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Study on the Design Path of Immersive Digital Resources for Museum Education from the Perspective of Situated Learning

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Abstract: ***Against the backdrop of the digital transformation of museum education and the rapid development of immersive technologies, this study focuses on the actual role of immersive digital resources in the learning processes of children and adolescents. Although immersive environments possess strong experiential attributes, their educational effectiveness fundamentally depends on how learners perceive, act, and construct understanding within specific learning situations. Therefore, it is necessary to re-examine the design logic of immersive resources from the perspective of learning theory. Anchored in situated learning theory, this study adopts a methodology combining literature review, multi-case analysis, and conceptual synthesis to explore the key elements that shape immersive digital resources in terms of learning-context construction, task-structure arrangement, and interaction-mechanism design. The study proposes an immersive learning design framework that is context-based, action-driven, and feedback-supported, thereby explaining how immersive technologies facilitate learners' meaning-making during experiential engagement. The findings provide theoretical reference for museums seeking to develop educational immersive resources under digitalization, and offer practical directions for optimizing instructional design in related applications.***

Keywords: Situated Learning, Museum Education, Immersive Experience, Digital Resource design**.**

1. Introduction

With the continuous advancement of digital technologies in the fields of culture and education, museums have gradually shifted from traditional spaces dominated by object display to learning environments that emphasize participation, experience, and meaning-making. The application of virtual reality, augmented reality, and immersive projection technologies enables visitors to engage with cultural content through multisensory experiences and to understand historical and artistic information in a more proactive manner. For children and adolescents, these technologies not only expand access to cultural knowledge but also provide new pathways for constructing meaning, expressing ideas, and developing sustained interest. In this context, how immersive digital resources can effectively fulfill educational functions has become a shared concern among museums and researchers.

Discussions on museum learning have long emphasized the importance of context. Falk and Dierking argue that visitors' learning is jointly influenced by personal background, social interaction, and the physical environment, and that learning occurs not only in front of exhibits but throughout the entire contextualized experience of museum visiting (Falk & Dierking, 2016). This perspective offers valuable insights for understanding the role of immersive technologies in museum education, as immersive digital environments are capable of constructing new contextual structures around learning goals, enabling children to gain experience through continuous observation, manipulation, and interaction. Such an environment- and activity-centered mode of learning aligns closely with the characteristics of museums as informal learning spaces.

In educational research, situated learning theory emphasizes that learners gradually form understanding through participation in authentic activities. Lave and Wenger point out that learning is a process embedded within social practice, and that knowledge is progressively constructed through participation and collaboration (Lave & Wenger, 1991). This theoretical lens provides inspiration for examining children's learning in museums, as immersive digital resources often reconstruct cultural and knowledge contexts around a specific theme, enabling learners to build connections with content through "real-like" activities. However, existing discussions tend to focus on the value of immersive technologies in enhancing visitor experience, information presentation, and engagement, while relatively limited attention has been given to how children develop continuous learning processes within immersive digital resources.

Building upon current academic and practical developments, this study seeks to examine the design approaches and learning pathways of immersive digital resources in museum education from the perspective of situated learning. Specifically, the study focuses on how immersive environments can provide children with comprehensible cultural contexts, clearly structured learning tasks, and appropriate modes of interaction, and explores how these components interact throughout the learning process. In addition, by analyzing multiple educationally oriented cases, the study identifies common design strategies within immersive digital resources, aiming to propose a theoretical framework and practical directions for future innovations in digital museum education.

2. Literature Review and Theoretical Framework

2.1 Educational Interpretations of Situated Learning Theory

The fundamental premise of situated learning emphasizes that learning activities must be closely connected to the environments, tasks, and social interactions in which they occur. In educational research, Brown, Collins, and Duguid systematically elaborated this perspective, arguing that knowledge can only be effectively understood within authentic or near-authentic contexts, and that learners gradually master concepts through participation in activities rather than through the transmission of abstract information (Brown, Collins, & Duguid, 1989). They contend that learning is not a process detached from its environment, but one that is constituted through interactions with tools, tasks, and other individuals, forming an integrated experiential whole. This view provides an important foundation for explaining children's learning in immersive digital environments, as the virtual spaces constructed by immersive technologies can simulate culturally meaningful contexts, enabling learners to naturally develop understanding through activity engagement.

Further research highlights the relationship between learning activities and social interaction. Greeno argues that learning is the result of interactions between individuals and their environments, and that the structure of activity influences how learners process information, pose questions, and form understanding (Greeno, 1998). This perspective suggests that within immersive digital resources, providing visual experience alone is insufficient; instead, task design and modes of interaction must support ongoing engagement between learners and content. The principles of activity, interaction, and situatedness proposed in situated learning theory thus offer a clear theoretical foundation for understanding the design of immersive educational resources.

2.2 Learning Characteristics of Museum Education

Learning in museums has long been regarded as a process centered on exploration and experience. In examining the relationship between learning and exhibition design, Hein argues that visitors construct understanding of exhibits through observation, manipulation, and exploration, and that learning outcomes are closely tied to the interactive opportunities provided by the exhibition (Hein, 1998). This constructivist perspective emphasizes that children often develop knowledge structures in museums through autonomous observation and exploratory manipulation. Immersive digital resources can extend this mode of experience by enabling learners to form more comprehensive cultural perceptions through narrative structures, visual environments, and interactive elements.

Moreover, research edited by Paris highlights exhibit-centered learning mechanisms, noting that children frequently develop cognition by communicating, imitating, or posing questions around objects or images, and that the design of learning activities must support these naturally occurring behaviors (Paris, 2002). This discussion indicates that within immersive digital environments, ensuring that children sustain continuous interaction with content and guiding them to express ideas through visual cues and contextual information are critical components of digital resource design. These perspectives from museum education research provide a solid basis for understanding how children engage in learning within immersive display contexts.

2.3 Educational Applications of Immersive Digital Resources

With the advancement of digital technologies, immersive environments have gradually become an important form of cultural and educational presentation. Wojciechowski and Cellary demonstrated that three-dimensional environments and immersive interaction can stimulate learners' motivation to engage, encouraging them to observe information more actively, experiment with actions, and receive immediate feedback, thereby facilitating the formation of understanding (Wojciechowski & Cellary, 2013). Their research emphasizes that the value of immersive experiences lies not only in enhancing visual appeal but also in fostering sustained participation and enabling learners to perceive the dynamic changes in information throughout the activity.

In the field of cultural heritage education, Kersten and Lindstaedt found that digital presentations possess significant advantages in helping learners understand abstract concepts and complex cultural contexts, particularly when such presentations are combined with clearly defined task structures. Under these conditions, learners are more likely to develop meaningful experiences through interaction (Kersten & Lindstaedt, 2012). This suggests that the educational effectiveness of immersive digital resources is not determined by technology alone, but rather depends on whether these resources provide coherent activity pathways and explicit operational goals for learners. Building upon these discussions, the present study further examines, from the perspective of situated learning, how immersive digital resources support children's learning processes through the design of context, task structures, and interaction mechanisms.

2.4 Analytical Framework of This Study

Drawing on the above body of research, this study proposes a conceptual framework for analyzing the educational design of immersive digital resources. The framework highlights the coordinated functioning of four core elements. The first is the contextual element, which provides the background for learning activities through visual environments, cultural symbols, and narrative structures, enabling learners to explore knowledge under conditions that approximate real-world situations. The second is the activity element, which focuses on task sequences, learner roles, and operational steps, allowing children to construct understanding through a series of purposeful actions. The third is the interaction element, involving digital tools, modes of feedback, and levels of interactivity, which determines whether learners remain continuously connected with the content. Finally, the support element includes guidance from educators, peer interaction, and reflective output, all of which exert significant influence on learning outcomes.

This framework lays the foundation for the subsequent case analyses and the development of a design-path model, helping explain how immersive digital resources function in museum education from the perspective of learning processes. At the same time, it provides a shared analytical lens that enables

systematic comparison across the different cases examined in this study.

3. Research Design and Case Selection

This study employs a multi-case analysis approach to examine the design characteristics and learning value of immersive digital resources in museum education. Multi-case analysis enables comparison across diverse practical contexts, allowing the identification of design strategies that share common structures and the exploration of their relationships with children's learning processes. Stake notes that multi-case research is suitable for observing phenomena across different settings, and that cross-case comparison can generate more explanatory and robust interpretive frameworks (Stake, 2006). For this study, variations among museums in educational goals, technological applications, and modes of presentation provide rich grounds for observing how immersive digital resources function. By analyzing several educationally oriented immersive display cases, this research investigates the relationships among context, task, interaction, and support mechanisms, thereby developing a design pathway appropriate for children's learning in museum settings.

The research materials primarily derive from publicly available educational resources, exhibition descriptions, project reports, and accounts from professional educational media. To ensure credibility and traceability, the study includes only cases with clearly articulated educational objectives, transparent technological features, and audience participation modes that can be clearly identified through documentation. Yin emphasizes that the validity of multi-case research depends on selecting representative cases and maintaining systematic and transparent procedures in data collection (Yin, 2018). Accordingly, this study relies on publicly accessible materials as the main source of evidence and adheres to explicit criteria during case selection to maximize methodological rigor. Since many educational projects have not yet generated peer-reviewed research reports, the study prioritizes cases published by authoritative institutions, described with clarity, and frequently referenced in practice, thereby enhancing the applied relevance of the findings.

In the case selection process, this study places particular focus on children as the primary audience, as they constitute one of the most common user groups of immersive digital resources and are central to many current innovations in museum education. Children's learning characteristics rely more heavily on intuitive experience, contextual construction, and concrete manipulation—features highly aligned with the learning affordances of immersive technologies. Therefore, selecting cases in which children are the main participants enables more effective observation of how situated learning theory is manifested in practice. Additionally, the study emphasizes diversity in technological forms so that the analytical outcomes encompass various types, including virtual reality, augmented reality, immersive projection, and interactive learning spaces, providing a more comprehensive demonstration of the educational value of immersive digital resources.

During the case analysis, this study adopts the situated learning framework as the primary analytic lens to identify how each case constructs learning contexts, designs task sequences, employs digital technologies as mediating tools, and provides necessary learning support. Through this analytical structure, the study identifies shared characteristics across the three cases and interprets their educational significance in light of situated learning theory. Methodologically, the study does not focus on technological details per se; rather, it emphasizes how technology is integrated into learning processes, how it shapes children's behavioral patterns, and how it influences the structure of their learning experiences.

Through this research design, the study aims to extract instructive design principles from cross-case comparison and, on this basis, propose a learning-path model for immersive digital resources. This model integrates theory and practice from the four dimensions of context, activity, interaction, and support, offering a set of reference directions for future innovation in museum-based digital education.

4. Case Studies and Analysis

This chapter analyzes three immersive digital resource cases drawn from distinct educational contexts, including historical–cultural displays, science education, and traditional culture–oriented exhibitions. Each case targets children as the primary audience and features clearly articulated educational aims, technological structures, and descriptions of learning activities in publicly available materials. These characteristics make the cases valuable sources for examining how immersive learning pathways can be constructed. Following the analytical structure of "context construction—task structure—interaction mode—support system," this chapter explores the three cases in detail. Visual documentation is incorporated where relevant to illustrate each case's learning characteristics from the perspectives of spatial environment and children's learning behaviors.

4.1 Immersive Historical–Cultural Projects at the British Museum's Samsung Digital Discovery Centre (SDDC)

Since its establishment in 2009, the British Museum's Samsung Digital Discovery Centre (SDDC) has continuously developed a series of children's educational programs centered on digital technologies. Among these initiatives, the "Bronze Age Virtual Reality Experience" and the augmented reality program "A Gift for Athena" stand out as two representative projects in recent years. (Figure 1)

The Bronze Age Virtual Reality Experience, formally launched for schools in 2019, reconstructs a Bronze Age roundhouse through three-dimensional digital modeling. Learners enter the historical environment using virtual reality headsets, observing domestic tools, dwelling structures, and environmental details to gain an intuitive and embodied understanding of ancient life represented by the artifacts. Guided by task prompts, children search for objects, memorize structural features, and engage in verbal expression or peer discussion after completing the experience. The VR environment thus enables learners to explore cultural meaning within a fully sensory and contextually coherent setting.

In contrast, A Gift for Athena relies primarily on augmented reality. Learners use tablet devices in the gallery to scan sculptures from the Parthenon. The image-recognition system displays digital information such as reconstructed patterns, restored colors, or symbolic interpretations, enabling children to examine supplementary content in direct relation to the original artifacts. The activity unfolds step by step through task cards that require learners to complete a series of observation and explanation tasks.

Despite their technological differences, both projects form a learning pathway characterized by "observation — manipulation — interpretation." Through this pathway, digital resources function as mediating tools for cultural understanding, while the structured tasks provide organizational support consistent with the principles of situated learning.

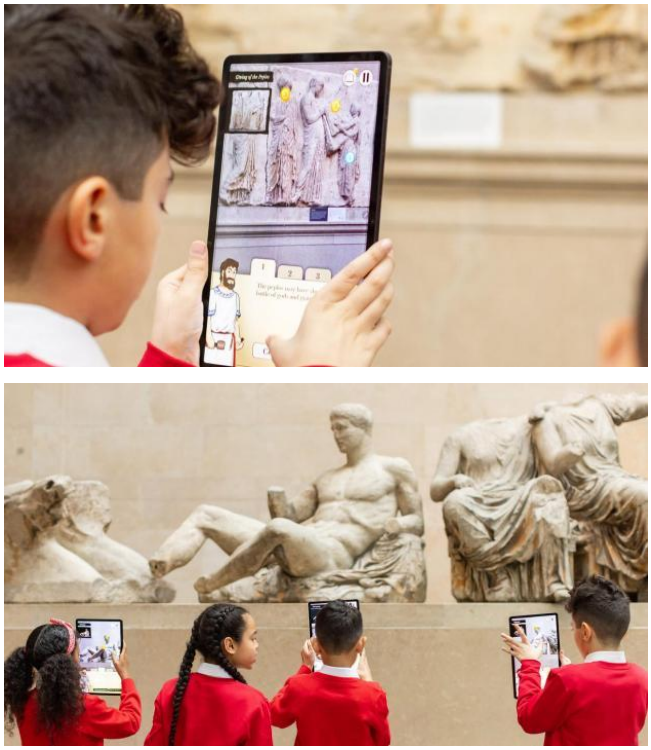

Figure 1: AR learning activity at the British Museum (SDDC)

4.2 Immersive Science Learning Spaces at Science Museum

The Phillip and Patricia Frost Museum of Science makes extensive use of immersive interactive environments to support context-based exploratory learning for children. (Figure 2) Among these environments, the M²L interactive space employs large-scale projection to create walk-in natural ecological scenes in which children can trigger changes — such as animated movements, water ripples, or animal behaviors—through actions such as walking, waving, or touching the floor. A stable causal link is established between children's bodily movements and the digital feedback, enabling learners to naturally grasp the dynamic structure of ecosystems through repeated experimentation and observation. This environment provides clear action pathways while maintaining a high degree of openness, allowing children to develop personalized modes of inquiry according to their own interests.

The museum's AI-themed interactive installations use motion-capture technology to translate children's movements into real-time visual transformations. The system detects actions such as raising hands, rotating the body, or shifting positions, and presents visualized algorithmic responses as immediate feedback. Through continuous adjustment of their actions and comparison of resulting differences, children gradually develop an intuitive understanding of "how the system perceives and responds." This experiential mode of participation reduces the conceptual barriers often associated with abstract technical ideas and introduces technological content into the learning process in a more manipulable and accessible form.

Overall, Frost Science Museum's immersive science education practices emphasize the construction of learning pathways through bodily interaction, environmental responsiveness, and task generation. Whether focused on natural ecosystems or artificial intelligence, these designs enable children to explore, experiment, and reflect independently within context-rich environments, providing effective support for their early understanding of scientific concepts.

Figure 2: Interactive ecology learning space at the Frost Science Museum

4.3 Cultural Narrative–Based Immersive Exhibitions at the Palace Museum Digital Pavilion

The Palace Museum's exploration of digital cultural presentation is exemplified by the "Digital Pavilion of the Hall of Supreme Harmony" series, among which Galloping Through Time: A Digital Art Exhibition on Horse Culture — opened to school groups in 2023—stands out as a representative example of recent immersive cultural education initiatives. (Figure 3) Centered on artifacts, paintings, and decorative patterns related to horses from the museum's collection, the exhibition constructs a visualized cultural context through panoramic digital projection,

animated narrative, and multimedia interaction.

Within the exhibition space, children follow the narrative thread to observe the forms of horse gear across dynasties, the symbolic meanings of patterns, and their associated social implications. Interactive screens allow them to compare structural differences among various motifs. Certain activities incorporate role-based tasks, such as simulating artisans' choices of materials or identifying the origins of decorative designs, enabling participants to understand cultural symbols as they progress through the tasks. Educators facilitate discussions at key moments, guiding learners to articulate their observations and gradually transforming experiential impressions into conceptual understanding.

This form of narrative-driven practice emphasizes modes of presenting cultural knowledge, allowing children to grasp abstract historical information through spatially embedded visual cues that run throughout the immersive environment.

Figure 3: Immersive digital heritage experience at the Palace Museum

4.4 Cross-Case Structural Analysis

A comparison of the three cases reveals notable differences in technological formats, thematic content, and modes of activity organization. However, within the situated learning framework, several shared structural features emerge. First, context construction in all three cases relies on thematic spaces and continuous experiential flows. Whether through historical reconstruction, scientific phenomenon simulation, or cultural storytelling, each environment provides a coherent background that situates learners within a directed activity setting. Second, task structure plays a central role across all cases. Learners are required to progress through sequenced tasks involving observation, interpretation, and expression. The presence of tasks gives directionality to the interactive process, enabling sensory experiences to be transformed into purposeful learning behaviors.

Third, each case incorporates interaction mechanisms supported by multimodal feedback. Visual cues, bodily movement, touch interaction, and device recognition technologies sustain learner agency and allow children to mobilize attention and action in intuitive ways. Fourth, support systems—including educator guidance, peer exchange, or structured output activities—help learners reflect on their experiences and consolidate immersive sensory impressions into conceptual understanding.

From an educational perspective, these projects collectively demonstrate the potential of immersive digital resources to promote children's active participation, guide exploratory behaviors, and support the formation of cultural or scientific understanding. The three cases suggest that the functions of immersive technologies in museum education extend beyond providing sensory stimulation; rather, they operate through an integrated sequence of contextualization, task progression, interaction, and support. This structural process provides the practical foundation for the design pathway proposed in the subsequent chapter.

Table 1: Comparison of Educational Structures and Immersive Features Across Cases

Analytical Dimension	Case1	Case2	Case3
Context Construction	Reconstruction of historical–cultural environments	Simulation of scientific phenomena or systems	Narrative-driven cultural visual space
Task Structure	Observation, comparison, narration	Exploratory actions and feedback-triggering behaviors	Identification, analysis, expression
Interaction Mode	Virtual reality and augmented reality	Motion capture and multi-screen projection	Touch interaction and multimedia narrative
Support System	Educator guidance and task sheets	On-screen prompts and educational explanations	Docent facilitation and organized learning activities
Learning Characteristics	Emphasis on cultural understanding	Emphasis on scientific inquiry	Emphasis on symbol and meaning construction

5. A Situated Learning–Based Design Pathway Model for Immersive Digital Resources

Building on the preceding case analyses, this chapter proposes a design pathway model for immersive digital resources, grounded in the theoretical core of situated learning. The three cases demonstrate that the educational value of immersive technologies does not arise from visual effects alone; rather, it depends on whether they support a coherent learning structure. In other words, learning does not occur within technology by default—it is gradually constructed through the integration of context, tasks, interaction, and support. Accordingly, this chapter presents a model that articulates the internal logic through which immersive digital resources generate learning pathways in museum education.

5.1 The Foundational Role of Context in Immersive Learning: From Perception to Meaning-Making

In immersive learning environments, context serves as the prerequisite for learning mechanisms to operate. The learner's initial entry into the space typically does not begin with

explicit concepts or instructions, but rather with a holistic sensory perception of the environment. Immersive digital resources use sound, light, imagery, and spatial configuration to create a directly experienceable framework of meaning, enabling children to enter knowledge-related situations naturally and without the need for external guidance. The function of context is not to deliver specific information, but to establish an "enterable world" in which learners can engage in a continuous process of perceiving, acting, and understanding.

The significance of immersive context lies in its ability to organize learners' attention and action tendencies in an integrated manner. Visual layers, spatial cues, and dynamic feedback within the environment together form a "perceptible structure" that invites spontaneous exploration, experimentation, and observation. These behaviors are not random reactions induced by technology; rather, they represent the entry point to learning shaped by the action possibilities inherent in the context itself. Situated learning theory emphasizes that meaning emerges through participation in context, and immersive technologies extend this context in perceptible ways that allow the meaning-making process to unfold more directly and concretely.

Furthermore, immersive contexts perform a "conceptual visualization" function by transforming abstract content into perceptible relational structures, enabling learners to acquire an initial framework for understanding at an early stage. Whether dealing with historical, scientific, or cultural themes, context—through the coordinated operation of symbols, spatial configurations, and narrative structures—provides the foundational layer of meaning that supports subsequent task engagement and knowledge development. This progression from holistic perception to differentiated understanding gives the learning process coherence while supporting children's agency and sustained engagement.

Thus, context constitutes both the starting point of immersive learning and the fundamental organizational principle of the entire learning pathway. By constructing a perceptible world, context enables learners to form directional understanding through experience and lays the essential groundwork for subsequent task performance, interactive participation, and reflective integration.

5.2 The Situated Learning Pathway Model: Constructing Knowledge Through Action

In immersive learning, context alone can only provide the starting point for understanding; the substantive unfolding of the learning process depends on how learners act within that context. Action is not an external addition to the environment but the very medium through which the environment becomes intelligible. This principle is evident across all three cases. Whether exploring artifacts in the Bronze Age virtual environment, probing variables in the science interaction space, or identifying symbols within a cultural narrative exhibition, children must engage in a series of organized actions to advance their understanding of the content. Learning does not arise from viewing or from the feeling of immersion itself; rather, it emerges through the progressive advancement of an action chain. Within this process, task sequences provide directionality, enabling learners to construct relationships among observation, comparison, inference, and expression, while interaction mechanisms reinforce attention and reasoning through immediate feedback, transforming simple experience into a process of meaning-making.

The situated learning pathway model is proposed on the basis of these mechanisms. It reveals that immersive digital resources facilitate learning not by displaying content but by organizing learners' actions to generate meaning. Learners first enter the context and form preliminary expectations of meaning through visual symbols, spatial structures, or narrative cues; they then engage in task-guided actions and continuously refine their understanding through interaction-driven feedback; finally, they integrate meaning through expression, discussion, or reflection, allowing experience to be transformed into articulable and conceptualized learning outcomes. Through repeated cycles, learners move back and forth between different levels of understanding, enabling knowledge to deepen progressively through experience.

To clarify this structure, the study constructs a situated learning pathway model for immersive digital resources (Figure 4). The model does not depict a technological workflow but rather outlines the logic of learning, emphasizing how understanding progresses from context to action, from action to integration, and from repeated cycles to stable comprehension.

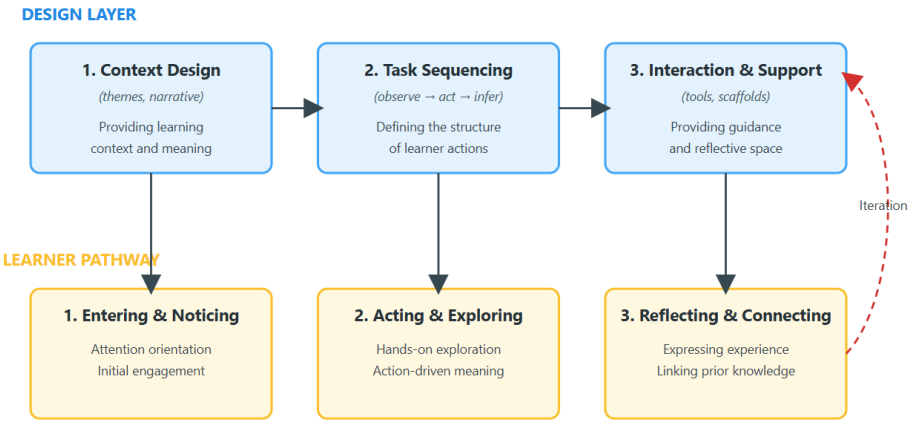

Figure 4: Situated learning pathway for immersive digital resources

5.3 Structural Design Elements: From Constructing Learning Pathways to Constructing Educational Meaning

Having clarified the operational mechanisms of the immersive learning pathway, it is necessary to further examine the structural elements that support and enable this pathway. Immersive learning does not occur spontaneously; it must be constituted through the coordinated functioning of the learning environment, task structure, interaction mode, and support system. The three cases clearly demonstrate this principle. The British Museum's historical–cultural programs transform immersive contexts into learning sites that prompt observation and narration by means of precise spatial reconstruction and task-card design. The children's science museum transforms scientific variables into testable and investigable action fields through motion capture and real-time feedback, allowing learners to form scientific inferences through continuous adjustments of their movements. The Palace Museum Digital Pavilion creates operable narrative nodes within a story-driven visual system, enabling learners to gradually establish symbolic and cultural associations through the observation of visual motifs. These elements form learning structures because they collectively constitute the design logic of immersive educational resources.

The structural design elements of immersive learning are illustrated in Figure 5. The diagram emphasizes that context construction, task chains, interaction mechanisms, and support systems are not four isolated steps but an interconnected and mutually reinforcing system. Context construction provides the starting point of meaning, enabling learners to form direct intuitive connections the moment they enter the environment. Task chains organize the progression of learning so that experiences do not remain at the sensory level. Interaction mechanisms provide the basis for action, allowing learners to obtain feedback through triggering, manipulating, or probing, thereby continuously refining their understanding through action. The support system transforms experiential engagement into expression through guidance, prompts, or discussion, stabilizing the formation of meaning. Together, these four elements determine whether immersive resources can generate effective educational impact in museum settings.

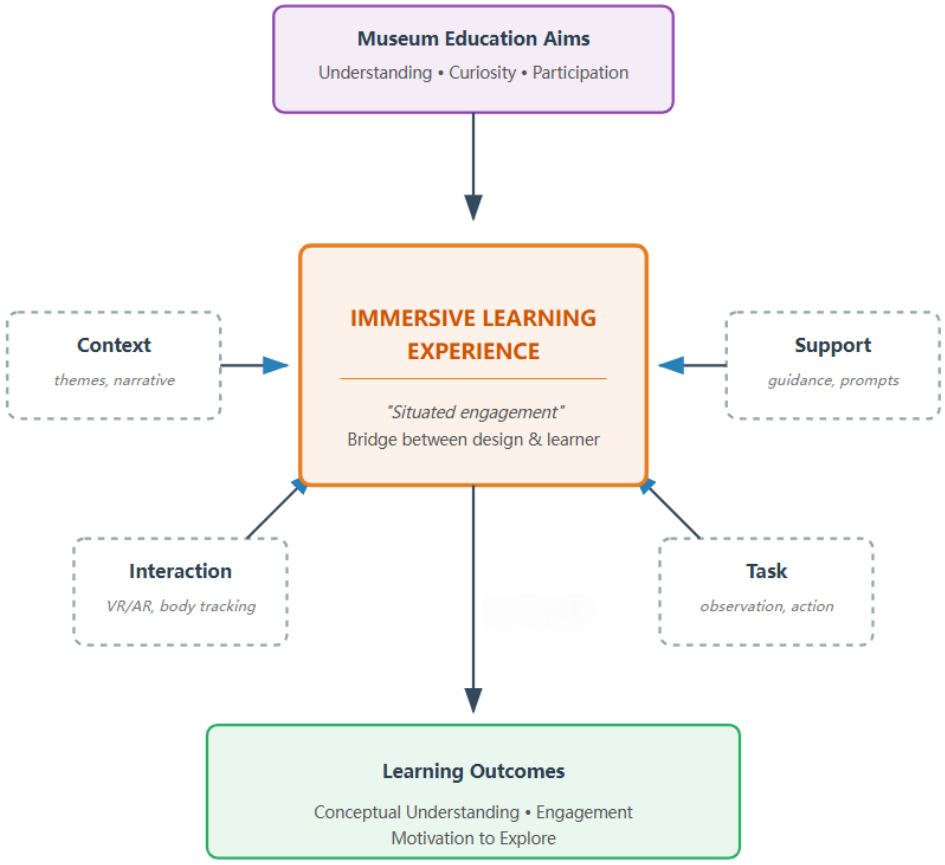

Figure 5: Structural design elements of immersive learning

6. Conclusion

Grounded in situated learning theory, this study examines the development trends and educational needs of immersive digital resources in museum education. Through a systematic analysis of three representative types of immersive display practices and a cross-case comparison, the study identifies the key mechanisms through which immersive learning occurs. The findings show that the educational value of immersive technologies in museums does not arise from visual immersion or technological novelty, but from the integrated structure they construct—namely, an enterable context, actionable tasks, responsive interactions, and reflective support. Within this structure, learners gradually form understanding through a continuous process of perception, action, feedback, and integration, allowing immersive experiences to be transformed into meaningful learning activities.

The situated learning pathway model proposed in this study reveals the logical starting points and developmental patterns of immersive learning, emphasizing that learning must be

grounded in perceivable contexts and supported by organized action chains and interaction mechanisms to enable meaning-making. At the same time, the structural design elements demonstrate that the educational effectiveness of immersive resources depends on the coordination of multiple dimensions rather than the intensification of any single technological component. The integration of context, tasks, interaction, and support not only offers children natural entry points into learning but also provides museums with actionable design strategies for educational resources.

From a practical perspective, this study contributes to guiding museums toward a more clearly defined educational orientation for immersive technologies within the broader landscape of digital transformation. Moving beyond earlier approaches that prioritized the emotional impact of displays, the study highlights the need for immersive resources to function as learning mediators that stimulate inquiry, organize action, and facilitate expression—ultimately supporting learners' knowledge construction and cultural understanding. Future research can further investigate the fine-grained behavioral characteristics of learning within immersive environments and examine, from an evaluative standpoint, how different design strategies influence learning outcomes, thereby advancing the ongoing innovation of museum education in the digital age.

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