is collected through interviews, and grounded theory is applied for coding. Ultimately, the study aims to establish an information communication framework for cultural heritage digital reading on social media under the influence of embodied cognitive factors.

Theoretical basis

Embodied cognition

The theory of embodied cognition originates from the philosophical proposition of the mind–body relationship. With the differentiation of disciplines and their expansion into cognitive psychology, it guided the field of cognitive science to transition from disembodied cognition to embodied cognition. Influenced by Descartes' mind–body dualism, traditional cognitive science viewed cognition as a computational process [7]. In the 1960s, cognitive psychology became the mainstream in Western psychology. Psychologists shifted their focus to internal mental processes, a perspective known as cognitivism. Currently, cognitive psychology is undergoing a post-cognitivist transformation, moving from disembodied cognition towards embodied cognition [8].

Modern European philosophers like Heidegger, and Merleau-Ponty, among others, represented a significant intellectual movement in which they critically reflected upon and challenged the dualism that had been in place since Plato. Their groundbreaking research collectively forms the philosophical foundation of embodied cognition. Merleau-Ponty used "body-subject in its ongoing active engagement with the world" to subvert Descartes' "i think that", which revealed the unity and embodiment of perception and action as well as the inseparability of the mind and body within their surrounding environment [9, 10]. Heidegger (1962) put forward the concept of present-at-hand (Vor handen) and ready-to-hand (Zuhanden), using the obtrusiveness of the present-at-hand object to contrast the embodiment of the ready-to-hand object, which further developed Husserl's ontology [11]. He also attempted to transcend the division between the subjective and objective by introducing the concept of "being-in-the-world". He emphasized that the body

gains knowledge of the world through interaction with it, blurring the boundaries between the subject and the object. These theories serve as the most direct philosophical underpinnings of embodied cognition. Don Ihde summarized and reflected on various theories related to embodiment, introducing the phenomenology of technology, which affirmed the important role that technology plays in embodied cognition. He believes that human life is inevitably related to technology, and summarizes the relationship between people and technology in the following four forms: embodied relations, hermeneutic relations alterity relations and background relations [12]. During which, due to its quasi-transparency, technology "withdraws" during its use. The subject, through technology, perceives the world and transforms it into the subject's bodily perception, laying the theoretical foundation for the development of embodied cognition in the field of communication studies.

These philosophical speculations collectively contributed to the emergence of embodied theory in the field of cognitive psychology. We can understand embodied cognition from three perspectives: embodied cognition, situated cognition and interactive cognition. Firstly, the embodied cognition implies that the body serves as the physiological foundation for cognition, and cognitive content is also provided by the body. In a biological sense, the brain is embedded in the body, while the body's behaviors and activities are embedded in the environment 13. The bodily states and specific modalities of cognition and behavior constitute the basis of information processing 14. An increasing number of scholars have also empirically demonstrated the foundational role of bodily factors. For instance, changes in posture and facial expressions can influence the generation of cognition and emotions in people 15. Secondly, the situated cognition implies that all cognition is closely related to very particular environments, which includes the physical world the body inhabits and the socio-cultural context in which cognition occurs [10]. Wilson summarized six representative viewpoints on the concept of embodied cognition. Although these theoretical perspectives have different emphases, they all highlight the importance of its situatedness by means of the environmental attributes of cognitive activities. They acknowledge that cognition is situated and recognize that the environment can help store cognitive information [6]. Rowlands also proposed that the external world stores information related to processes such as perception, memory, and reasoning [16]. Cognitive processes are influenced not only by internal factors but also by the external environment. Cognition is related to both the physical environment and the socio-cultural environment. The cultural context in Lakoff's metaphorical concepts and the cultural body proposed by Don Ihde provide possibilities for us to consider the situatedness of cognition from a socio-cultural perspective. Lastly, the interactive cognition implies that cognition, the body, and the environment form a dynamic unity. Cognition is not an isolated event confined to the mind but rather a systemic event composed of multiple factors, where these factors interact causally and shape each other mutually [17].

Embodied communication

With the rise of the second generation of cognitive sciences, the disembodied communication paradigm, which initially placed heavy emphasis on consciousness and downplayed materiality, gradually evolved into an embodied communication paradigm that highlights the presence of media. Influenced by Western philosophical traditions, communication had long been viewed as the exchange of ideas and the alignment of consciousness, with the body regarded as an obstacle that needs to be overcome in the process of information transmission. However, as media technologies rapidly advances, mobile networks have been linking communication more closely with the specific temporal and spatial locations and scenes of the body. The proliferation of mobile devices has reduced the heterogeneity of media and increased their transparency. Social media, as the underlying infrastructure for various forms of media, ushered in a new era where "everyone communicates, and communication is for everyone". The introduction of "embodiment", with this subversive idea, has challenged the traditional disembodied knowledge in communication studies and gave rise to a new embodied communication paradigm. McLuhan M's "The Extensions of Man" theory played a crucial role in bringing the body back into the communication process [18].

The resurgence of the body in interpersonal communication is closely associated with the development of media technologies and a critical reevaluation of traditional communication models [19]. Simmel argued that the pursuit of emerging media technologies often led to a sacrifice of communication effectiveness in favor of efficiency, overlooking the significance of the body in this process [20]. Peters suggested that text-based communication, which bridges distances, often results in the distortion of dialogue [21]. Fortunati pointed out that while media technology transcends spatial and temporal constraints, it falls short of fully engaging language expression and bodily senses, leading to less-than-ideal communication outcomes [5]. With the introduction of embodied cognition theory into the field of communication studies, an increasing number of scholars have come to recognize the foundational role the body plays in communication [22–24].

The shift towards a people-centric approach in museums emphasizes the deeper participation and independent creativity of the public within museums, actively utilizing social media to promote multi-directional information communication, which has become an essential component of museum operations. This developmental trend has created opportunities for the reintegration of the body in communication activities. Firstly, the body, in the context of museum information communication, is not just a passive recipient but an active cognitive entity that constructs meaning [25]. As screens become increasingly pervasive, the presence of the body is emerging as the new norm in communication. In the realm of mobile and social media, information communication is imbued with an unprecedented sense of authenticity. Museums are no longer solely focused on transmission efficiency; instead, they are harnessing the full range of sensory and motor experiences to achieve enhanced communication effects. Essentially, they are returning to embodied practices centered on experiential knowledge from discursive practices. Secondly, cognition takes shape through the interaction between the body and environment [6]. The construction and communication of museum information are significantly influenced by the specific context in which the information recipients find themselves. This influence stems from their physical surroundings and the situational ambiance that the content evokes. Lastly, communication and cognition form a dynamic co-determination system where the relationship between communicators and recipients is not linear but characterized by mutual influence and interdependence [26]. The effectiveness of information communication depends not only on communicators but also on the extent of audience engagement and the feedback loop. Museum information communication is a collaborative process involving both the museum and its audience. Active interaction between audiences and content allows them to construct new meanings and contributes to the development of communicators' understanding.

Embodied reading, evolving from embodied communication, represents the embodiment in reading behavior in the context of new media. The emergence of new meanings in texts is directly dependent on the new forms of those texts [27]. Reading, an ancient activity, continuously evolves as new forms are iterated. The transformation of communication methods has taken reading from its origins of being "body-dependent" to the era of mass media when it was "body-independent." Today, with the development of new media technology and social networks, there is a resurgence of the body in the act of reading digital reading via social networks is at the forefront of embodied reading in the new media era, leading the return of bodily elements to reading through the full engagement of the senses and the anthropotropic of the media. Reading is no longer a static process of looking with one's eyes, it has become a dynamic act of the body's interaction.

As a frontier of embodied cognition research in the field of communication, scholarly attention on embodied reading has primarily focused on three aspects: situation, technology, and experience. In the situation-related research, the relationship between reading and the situation has garnered extensive attention and discussion. Empirical evidence has demonstrated that being in an appropriate reading environment has a positive impact on reading effectiveness [6, 28]. Additionally, cross-cultural metaphor theory has shown that broader life situations can influence the effectiveness of information communication. Research in the field of technology has concentrated on discussing the influence of media technology and the development of mobile media on the embodiment of reading. Technological advancements have transformed the medium from being an extension of the body into an integral part of the body itself. Mobile phones, as the most widely used and representative embodiment screens, have become a transparent medium that brings the world to us and integrates itself into our perception of the world [29]. Compared to the mobile phone screen, we tend to focus more on the content presented on the screen, such as text and images [30]. Research in the realm of experience has centered on the interactive relationship between the body and the environment during the reading process. The body acquires a sense of reality in virtual space through imagination during the reading process, making reading an experiential process. Emotions, which are psychological experiences generated by the body's reactions to emotional stimuli during interactions with the environment, are also a significant manifestation of embodiment [15]. The embodiment of emotions forms the basis for empathy, which is an essential experiential process and mode during the reading process.

Cultural heritage communication and social media

With the rise of new museology and the rapid development of mobile media, institutions for cultural heritage communications, including museums, have actively engaged in the development and construction of society, thus altering the previous binary separation of subject and object relationships. In the twenty-first century, the vigorous development of new media and social networks has once again reshaped the presentation and communication of social information. In this process, the privileged status of communicators has been disrupted, and a diverse and equal multi-directional information communication model has gradually become mainstream,

shaping a new paradigm of multi-directional communication created by everyone.

Antony Mayfield defined social media as a new type of online media that provides users with extensive participation space, suggesting that the appropriate use of social media can help museums and cultural heritage institutions shed their elitist reputation [31]. However, it also requires relinquishing some authority for authenticity. Russo pointed out that the most significant challenge posed by the application of social media is transforming the previous one-to-many communication model into a many-to-many communication model [32]. The role and significance of social media have gradually gained widespread recognition in the academic community. Subsequently, many scholars have conducted specialized research for specific regions or institutions, attempting to propose pathways to enhance social media information communication or exploring strategies to improve the audience's experience from a specific perspective. For example, Jenny Kidd proposed a marketing, inclusion, and cooperation framework for implementing social media activities from the perspective of public participation [33]. Lessard, on the other hand, focused on museums' use of social media for knowledge communication and introduced the SCOPE framework for designing and evaluating museum social media activities [34].

Cultural heritage social media digital reading exhibits characteristics of both browsing-style reading and in-depth reading. The former is deeply integrated with modern mobile networks, and users primarily engage in this type of reading for leisure and entertainment. Its presentation style and mode of communication align with the communication logic of social networks, featuring fragmentary, jump-around, and fast-food-like content. On the other hand, the latter has characteristics of authority and seriousness in its content. It primarily revolves around relics, cultural heritage, and historical knowledge. It has a certain reading threshold and comprehension difficulty, requiring readers to have a higher level of engagement and immersion in the content. This means that the reading process is characterized by completeness and coherence.

The fast-paced style of social media, coupled with high levels of professionalism in the content, has led to various challenges in the development of cultural heritage digital reading. Currently, cultural heritage digital reading aligns with the public's demand and habits of using social media by emphasizing fast-paced, fragmented content. However, in this process, an overemphasis on visually impactful communication methods can bind people to a visual-centric approach. Simultaneously, a sole pursuit of exposure while neglecting content and disregarding substance not only goes against the essence of cultural heritage information communication but also contradicts the educational intent. The dual nature of cultural heritage information communication requires us to seek a digital reading information communication paradigm that combines both effective communication and reading quality.

This article introduces embodied communication theory to the field of cultural heritage digital reading. Through interviews and the collection of primary data, grounded analysis is utilized to discuss whether embodiment, with its characteristics in museum communication, including embodied cognition, situational cognition, and interactive cognition, can enhance the effectiveness of communication. Based on the results of grounded analysis, a model is constructed to further explore how embodiment influences information communication effectiveness. The aim of this article is to guide reading behavior back to its bodily essence, emphasizing the interaction between readers' physical elements and their environment to achieve better knowledge communication effectiveness. It provides a new path of thinking for the communication of cultural heritage information.

Research method

Research design

Data acquisition method

The study applies the interview method to collecting primary data and extracting effective statements to form an original corpus. The author, based on the purpose of this study and drawing on relevant research results, designed a semi-structured interview outline as shown in Table 1. In order to ensure the content validity of the interview outline, a pre-test was conducted before the formal interviews. Based on the analysis of the interview data from three pre-test participants and their feedback suggestions on the interview questions, certain modifications were made to the questions and wording in the interview outline, resulting in the formal semi-structured interview outline.

The primary interview format employed in this study is face-to-face interviews, with online interviews as a supplementary method. Before each interview, the researcher would introduce its purposes and guidelines to the interviewees, and solemnly commit to maintaining the confidentiality of the related data, in order to alleviate the their concerns about the disclosure of personal information and privacy. The interviews were conducted between May and August 2023, with each interview lasting 20 to 30 min. During the interview process, informed consent is obtained from the interviewees, and both audio and written records are maintained. Throughout the interviews, the author guides the interviewees to actively express their

Table 1 Interview outline

Order	Interview purposes	Interview questions
1	The motivation of the interviewees for using social media to read cultural heritage-related information	(1) What are the reasons behind your frequent usage of social media platforms to read cultural heritage-related information? (2) What are the characteristics of the digital presentation methods within social media platforms regarding the dissemination of cultural heritage information, in your opinion?
2	The interviewees' evaluation of their reading experience and the dissemination effectiveness of cultural heritage information on social media platforms	(1) What factors, both positively and negatively, influence your reading experience and comprehension level when using social media to read cultural heritage-related information? (2) When utilizing social media to peruse cultural heritage-related information, what factors stimulate your interest and provoke a desire to share with others, both positively and negatively? (3) Can the involvement of the body, the creation of scenes, and the incorporation of social attributes enhance your reading experience and deepen your understanding of the content? If so, how do these factors operate, both in terms of presentation format and textual content?
3	The interviewees' outlook and expectations regarding reading cultural heritage on social media platforms	(1) Based on your past usage experiences, what are your expectations regarding the dissemination of cultural heritage information on social media platforms? (2) Based on the trends in the social or industrial development, what are your expectations regarding the dissemination of cultural heritage information on social media platforms?

experiences and feelings. In addition to the predefined interview outline, new questions are improvised based on the interviewees' responses to ensure the comprehensiveness and richness of the interview data.

Data analysis method

After collecting raw interview data in this study, grounded theory analysis was employed. Grounded theory, proposed by Anselm Strauss and Barney Glaser in 1980, is a qualitative research method that involves the collection and analysis of data to develop inductive conclusions about a particular phenomenon by applying systematic procedures. For instance, Li used grounded theory to establish the impact model of digital communication on intangible cultural heritage in the handicraft domain [35]. In this article, material was collected in the form of semi-structured interviews. After the interviews concluded, the textual versions of the interviews were screened, and relevant effective statements were retained to form the original database. Grounded theory was then used to systematically explore the factors influencing communication effectiveness of the audience during the reading process. Material analysis was conducted through open coding, axial coding, and selective coding. Ultimately, a model of embodied cognition influencing cultural heritage information communication was constructed, and corresponding enhancement strategies were proposed based on this model.

Data collection process

Interviewees

The study selected a total of 30 social media platform users aged between 18 and 60. Each interview with the interviewees lasted approximately 30 min. The interview opened an online registration channel and required applicants to submit a personal introduction including age, education, identity, information acquisition habits, etc. Participants were selected based on these criteria and divided into four categories: scholars in relevant fields, professionals in relevant fields, students in relevant disciplines, and general audiences.

The interviewees all had a certain level of knowledge about museums, prior museum visiting experiences, and a strong desire to acquire cultural heritage knowledge. Additionally, all interviewees had a habit of using social media platforms to access information and knowledge related to cultural heritage. The interviewees primarily consist of individuals with high activity levels on social media platforms and a strong desire for cultural heritage-related information. To ensure the scientific and comprehensive collection of information, interviewees of different age groups, backgrounds, and education levels were invited to participate in the interviews, aiming to enrich the research perspectives and expression of needs. The basic information of the interviewees is shown in Tables 2 and 3.

Table 2 Basic information of the interviewees-1

Items	Classification	Number of people	Proportion (%)
Age	Under 18	3	10
	19 to 30	10	33
	31 to 45	10	33
	45 to 55	5	16.7
	55 and above	2	6.7
Educational background	Senior high school	3	10
	Bachelor degree	12	40
	Master degree	15	50
Identity	Expert	4	13.4
	Professional	6	20
	Student	10	33.4
	Enthusiast and audience	10	33.4
Total		30	

Data Analysis

Open coding

Open coding is the first step in the coding methodology of grounded theory, which involves carefully reading the original data, conceptualizing the original statements, and further summarizing the process of initial category induction.In this study, the recordings obtained from interviews were transcribed into text. While respecting the original intentions of the interviewees' expressions, meaningless pauses and ambiguous statements were removed from the text. Additionally, simple merging and de-duplication of the textual data were performed to obtain clearer and more meaningful textual materials. Subsequently, in the secondary analysis, this study once again removed certain statements from the original data that were either not highly relevant to the digital reading of cultural heritage social media platforms or lacked clarity in meaning, resulting in refined raw data. It initially categorized statements based on their core meanings, synthesizing elements with similar nature and content into conceptualizations. As a result, 27 conceptualized labels (A1-A27) were obtained. Examples of original statements along with their conceptualized results are provided in Appendix A. Moreover, further connotative analysis was conducted on the adjacent initial concepts, resulting in 12 initial categories (B1-B12). The results of open coding are presented in Table 4.

Axial coding

Axial coding is a crucial step in programming the grounded theory, which involves, on the foundation of open coding, merges similar codes to form more general macro concepts. This study, based on the 12 initial concepts, has identified the core concepts as platform usage experience, sensory experience, behavioral experience, contextual experience, social experience, and emotional experience, as shown in Table 5. Combined with the characteristics of embodied communication, this study further corresponds the core concepts with the embodied cognition, situational cognition, and interactive cognition. The connotation of core concepts is shown in Appendix B.

Selective coding

Based on the six core concepts, this study used selective coding to analyzing their functional pathways and relational structures, constructs a grounded theory model of the factors influencing digital reading on social media platforms, as shown in Fig. 1.

More specifically, these six types of experiences are deeply rooted in embodied cognition, closely related to the body, and interwoven throughout the interaction between the body and the different scenarios. They

Table 3 Basic information of the interviewees-2

Identity	Number of interviewee	Characteristic
Expert	4	All four interviewees are scholars in relevant fields, engaged in research related to the dissemination of cultural heritage information, and they are able to provide insightful perspectives on topics related to social media information dissemination
Professional	6	All five interviewees are professionals in relevant industries who have been involved in practical work related to the dissemination of cultural heritage information. They possess a certain understanding of content publishing and operations on social media platforms and have some thoughts on topics related to social media information dissemination
Student	10	All ten interviewees are students in relevant majors such as museum studies, cultural heritage, and communication. Most of them have completed internships at museums or other cultural heritage institutions, possessing relevant professional knowledge and a high level of activity on social media platforms
Enthusiast and audience	10	All ten interviewees are enthusiasts of cultural heritage knowledge. They have all visited museums or cultural heritage institutions multiple times, and some have volunteered in social outreach programs for museums. They possess a certain reservoir of cultural heritage knowledge and a strong desire for learning

Table 4 Open coding output

Initial concept categories	Conceptualization
B1 Platform functionality	A1 Platform usability
	A2 Functional rationality
B2 Push mechanism	A3 Precision of push
B3 Visual and auditory sensations	A17 Attractive images
	A20 Pleasant audio
	A23 Exquisite videos
B4 Layout design	A26 Refined graphics and text layout
	A27 Comfortable background colors
B5 Interaction with content authors	A4 Voting interaction
	A6 Participation in lottery interaction
B6 Interaction with content	A5 Flip Phone interaction
	A7 Specific gesture interaction
	A8 Question–answer interaction
B7 Creating scenarios with text and image	A13 Diverse text content
	A14 Strong contextual text content
	A16 Vivid Text content description
B8 Creating scenarios with audio and video	A19 Scene creation with images
	A22 Atmosphere creation with audio
	A25 Scene creation with videos
B9 Shaping emotions with text and image	A15 Text content evokes empathy
	A18 Images evoke empathy
B10 Shaping emotions with audio and video	A21 Audio evokes empathy
	A24 Videos evoke empathy
B11 Sharing content	A9 In-viewing
	A11 Reposting
B12 Expressing opinions	A10 Commenting
	A12 Backstage messaging

Table 5 Axial coding output

Dimension	Core concept categories	Initial concept categories
Embodied cognition	Functional experience	B1 Platform functionality
		B2 Push mechanism
	Sensory experience	B3 Visual and auditory sensations
		B4 Layout design
	Interactive experience	B5 Interaction with content authors
		B6 Interaction with content
Situational cognition	Scene simulation	B7 Creating scenarios with text and image
		B8 Creating scenarios with audio and video
	Emotional elevation	B9 Shaping emotions with text and image
		B10 Shaping emotions with audio and video
Interactive cognition	Social experience	B11 Sharing content
		B12 Expressing opinions

all play a direct role in influencing the effectiveness of information communication in cultural heritage social media digital reading. Functional experience, sensory experience, and interactive experience fall within the category of embodied cognition. Among these, the platform usage experience serves as the foundation of cultural

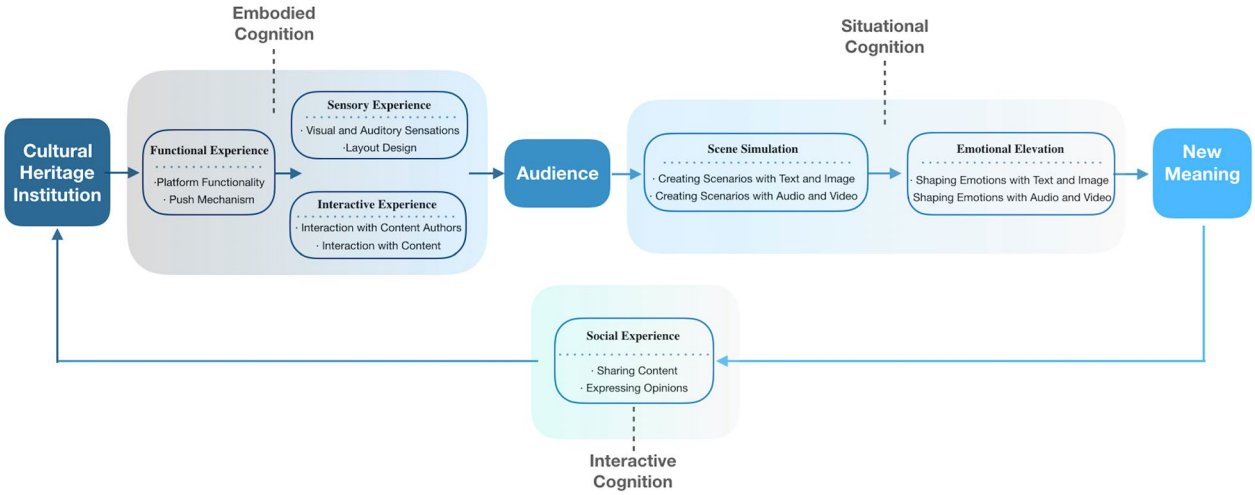

Fig. 1 Relationship structure

heritage information communication and represents the first impression left on readers in digital reading. Its usability and rationality directly affect other reading experiences, making it the initial link in the process of cultural heritage information communication. Sensory and interactive experiences, in turn, fully engage the audience's bodily factors, collectively influencing the information transmission process from cultural heritage institutions to the audience. Scene simulation and emotional elevation come into play in the audience's understanding, internalization of information, and generation of new meaning. These belong to the interactive category of embodied cognition. Through scene simulation, the audience gains a sense of realism in the virtual space, transforming the reading process into an experiential one. Subsequently, as the audience experiences the changes of emotions in this "real" virtual space, emotional elevation during the reading process enhances their reading experiences. Social experience impacts the information feedback process between the audience and cultural heritage institutions. Building upon the previous experiences, the audience generates new meaning and actively provides feedback, ultimately creating a positive dynamic cycle in cultural heritage digital reading information communication that balances communication effectiveness and quality.

Theoretical saturation test

After the completion of coding, this study supplemented interviews with 4 participants, each representing a different category (scholar, professional, student, enthusiast), and conducted independent coding for these 4 sets of sample data. The results showed that no new logic or causality was generated in the related categories. This confirms that the coding process described above is comprehensive and effective. Therefore, this paper concludes that theoretical saturation test has been passed.

Discussion and conclusion

Based on the coding process and its results described above, this study has constructed a theoretical model of the factors influencing the effectiveness of digital reading information communication on cultural heritage social media platforms under the influence of embodied cognition theory, as depicted in Fig. 2.

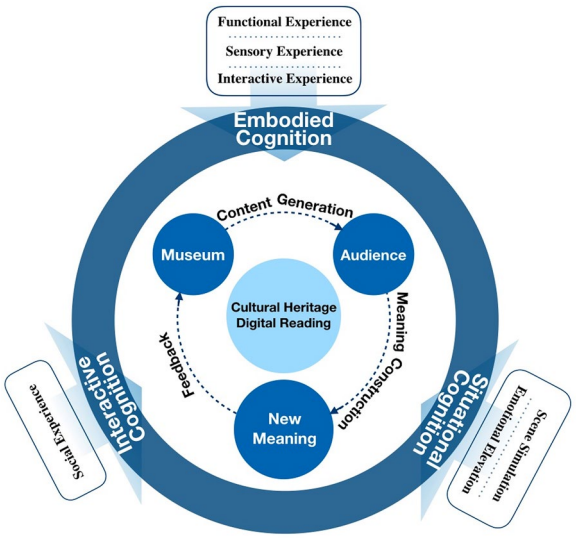

Fig. 2 Theoretical model

Impact of embodied cognition on cultural heritage digital reading information communication

Functional experience refers to the experience of readers when they engage in digital reading using mobile devices via social media platforms, encompassing two sub-dimensions: platform functionality and push mechanisms. Concerning the platform itself, usability and rationality are two crucial factors that influence the communication of museum digital reading information. The more natural the platform usage experience, and the more transparent the mobile interface becomes, with the user and the mobile medium represented by the phone screen merging into one, an embodied relationship is established. Regarding push mechanisms, more accurate and efficient mechanisms can minimize the time readers spend searching blindly or browsing without a specific purpose, further reducing the heterogeneity of intermediaries. The stronger the usability and the more comprehensive the functionality of the platform, the lower the platform's heterogeneity and the higher its transparency. This, in turn, enhances embodiment and, consequently, improves the information communication experience and effectiveness of cultural heritage digital reading.

Sensory experience refers to the activation of multiple senses, such as vision and hearing, which readers fully engage during the digital reading process. According to embodied cognition theory, cognition is not merely a mental activity; rather, it involves the full engagement of bodily factors in the context of interactions between the body and the environment. The communication of cultural heritage information relies on physical objects, with offline information communication supported by exhibitions and educational activities, characterized by tangibility and physical presence. This approach effectively stimulates the audience's senses and leverages the advantages of physical objects. In addition, online information communication, facilitated by new media platforms, should focus on diversifying information presentation. By incorporating images, audio, and video that resonate with the content, it activates the senses that align with the content, thus involving multiple sensory perceptions. This approach aims to recreate the bodily presence of the audience, capitalizing on the strengths of "tangibility". Throughout this process, embodied technology enhances the visual and auditory experiences of readers. Readers, in a sense of "physical presence", can see or hear scenes that were previously inaccessible, resulting in an enhanced reading experience and a more effective information communication effect.

Interactive experience refers to the reader's actions during the digital reading process that involve interacting with the information content, such as flipping the phone to display content, tapping the screen for answers, and using specific gestures to interact. Museum information typically carries authority and seriousness and may have a certain level of comprehension barrier for the audience. On the one hand, interactive presentation methods like flipping the phone or using gesture controls can pique the audience's interest and effectively balance the seriousness of cultural heritage information. On the other hand, interactions such as clicking to answer questions or participating in polls, when aligned with the digital reading content, can stimulate audience reflection, deepening their understanding of cultural heritage content. By leveraging the reader's engagement and comprehension, interactive experiences can enhance the reading experience and information communication effectiveness while maintaining content professionalism.

Based on the crucial roles that functional experience, sensory experience, and interactive experience play in embodied cognition, this article suggests that digital reading in cultural heritage should enhance its embodied cognition to pique reader interest. In terms of the reading experience and content presentation, mobilizing bodily factors to stimulate reader interest, prolong reading time, and enhance content comprehension can lead to better information communication effectiveness. In the reading experience, it's essential to improve the accessibility of reading features on social media platforms and ensure the comfort of the reading interface, thus minimizing the heterogeneity of the medium. Cultural heritage institutions, such as museums, have a responsibility to serve the public and society, and digital reading on social media platforms has a broad target audience. Therefore, it's crucial to consider the reading habits of the majority of readers. This involves creating simple and rational registration processes and platform features, establishing effective and precise push mechanisms, and providing a streamlined and efficient experience for the target audience.

Concerning content presentation, museums should also consider the impact of bodily factors in organizing and presenting digital reading content. On one hand, they should reduce visual fatigue by employing comfortable layout and appropriate font colors and sizes to enhance the reading experience for platform users. On the other hand, museums should leverage the advantages of social media and mobile devices to engage multiple sensory perceptions and bodily actions. Through the integration of images, audio, and video with text content, readers' visual and auditory senses can be activated to enhance the effectiveness of information communication. Besides, digital reading by museums should adapt to the characteristics and functionalities of different social media platforms and encourage bodily involvement in content presentation. This could include actions

like flipping the phone, using gesture controls, participating in polls, and more. By increasing sensory perception and bodily engagement, the information becomes more engaging, maintaining reader interest and ensuring a better communication effect.

Impact of situational cognition on the cultural heritage digital reading information communication

Situational experience refers to the process in which readers combine their current situation and existing knowledge during digital reading and construct new meanings. The effectiveness of cultural heritage information communication is closely related to the situation in which the information recipients find themselves. Situation here has a dual meaning: one is the situational memory created by the recipients' living environment, and the other is the situation formed in the recipients' minds during the reading process. Both of these situations play a crucial role in the internalization and understanding of cultural heritage information and the creation of new meaning. At the level of content creation, cultural heritage information should be rooted in the readers' living environment and knowledge to awaken the readers' situational memories. In terms of content communication, cultural heritage information should use vivid and diverse language and effective integration of audio and video to stimulate the readers' situational imagination and create a shared situation between the sender and the receiver. By invoking familiar situations, building upon existing knowledge, recognizing new information, and further constructing scenarios, readers complete the process of reinterpreting cultural heritage information.

Emotional experience refers to the readers' ability to empathize with the contents of the articles and have their emotions activated during the digital reading process. Emotions include the fundamental emotions, attitudes, internal needs, and motivations that readers experience during digital reading. Emotions are closely related to the body and form a mutual, bidirectional relationship with cognition. The construction of a situation in the process of cultural heritage information communication places both the sender and the receiver in the same emotional state. By invoking deep emotions, it deepens the level of information exchange and leads to better communication effectiveness and reading experience. Cultural heritage information communication institutions, such as museums, can leverage their rich cultural heritage resources, including historical, cultural, and regional content, along with multimedia (text, images, and audio-visual materials), to create an emotional environment that evokes deep emotional responses from readers. This can trigger readers' cultural confidence and patriotism, and in the process of emotional empathy, achieve better information communication effectiveness and reading experience.

Based on the roles of situational and emotional experiences in embodied cognition, this article suggests that cultural heritage digital reading should create a situational cognition to enhance comprehension. Cultural heritage-related information often carries authority and professionalism, resulting in higher reading thresholds and comprehension difficulties. In selecting themes, emphasis should be placed on evoking situational and emotional responses by choosing topics that resonate with the audience's lives and interests, hitting upon current social trends. By guiding the audience to leverage their prior experiences to understand and construct new knowledge, better information communication effectiveness can be achieved. In writing the content, using compelling storytelling and resonating thematic content can evoke readers' emotions and foster emotional resonance, resulting in better information communication effectiveness.

Impact of interactive cognition on cultural heritage digital reading information communication

Social experience refers to the reader's actions on social media during the digital reading process, which includes two dimensions: sharing content and expressing opinions. Embodiment theory posits that cognition and communication mutually influence and depend on each other. Readers, while receiving information, are actively constructing meaning and creating content. This forms a two-way communication between the reader and the information provider, jointly creating a virtuous cycle. The use of mobile networks for social engagement is an essential component of cultural heritage information communication. Sharing and forwarding content are crucial means to expand the reach and impact of information communication, while discussions and comments are indispensable for the information communication process. These interactions not only aid readers in constructing meaning but also serve as a vital means for cultural heritage institutions, such as museums, to adopt a people-centric approach and listen to public discourse. Social experiences can fully engage in bi-directional interactions between information recipients and information providers. This enhances the information communication effectiveness and audience reading experience in the context of coupled cognition and communication.

Based on the significant role of social experience in cultural heritage embodied cognition, this article suggests that interactive cognition should be prioritized to create a two-way construction of meaning. Cultural heritage institutions should fully leverage the interactive cognition and real-time nature of social media to facilitate

dialogues and exchanges between information providers and the public. Behaviors such as sharing and commenting are vital means of interaction in the context of digital reading on social media. Cultural heritage institutions should act as facilitators and coordinators to create a positive social environment from both content creation and later maintenance perspectives. Firstly, cultural heritage institutions should release content with high levels of discussion, attention, and national interest to stimulate the audience's enthusiasm for sharing and discussing content. In shaping their own social media personalities, the audience completes the re-communication or re-creation of information, thereby enabling communication and dialogue with cultural heritage institutions. Secondly, there should be designated individuals responsible for the operation of the comment section of digital reading on social media. They should promptly filter, manage, and respond to content and use some of the information provided by users in the construction of cultural heritage digital reading articles. Even when identifying issues through user feedback, cultural heritage institutions should actively address them to foster a positive social ecosystem.

Conclusion

This article, starting from the particularity of cultural heritage information, uses grounded theory to summarize the role of embodied factors in the dissemination process of cultural heritage information based on interviews and text analysis. On this basis, it constructs a theoretical model of the factors influencing the effectiveness of information communication in cultural heritage digital reading on the social media platform under the influence of embodied cognition theory. From the perspectives of embodied cognition, situational cognition, and interactive cognition, the article proposes six factors: functional experience, sensory experience, interactive experience, scene simulation, emotional elevation and social experience. Combined with the characteristics of cultural heritage information dissemination via social media, it suggests that the dissemination of cultural heritage information should be improved in terms of form, content, and social aspects to provide a better reading experience for the audience.

The theoretical model of influencing factors on cultural heritage information dissemination via social media constructed in this article holds significant importance for both the theoretical framework and practical application of cultural heritage information dissemination. This study considers the perspectives of relevant practitioners and audiences in understanding cultural heritage content, exploring the pathways through which embodied factors play a role, thereby broadening our understanding of cultural heritage information dissemination via social media. However, the proposed model still requires further validation, as the exact relationships between variables have not been tested using quantitative research methods. Additionally, this study is limited to Chinese audiences, resulting in constraints regarding sample size and selection scope, and lacking long-term follow-up surveys. Therefore, future research should aim to expand the sample range, extend the study period, and refine the relationships between variables, to enhance the reliability and validity of related research, providing theoretical foundations and improvement pathways for cultural heritage information dissemination via social media.

Supplementary Information

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Additional file 1.

Additional file 2.

Author contributions

J.Z. and C.X. wrote the main manuscript text. All authors read and approved the final manuscript.

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Declarations

Ethics approval and consent to participate

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the patients/participants or patients/participants legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements. All participants provided informed consent before participating in the study. The anonymity and confidentiality of the participants were guaranteed, and participation was completely voluntary.

Competing interests

The authors declare no competing interests.

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