

Multisensory engagement and inclusive learning: Exploring the museum experiences of Chinese visually impaired children



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ABSTRACT

Article History

Received: 17 November 2025

Revised: 3 February 2026

Accepted: 24 February 2026

Published: 11 March 2026

Keywords

Engagement

Experiential education

Inclusive museum

Multisensory learning

Visually impaired children

Quasi-experimental design.

The researcher utilized the Multisensory Learning Theory and the Three-Dimensional Engagement Theory to support the methodology of this study, which employed both quantitative and qualitative methods of data collection through a combination of surveys and interviews. The research participant selection process was a purposive sample taken from two specific special educational schools in Fujian Province of China. There were thirty children who were visually impaired who participated in both multisensory exhibitions and conventional exhibitions. Based on the quantitative data collected, there was found to be a very large effect size on all dimensions of comfort, engagement, reinforcement, meaningfulness, and service for the children who attended the multisensory exhibition versus those who attended the traditional exhibition of museum exhibits. The qualitative data revealed that through the use of tactile, auditory, and visual stimuli, the children who attended the multisensory exhibition were afforded much greater emotional security, were more curious, and had a much stronger base for a cognitive understanding of the exhibits. Additionally, through a supportive staff member interaction environment, the children-built confidence and a sense of belonging. It offers practitioners an evidence-based reference for creating inclusive, child-focused educational environments that promote autonomy, confidence, and substantive participation for visually impaired learners.

Contribution/ Originality: This research combines the study of multisensory learning and the theories of engagement to illustrate the transition from accessibility to meaningful learning through multisensory design. It offers empirical support and actionable steps to effectively create emotionally engaging and inclusive museum experiences for visually impaired children.

1. INTRODUCTION

In recent years, museums across the globe have focused on greater inclusivity in education and equitable cultural participation, acknowledging their duty to provide cultural services to all diverse audiences, large and small, including children with disabilities [1]. The post-COVID world has accelerated the global expansion of access and participatory learning for these institutions. Museums worldwide have begun utilizing tactile, auditory, and digital multimodal tools and have developed innovative methods to enhance engagement with visually impaired visitors using all three modalities [2]. In China, this shift in accessibility and participatory learning is aligned with national strategies that foster the creation of quality, equitable, and accessible public cultural services. The 14th 5-Year Plan for the Protection and Development of Persons with Disabilities [3] and the public cultural services quality development

plan particularly encourage museums to develop multisensory access and create opportunities for culturally meaningful participation for children with disabilities. Yet, despite significant progress in this area, many museums across China remain predominantly visually focused, therefore restricting the ability of many visually impaired children to access and experience cultural activities at museums in China.

Multiple research studies show that traditional exhibitions emphasizing visual presentation tend to create numerous barriers, limiting access to interpretive information for individuals with visual impairments, as well as restricting opportunities for active participation in the learning process [4]. These barriers are particularly evident when working with children, as their ability to experience and learn from informal education relies heavily on rich sensory exploration and active emotional involvement. Consequently, children with visual impairments may not have the opportunity or ability to independently or meaningfully experience an exhibition due to the limited availability of tactile materials and a lack of sensory tools for understanding. This limitation hampers their capacity to participate in cultural activities, develop cognitively, and integrate socially.

At the same time, the increasing emphasis on multisensory exhibition design in museums has led several researchers to acknowledge the ability of multisensory exhibition design to improve accessibility, learning, and enjoyment for blind visitors. By integrating touch, sound, and smell into the learning process, multisensory learning theory asserts that the activation of different neural pathways allows both memory recall and understanding to occur more rapidly and effectively than will occur if only one type of neural pathway is activated [5]. Researchers have shown that the inclusion of tactile reproductions of works of art, soundscapes, and spatially located audio in museums has increased cognitive interaction, as well as emotional attachment, to works of art by blind visitors [6]. Researchers studying the impact of using multisensory approaches on the participation of visually impaired children in cultural education have produced new evidence from emerging China, although the number of studies on this subject is limited [7]. In addition, while multisensory experiences are an expanding focus of public discussion surrounding accessibility in museums, the actual effectiveness of multisensory experiences for visually impaired children in the real-world context of Chinese museums has not been sufficiently investigated.

This research study aims to evaluate the impact of multisensory exhibition environments on the experiences of visually impaired children compared to traditional exhibition environments. A quasi-experimental mixed-methods approach was employed to assess how children's verbal, emotional, and cognitive experiences changed after visiting or entering either of two kinds of exhibitions (traditional or multisensory). Additionally, children's own perceptions of the multisensory environment were explored to determine which specific sensory elements they found to be the most valuable or significant.

This study adds to the knowledge base of multisensory learning, as existing research does not capture or document experience as a variable, nor does it provide a direct method for utilizing this model in China. Furthermore, this study contributes to the body of literature on accessibility in museums within China by capturing the multifaceted experience (observable and experiential) of children with visual impairments through the application of quasi-experimental mixed methods research. The findings of this research offer evidence of design strategies that will enhance the potential for inclusion and education of visually impaired children through alignment with the current public cultural service reforms in China. Overall, the contributions made by this study strengthen the body of knowledge related to creating equitable and accessible museum environments that support the rights to culture and education of visually impaired children.

2. LITERATURE REVIEW

2.1. Multisensory Learning Theory

The concept of Multisensory Learning proposes that information presented via more than one sense (i.e., by using sight, sound, touch, movement) results in improved learning [8]. Recent research suggests that when visitors interact with multiple senses, they activate several cognitive systems and develop a better understanding of concepts

and form more intense emotions (for example, when there is little to no visual input). Vikmane et al. [9] found that adding tactile, auditory, and olfactory components allowed those who are blind or who have low vision to have greater intellectual and emotional access to museums. Research also shows that multisensory learning compensates for a lack of visual cues by promoting imagination, memory, and meaning creation. The development of assistive technologies has resulted in new opportunities to utilize multisensory approaches. Tactile models allow blind and visually impaired users to independently discover the object using tactile information while also using multimedia. Multisensory planetariums have recently been built as examples of highly innovative multisensory museums. Varano and Zanella [10], for example, created a planetarium where the presentation of astronomical data is done using tactile representations, spatial audio, and vibration. Their research demonstrated that non-visual channels were capable of transmitting information and communicated successfully when there was a very high level of abstraction. Eardley et al. [11] propose that instead of relying solely on visual models, museums should acknowledge the legitimacy of an articulated multisensory support system as a way to enhance interpretation and education using multisensory methods.

Furthermore, researchers indicate that multisensory methods assist with individuals' ability to engage socially. Collaborative efforts between museums and blind communities are being promoted through several forms of multisensory experiences, including tactile models, sound-enhanced storytelling, and live-action events [12]. Augmented reality (AR) also provides evidence that digitally simulating multisensory experiences may increase levels of interest and understanding for museum visitors [13]. This research supports cognitive theories that state that visually impaired children can build spatial awareness and conceptual coherence through their tactile and aural experiences. Investigations into special education have shown that providing children with opportunities to explore their environment using touch and movement-based experiences enhances their concept formation and communication abilities [14]. Material engagement theories assert that by manipulating physical objects, learners can express their thoughts in ways that build their cognitive structures through touch [15]. Since visually impaired children use touch and hearing as their primary means of processing environmental stimuli, multisensory experiences provide a solid theoretical basis for structuring a museum experience that includes a range of sensory entry points.

The development of a multisensory exhibition and interpretations related to children's understanding of and reactions to sound, tactile, and interpretive audio components were informed by the theory of Multisensory Learning. The use of these theories enables us to evaluate the impact of sound, tactile models, and audio components on cognitive processing, as well as on the overall experience of children who have visual impairments.

2.2. Three-Dimensional Engagement Theory

The theory of engagement is a multidimensional framework that encompasses three primary elements: the three types of engagement (behavioral, emotional, and cognitive). Engagement theory has been widely applied and informs the evaluation of how learners interact with their educational experiences, whether formally or informally. Recent research into museums and how people participate in interactive learning through museums suggests that all three dimensions should be measured together. The behaviors of visitors allow us to identify if they are participating in self-directed learning at the museum [16] or interacting with their environment, while also measuring how emotional and cognitive engagement lead to sustained focus and create deeper and richer meaning in immersive environments [17]. Cognitive engagement is defined by mental effort, reflective thought, and making sense of or connecting new information to previously held knowledge; Xu et al. [18] found that as visitors used holographic displays, they exhibited high levels of both emotional and cognitive engagement, which significantly influenced their overall engagement levels.

The impact of inclusion studies on the visitor experience of those who are disabled is also emphasized through the use of experience. Though museums typically focus on providing physical access for persons with disabilities, they tend to overlook the emotional and cognitive participation of these visitors when focusing only on physical access

[11]. For example, Lee et al. [19] provided evidence that, through the use of sensitive cues and inclusive sensory design, the emotional interpretation of a piece of art increases the cognitive understanding of that piece. Evidence from the visually impaired community has shown that engagement is derived from two sources: through the act of engaging with the item or artwork, as well as through a sense of social and emotional safety and support in the learning experience [20]. Within the Chinese context, Qi and He [21] indicated that many museum exhibits do not contain enough interactivity for diverse groups of visitors to be fully engaged. In addition, a study conducted by Shao and Meng [22] showed that both emotional resonance and cognitive involvement are necessary to produce effective museum-based learning outcomes for children. Therefore, the current study uses the Three-Dimensional Engagement Theory to assess the responses of visually impaired children to traditional versus multisensory exhibitions.

3. METHODOLOGY

3.1. Research Design

In order to investigate how multisensory museum exhibits affect the experiences of visually impaired children in Fujian Province, China, this study utilized a quasi-experimental, mixed-methods design. A combination of qualitative and quantitative approaches provided the necessary numerical and contextual data as evidence of this change [23].

3.2. Participants and Sampling

Thirty children aged between 6 and 12 who are visually impaired were selected from two schools located in Fujian Province (Xiamen Special Education School and Fuzhou School for the Blind). Children were selected purposefully; utilizing purposive sampling allowed researchers to select a group of participants who best represent various levels of visual impairment. Additionally, purposive sampling enabled the researcher to select a group of participants that contained the most information regarding the research objectives; thus, this method provided deeper insight into particular characteristics and experiences of the group [24]. Each child experienced a museum visit within the past year; therefore, the children could relate their experience to the exhibition context used in the study. Inclusion criteria for study participants included (a) a formal diagnosis of visual impairment from the local educational authority, (b) adequate comprehension and communication skills, and (c) written consent from the parent or guardian of the child. Children with other disabilities that may have affected the experimental activities were excluded from the study. To ensure safety and comfort for the participants, a parent, guardian, or teacher accompanied each participant during the experiment.

3.3. Experimental Setting and Materials

The experimental phase took place at the Xiamen Science and Technology Museum in Fujian Province, a public institution with experience in inclusive, tactile exhibitions. Two forms of exhibition were organized.

3.3.1. Traditional Exhibition (Pre-test Condition)

A conventional display with visual information as the main interpretive mode, providing limited tactile or auditory input. This represents the typical experience available to the public.

3.3.2. Multisensory Exhibition (Pos-Test Condition)

a. Auditory: Ambient sound (the sound of sea, waves, and seabirds), voice narration (background introduction of the porcelain exhibition of the "Wan Jiao No.1" shipwreck), and touch-triggered sound (the user makes a sound after touching the display board, button, or object).

b. Tactile: 3D-printed replicas, textured models (highlight the patterns of porcelain), and touch-sensitive navigation aids.

- c. Olfactory: Ocean-related scent.
- d. Spatial accessibility: Braille labels, large-font signage, and directional floor paths.
- e. service support: Personalised guidance from trained staff.

To ensure accessibility, the environment included tactile floor paths, audio navigation cues, braille signage, and assistive staff support. Before each session, the research team conducted safety checks and pre-briefings to orient participants to the space and procedures.

3.4. Instruments and Measures

In order to gather data for the project, two research tools were used. A questionnaire was employed to collect quantifiable data on the perceived changes in how participants felt by attending exhibits and the effects of being exposed to exhibits. A semi-structured interview method was used to collect qualitative data on the effects of exposure on the individuals' experience by allowing us to ask open-ended questions.

3.4.1. Exhibition Assessment Questionnaire for Visually Impaired Children

This assessment tool's methodology is the combination of the key performance indicators (KPIs) [25] that were defined in the framework for assessing excellence in exhibitions [24], along with the use of several theoretical constructs introduced by Fredricks et al. [26], which pertain to the behavioural, emotional, and cognitive engagements of the participants. This instrument has a total of 38 individual items, which can be grouped into five different dimensions. All five dimensions correspond to significant aspects of the overall experience for visually impaired children visiting an exhibition.

a. Comfortable (12 items)

The comfort aspects of the evaluation focus on how easy it is for visitors to navigate the exhibit space and find the exhibits. The comfort aspects of the exhibit include determining whether visitors were physically comfortable while visiting the exhibit and where they could find exhibits easily. Additionally, the comfort aspects also take into account the sensory environment of the exhibit, including the use of lighting, sound, and how the layout of the exhibit space affects a visitor's ability to explore independently, such as the amount of background noise that is considered distracting and whether tactile paths and rails assist with assisting a visitor to navigate independently.

b. Engaging (10 items)

The engaging dimension of the experience assesses participants' levels of interest, attention, and motivation to engage with the exhibit. This dimension evaluates whether the multisensory features of the exhibit engaged visitors, encouraging them to explore and remain curious about what they viewed in the exhibition. Questions asked of children included the extent to which they liked to touch exhibits, listen to sounds associated with the exhibits, and engage in guided activities with staff members associated with the exhibits.

c. Reinforcing (5 items)

Dimensions that include reinforcement are whether those participating felt they were able to enhance their understanding of what the exhibit was trying to communicate, as well as where they would find the new information to be relatable to themselves or their studies within the classroom.

d. Meaningful (5 items)

The meaningful dimension of the museum experience relates to how participants experience the exhibition emotionally or reflectively. This dimension assesses whether participants found the exhibition to be inspirational and emotionally or intellectually engaging. Several questions were asked of the participants, including whether the exhibition generated feelings of curiosity, empathy, and/or connection (i.e., cultural heritage).

e. Service (6 items)

This study includes an additional dimension of Service as a contributor to an individual's environment and therefore the ability to access a collection. Human interaction and institutionally offered assistance are critical

considerations in a person being able to access their collection. The quality of help a visitor receives from museum staff is also documented through Service, as is how well they provide information to visitors about the collection and how accommodating they are. Survey questions included asking participants if the staff provided good directions, gave them verbal descriptions of exhibits, or assisted them in finding their way through the exhibit area.

A 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) was used as a rating tool for the study. To support the needs of the study and accommodate participants' sensory requirements, a tactile scoring card system was created with a texture gradient from smooth to rough (1 - 7), which was used in conjunction with auditory tone cues. The researcher provided a read-aloud of each question to assist with understanding, and parents confirmed answers when required. The questionnaire had a Cronbach's $\alpha = 0.86$ for the overall reliability concerning internal consistency across all dimensions. The subscale reliabilities ranged from 0.74 (Comfortable) to 0.88 (Engaging), indicating acceptable levels of stability [27]. Content validity was established through expert review by museum educators and special education professionals. Exploratory factor analysis supported the five-dimensional factor structure for construct validity.

3.4.2. Semi-Structured Interviews

The eight participants who completed the questionnaire after the multisensory exhibition also took part in follow-up semi-structured interviews to explore their thoughts about the exhibition in greater detail. The duration of all interviews was approximately thirty to forty-five minutes and was conducted in private and comfortable environments. Interview guides contained various types of open-ended questions, e.g., Which of your senses helped you best to understand the exhibit? And what differences do you perceive regarding your experience on this visit compared to your first visit? Recordings of interviews (all with the subject's consent) were transcribed verbatim. The combination of qualitative data from interviews and quantitative data from the research study presented in [28] provides a good contextual framework for interpreting patterns and changes in participant response.

3.5. Procedure

Instead of using separate control and experimental groups, this study used a cohort of children with visual impairment and assessed their engagement in both traditional (Zone C) and multisensory (Zone B) exhibit environments. The study was based on a flowchart shown in Figure 1. The first phase of this study consisted of each child's individual visit to the traditional exhibit (Zone C). After a period of one week to allow for any memory distortion or carryover effects to diminish, participants A, B, and C returned to Zone A (the traditional exhibit) to complete the participant questionnaire. Each participant's visit (Zone B and Zone C) and total length of stay at each zone were documented by event staff trained in documenting the visits and length of stays at each zone.

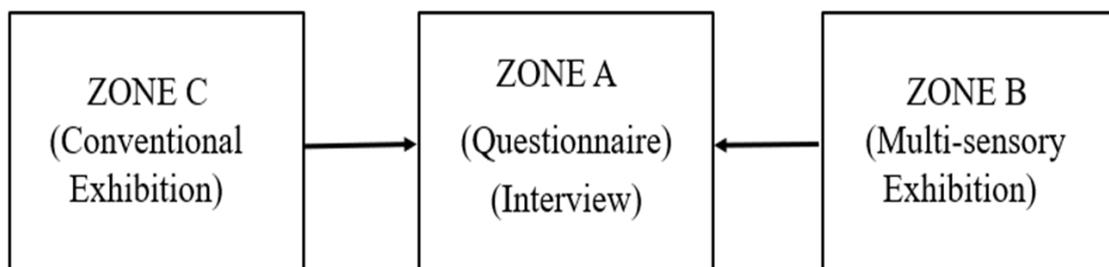


Figure 1. Experimental flowchart in the study.

3.6. Data Analysis

The questionnaire responses were subjected to statistical analysis using SPSS Software version 28.0. Each dimension of the questionnaire was assessed by means of descriptive statistics. To determine whether multisensory design enhances a person's overall experience, we used the paired-sample t-test to compare the scores for pre- and

post-tests, along with calculating the effect size (Cohen's d) to quantify the magnitude of change in participants' scores from pre-test to post-test [29]. In addition to quantitative analysis, we also performed thematic analysis of the qualitative data [30] from the interviews using the NVivo program, Version 12. NVivo facilitated both inductive and deductive coding approaches, as specified in the tripartite engagement framework. The reliability of the coding process was established by having both researchers independently code the transcripts, then compare their respective codes and reconcile any differences, resulting in an inter-coder reliability coefficient of 0.87. Furthermore, triangulation was employed by comparing themes from the interview transcripts with the quantitative results and observational notes to enhance the validity of the study findings.

4. RESULT

4.1. Quantitative Analysis

The multisensory exhibit, as shown in Figure 2, received consistently higher scores across the ten assessment categories than the regular exhibit, indicating a better experience for visitors. In the comfort category, there was a statistically significant difference between the multisensory exhibit (M=5.74) and the traditional exhibit (M=4.75), signifying that participants who viewed the multisensory exhibit rated it as providing a higher level of comfort than those who viewed the traditional exhibit. For the engagement category, the multisensory exhibit also had the highest average rating across all ten categories (M=5.96) compared to the traditional exhibit, which had a lower average rating (M=4.87). These results suggest that multisensory exhibits utilizing both tactile and audio sensory modalities facilitate greater engagement levels and interest among children than traditional exhibits. The reinforcement category measures how effectively the exhibit helps to connect or solidify new learning, and the multisensory exhibit scored much higher (M=5.67) than the regular exhibition (M=4.64). Regarding the meaningful category, which assesses the personal connection between an individual and the exhibit, the multisensory exhibit received an average rating of 5.86, whereas the regular format received an average rating of 5.05. Since sensory input can influence how a person interprets the material in an exhibit, creating more connections between sensory input and an individual's interpretation may increase emotional attachment and foster a deeper appreciation for the exhibit's content. Similarly, in terms of service, the multisensory exhibit received an average score of 5.81, while the traditional exhibition scored 5.35. Both scored fairly high; however, due to greater consistency in providing exhibit materials and staff prepared to engage with the public through multimodal interaction, the multisensory exhibition offered a superior service experience for visitors compared to the traditional exhibits.

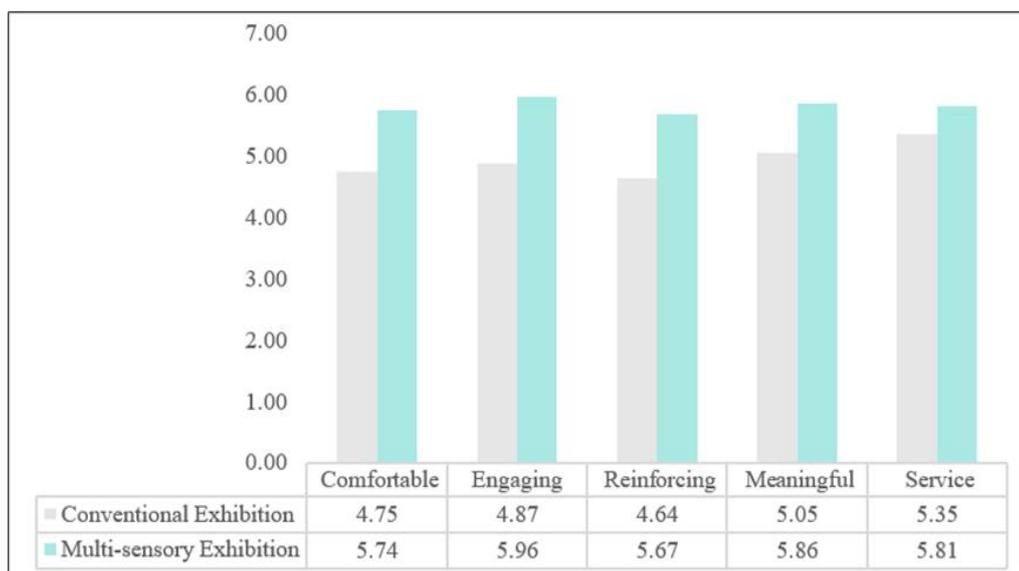


Figure 2. The comparison of multisensory experiences in different museum exhibitions.

To determine whether the multisensory exhibit provided participants with an improved experience relative to the traditional methods used in the exhibits, a series of paired sample t-tests were conducted (refer to Table 1 for the results). The results of all dimensions analyzed were significantly higher than traditional methods at $p < 0.001$; this indicates that the multisensory exhibit positively enhanced the museum experience for children with vision impairment. More specifically, the participants were statistically more comfortable interacting with the multisensory exhibit than with the traditional exhibit. Statistically speaking, the level of comfort experienced by participants was found to be statistically significant using the t statistic ($t(29) = -8.40$; $p < 0.001$; Cohen's $d = 1.53$). Additionally, the large effect size of Cohen's $d = 1.53$ indicates that the use of touch and improved spatial design provided effective methods of addressing the discomfort and uncertainty encountered during exploration.

The engagement dimension experienced significant improvements ($t(29) = -6.09$, $p < 0.001$, $d = 1.11$). Thus, multisensory cues are more effective in capturing children's attention than traditional visual displays. Furthermore, there were substantial increases in reinforcement scores following the multisensory experience ($t(29) = -5.80$, $p < 0.001$, $d = 1.06$). Therefore, it can be concluded that multimodal inputs facilitated the consolidation of knowledge and the integration of new concepts into previously learned material, supporting the cognitive engagement dimension. For meaningful participants, the Multisensory Exhibition received a significantly higher rating than for non-meaningful participants ($t(29) = -4.77$, $p < 0.001$, $d = 0.87$). Although this effect size is smaller than that observed in other dimensions, it still represents a large effect size. This indicates that multisensory interaction increased emotional resonance and personal significance of the visit. The final results showed that Service Ratings also significantly improved ($t(29) = -5.54$, $p < 0.001$, $d = 1.01$). This effect size suggests that staff communication, accessibility assistance, and interpretive guidance were perceived as more responsive and supportive under the multisensory condition.

Table 1. Paired samples test between the conventional exhibition and the multi-sensory exhibition.

	Mean	95% confidence interval of the difference		t	Sig. (2-tailed)	Cohen's d
		Lower	Upper			
Comfortable	-0.988	-1.229	-0.748	-8.396	0.000	1.53
Engaging	-1.092	-1.459	-0.725	-6.093	0.000	1.11
Reinforcing	-1.033	-1.397	-0.668	-5.795	0.000	1.06
Meaningful	-0.811	-1.160	-0.463	-4.766	0.000	0.87
Service	-0.464	-0.636	-0.293	-5.536	0.000	1.01

4.2. Qualitative Analysis

Table 2 shows that qualitative and quantitative data provide a more comprehensive understanding of the multisensory exhibit as experienced and interpreted by children with visual impairment than either type of data alone. The analysis of the interview transcripts produced five major themes that together indicate that the multisensory design provided participants with both an increased opportunity to experience the multisensory exhibition through their senses and an increased emotional, mental, and physical engagement in the exhibition.

Multisensory exhibits create a comfortable and confident atmosphere for children, and they feel less dependent on external aides when navigating the exhibit. This is due to several factors, including the use of tactile maps, audio signals regarding their position within the exhibit, and touchable textures that help to differentiate their location within the exhibit from everything else. Participants were able to establish their own mental map of the exhibit prior to hearing audio information regarding the location of the items exhibited, allowing them to feel more comfortable traversing the exhibit on their own.

Table 2. Thematic analysis of interview responses from visually impaired children.

Themes	Subthemes	Selected statements
Comfort and accessibility	Spatial orientation and tactile assurance	<p>“When I touched the model first, I could picture where things were. I didn’t feel lost like before.” (P3)</p> <p>“The sound that guided us between zones made me feel safe walking on my own.” (P6)</p> <p>“The tactile map helped me know which way to go; it was like a guide for my hands.” (P7)</p>
Engagement and curiosity	Active sensory exploration	<p>“I liked that I could touch and hear at the same time, it made me want to know more.” (P5)</p> <p>“I kept going back to the tactile map because it was fun figuring out the shapes.” (P8)</p> <p>“I tried to guess what the sound was before the guide explained, it was like a game.” (P3)</p> <p>“I even asked to replay the sound part twice, I wanted to hear it again.” (P4)</p>
	Sustained attention and emotional involvement	<p>“In the old exhibition, I listened for a bit and got bored. But here, every object made a new sound or story.” (P2)</p> <p>“I felt excited each time the guide played a new sound. I wanted to guess what it was before she said it.” (P7)</p> <p>“The smells and sounds kept changing, so I didn’t lose interest.” (P6)</p> <p>“When the sound of rain came, I closed my eyes and felt like I was inside the story.” (P5)</p>
	Deepened comprehension through multimodal cues	<p>“I understood more because I could feel and hear together, it made the idea clearer.” (P2)</p> <p>“Before, I just listened. Now I could imagine how it looked.” (P6)</p> <p>“When I touched the dragon scales and heard its sound, I understood why people say dragons are powerful.” (P1)</p> <p>“Hearing the guide’s voice while touching helped me picture things better in my mind.” (P7)</p>
Meaningful and personal connection	Emotional resonance and self-expression	<p>“It felt like the museum wanted me there. I could ‘see’ in my own way.” (P1)</p> <p>“I liked that I could tell my own story about what I heard and touched.” (P6)</p> <p>“When I finished exploring, I felt proud. I could explain things to my classmates.” (P3)</p> <p>“The exhibit made me feel I could be part of the world others see.” (P4)</p>
	Cultural and imaginative engagement	<p>“When I smelled the incense, I thought of the temples near my home; it made me feel proud.” (P6)</p> <p>“The tactile dragon was my favorite; I imagined it flying while I touched the scales.” (P5)</p>
Service and interaction support	Responsive staff and guided dialogue	<p>“The staff explained things clearly and waited for me to finish touching before talking.” (P3)</p> <p>“I felt respected, they didn’t rush or treat me like I needed extra help.” (P2)</p> <p>“They asked what I felt instead of just telling me facts.” (P4)</p>
	Inclusive atmosphere and peer interaction	<p>“We shared what we guessed from the sounds; it felt like teamwork.” (P8)</p> <p>“The volunteers asked what I thought instead of telling me everything, which made me confident.” (P6)</p> <p>“My friend and I compared what we imagined from the same sound, it was fun.” (P1)</p> <p>“Everyone was laughing and guessing together; it didn’t feel like a ‘special’ group.” (P7)</p>

According to interview responses, the utilization of multisensory elements resulted in a combination of enduring engagement and emotional connection with the attendees of the exhibits. Numerous children indicated that the use of audible, olfactory, and tactile inputs encouraged continued exploration of the exhibits. The active and interactive nature of the installations enabled visitors to focus their attention for extended periods and gave participants the

chance to engage directly with the installation while they were there. Compared to typical exhibits, which generally produce a rapid decrease in visitor interest, the multisensory environment provided children with enhanced excitement and internal motivation to explore and increased their level of emotional involvement with the installation. Many children indicated that the ability to hear animal sounds and interact with geological models helped them remember information previously learned, and that auditory and tactile stimulation provided a simultaneous means for them to develop a greater understanding of conceptual abstractions. Combining tactile and auditory stimulation enabled children to better remember previously learned information and allowed them to develop a better understanding of conceptual abstractions.

Multiple sensory presentations also helped to foster an emotional and cultural bond that is very important for many users. For example, some of the children who attended the exhibit related particular sensory experiences with their own memories and cultural backgrounds, which ultimately helped them feel more culturally connected to the exhibit and, therefore, more at home. Culturally specific sensory design was validated through this experience. Additionally, participants stated that the positive social experiences they had during the event were major contributors to how attendees experienced the exhibit. Supportive behaviors from staff members enhanced attendees' confidence and sense of belonging to the exhibition. Children also described how they participated in collaborative experiences with their classmates and staff members, such as discussing sound and texture, which helped foster a feeling of inclusion.

5. DISCUSSION

There was clear evidence from this study that multisensory exhibitions improved the experiences of children with visual impairments significantly. The quantitative analysis confirmed findings that indicated a considerable improvement across all five areas of experience examined in this study. Furthermore, an analysis of the qualitative data showed how tactile, auditory, and olfactory information influenced children's thoughts, feelings, and cognitions towards museums.

To start, the incorporation of multiple senses into an exhibition enhanced improvements in educational achievement, as it helped activate embodied and multimodal thinking processes that allowed individuals to create meaning through integrated sensory stimuli (not just through language). When many different kinds of sensory input combine to produce an experience (i.e., touch, sound, etc.), then that experience leads to a more profound and longer-lasting understanding because when several different types of sensory inputs are used together, they activate various brain pathways associated with memory and comprehension [8, 9, 31]. Children's descriptions of being able to learn more comprehensively through the combined tactile and auditory experiences illustrated this concept. In this way, the tactile and auditory aspects helped translate abstract concepts into tangible understanding [15, 32]. Ultimately, the multisensory space was not only helpful for children's learning, but it also created a level playing field for children with visual impairments and gave them similar opportunities to access deeper concepts as did their sighted peers.

Participants in this study experienced increased emotional and behavioral engagement because of the emotional resonance and empowerment of their sensory experiences. The Three-Dimensional Engagement Theory [16, 17] explains how continued active engagement can only occur through emotional engagement and perceived self-control of one's experiences. Additionally, the multisensory component of the children's exploration, using tactile and spatial audio elements, increased the overall knowledge of the exhibit space while lowering anxiety and increasing curiosity. This supports the idea that when museums can remove all visual stimuli, they create empowerment for visitors rather than limiting access [11]. Creating an emotionally safe space for children builds internal motivation. The novelty of their sensory system will help maintain attention, but through the excitement and confidence expressed by these children, emotional engagement is not just an afterthought; it is a fundamental part of what these audiences with visual impairment learn. It can also be noted that [16] believes the emotional investment created by an audience's

ability to recreate their environment will enhance the audience's capacity to demonstrate perseverance and progress their exploration into productive learning activities.

The articles ultimately clarify that the multisensory inclusion of technology and design created by human interactions has an important role [33] in this area. Qi and He [21] have further stated that inclusive learning environments rely on the ability of facilitators and participants to communicate empathetically rather than through technical means, hence the recognition of accessibility through dialogue. The staff members' abilities to provide time, patience, and interactive knowledge magnify the effects of the sensory design because they allow children to feel respected and competent. Collectively, these observations indicate that the success of multisensory exhibitions depends equally on the design of the multisensory environment and on their ability to provide inclusive learning environments that foster emotionally connected and socially engaged learning ecosystems.

6. CONCLUSIONS

This research investigated the impact of sensory museums on the experiences of preschool-aged children with visual disabilities by utilizing Multisensory Learning Theory in conjunction with the 3-dimensional Engagement Theory. Outcomes of quantitative data analysis indicated that each measure of improvement was statistically significant among all dimensions; qualitative findings provided valuable insight into the influence of sensory design (e.g., lighting, colour, sound) and social engagement on improving the ability of students with disabilities to be included and have access to learning opportunities.

6.1. Theoretical Implications

The current research confirmed the role of multisensory experiences in not only providing information but also enabling the development of cognitive images, emotional connections, and cultural meanings simultaneously with those experiences. Children were able to grasp and retain concepts through both tactile and auditory experiences, demonstrating a connection between cognition and perception through physical interaction. Additionally, the results show that all three types of engagement reinforce one another. For example, children who feel safe and are interested in what they are learning tend to explore more vigorously and understand more thoroughly. This supports the notion that motivation and meaning develop together [16]. By illustrating how sensory learning builds experiences, this research integrates multisensory theories and engagement theory.

6.2. Practical Implications

Based on the above study, it is clear that inclusive design for museums must incorporate all of the senses of users, as well as opportunities for interaction with humans, as well as the exhibits themselves. Inclusive design provides an opportunity to improve museum exhibits for all visitors through the use of tactile models, spatial sound, and scent. All visitors will feel more comfortable and confident in their own unique way. By integrating these aspects into an inclusive design, museums will create a shared experience of accessibility, rather than an isolated service. Museums should also consider the involvement of visually impaired individuals in the development and testing of exhibit designs, as recommended by Eardley et al. [11]. Collaborative design processes lead to not only improved access but also greater emotional involvement and engagement in the co-creation process.

6.3. Limitations and Future Research

There are a few limitations to our research. Initially, the number of children who participated was limited to the number of children who visited just one museum, making it difficult to generalize our findings beyond that museum. The conclusion of this study would need to be expanded to include more children's museums, as well as children with visual disabilities from multiple locations. Secondly, the methods of collecting information from participants were predominantly through interviews and observations, thus reflecting personal opinion rather than being objective. To

obtain more accurate results, additional methods of collecting data from children should be utilized, such as through technology or behavior. In addition, we did not study how many times the children benefitted from multisensory learning when using it over time; thus, we will require additional studies to determine how long the benefits of multisensory learning remain and how it affects the children's self-confidence and long-term knowledge. With these limitations in mind, our research provides a solid base for enhancing accessible designs for museums and indicates that multisensory learning will continue to influence research and applied practice moving forward.

Funding: This study received no specific financial support.

Institutional Review Board Statement: This study was approved by the Institutional Review Board of Sanming University, China, under protocol number [IRB No. 20250811], dated May 6, 2025. Informed verbal consent was obtained from all participants, and all data were anonymized to protect participant confidentiality.

Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

Competing Interests: The authors declare that they have no competing interests.

Authors' Contributions: Both authors contributed equally to the conception and design of the study. Both authors have read and agreed to the published version of the manuscript.

Disclosure of AI Use: The author(s) used OpenAI's ChatGPT (4o) to polish and enhance the readability of the manuscript. All outputs were reviewed and verified by the authors.

REFERENCES

- [1] O. Abd El Wareath, "The role of educational museums in the development of education," *International Journal of Humanities and Language Research*, vol. 5, no. 1, pp. 36-48, 2022.
- [2] R. Vaz, D. Freitas, and A. Coelho, "Blind and visually impaired visitors' experiences in museums: Increasing accessibility through assistive technologies," *The International Journal of the Inclusive Museum*, vol. 13, no. 2, pp. 57-80, 2020. <https://doi.org/10.18848/1835-2014/cgp/v13i02/57-80>
- [3] State Council of China, "The 14th Five-Year plan for the protection and development of persons with disabilities," Retrieved: https://www.gov.cn/zhengce/zhengceku/2021-07/21/content_5626391.htm. 2022.
- [4] P. Vasilakou, S. Mineiko, T. M. Hasioti, Z. Gavriilidou, and A. Drigas, "The accessibility of visually impaired people to museums and art through ICTs," *Technium Social Sciences Journal*, vol. 35, pp. 263-284, 2022.
- [5] U. Noppeney, "Perceptual inference, learning, and attention in a multisensory world," *Annual Review of Neuroscience*, vol. 44, no. 1, pp. 449-473, 2021. <https://doi.org/10.1146/annurev-neuro-100120-085519>
- [6] C. Chen, N. Murray, and C. Keighrey, "The design of an interactive multisensory 2.5D virtual reality art exhibit for individuals with visual impairments," in *Proceedings of the 1st International Workshop on Multi-Sensorial Media and Applications*, 2025, pp. 86-92.
- [7] Z. Y. Zhang and L. Q. Ye, "Design of museum literary creation products based on multi-sensory experience," *Packaging Engineering*, vol. 42, no. 18, pp. 368-373, 2021.
- [8] S. M. Chit, K. M. Yap, and A. Ahmad, "Multi-sensory learning framework for visually impaired learners: Use of 3D, haptic, audio, olfactory media," *Multimedia Tools and Applications*, vol. 83, no. 34, pp. 81711-81723, 2024. <https://doi.org/10.1007/s11042-024-18249-1>
- [9] E. Vikmane, M. Ņikitina, L. Brutāne, and L. K. Cērpa, "Multisensory approach to museum accessibility and experience enhancement," *Culture Crossroads*, vol. 25, pp. 21-32, 2024. <https://doi.org/10.55877/cc.vol25.503>
- [10] S. Varano and A. Zanella, "Design and evaluation of a multi-sensory representation of scientific data," *Frontiers in Education*, vol. 8, p. 1082249, 2023. <https://doi.org/10.3389/educ.2023.1082249>
- [11] A. F. Eardley, H. Thompson, A. Fineman, R. Hutchinson, L. Bywood, and M. Cock, "Devisualizing the museum: From access to inclusion," *Journal of Museum Education*, vol. 47, no. 2, pp. 150-165, 2022. <https://doi.org/10.1080/10598650.2022.2077067>

- [12] M. Butler, A. Tang, E. R. Blom, S. K. Kane, and J. Borchers, "A gallery in my hand: A multi-exhibition investigation of accessible and inclusive gallery experiences for blind and low vision visitors," in *Proceedings of the 25th International ACM SIGACCESS Conference on Computers and Accessibility*, 2023.
- [13] A. Cheng, W. Zhang, A. Feng, Y. Wu, and W. Li, "Exploring psychological dimensions of augmented reality in education: A study on learning motivation and achievement in museums," *Frontiers in Psychology*, vol. 16, p. 1514117, 2025. <https://doi.org/10.3389/fpsyg.2025.1514117>
- [14] S. May, K. Todd, S. G. Daley, and G. Rappolt-Schlichtmann, "Measurement of science museum visitors' emotional experiences at exhibits designed to encourage productive struggle," *Curator: The Museum Journal*, vol. 65, no. 1, pp. 161-185, 2022. <https://doi.org/10.1111/cura.12449>
- [15] C. Groth and M. S. Gulliksen, *Thinking through hands in education. In Embodied Learning and Teaching Using the 4E Cognition Approach*. London, UK: Routledge, 2024, pp. 83–92.
- [16] D. Lewalter, K. Neubauer, and S. Moser, "Self-regulated STEM learning in museums—the role of learner characteristics and visit-related activities in school," *International Journal of STEM Education*, vol. 12, no. 1, p. 56, 2025. <https://doi.org/10.1186/s40594-025-00577-9>
- [17] P. Ariya, N. Wongwan, P. Worrugin, K. Intawong, and K. Puritat, "Immersive realities in museums: Evaluating the impact of VR, VR360, and MR on visitor presence, engagement and motivation," *Virtual Reality*, vol. 29, no. 3, p. 117, 2025. <https://doi.org/10.1007/s10055-025-01201-5>
- [18] Z. Xu, D. Sun, G. Xia, and S. Wang, "Exploring emotional and cognitive engagement with holographic displays in museums," *ACM Journal on Computing and Cultural Heritage*, vol. 18, no. 3, pp. 1–24, 2025. <https://doi.org/10.1145/3736772>
- [19] J. H. Lee, C. Hwang, J. Huh, and J. Kim, "Development of sensory-friendly inclusive design based on sensory integration theory," *The Design Journal*, vol. 28, no. 3, pp. 413–431, 2025. <https://doi.org/10.1080/14606925.2025.2461927>
- [20] Q. Zhang, "Interactive multi-sensory environment (iMSE) design to support social engagement for visually impaired (VI) children in China," in *Proceedings of the 23rd Annual ACM Interaction Design and Children Conference*, 2024, pp. 980–983.
- [21] J. Qi and M. He, "Museum exhibition interactivity and visitor participation: The missing emotional-cognitive-behavioral engagement," *Journal of Humanities and Social Sciences*, vol. 1, no. 8, pp. 238–250, 2025.
- [22] Y. Shao and F. Meng, "Teaching and learning mechanism of museum study tourism: A situated cognition perspective," *Journal of Chinese Ecotourism*, vol. 13, no. 3, pp. 494–509, 2023.
- [23] J. W. Creswell and P. V. L. Clark, *Designing and conducting mixed methods research*, 3rd ed. Thousand Oaks, CA: SAGE Publications, 2018.
- [24] O. Tajik, J. Golzar, and S. Noor, "Purposive sampling," *International Journal of Education and Learning Studies*, vol. 2, no. 2, pp. 1–9, 2024.
- [25] K. S. Rice, "Judging exhibitions: A framework for assessing excellence (Serrell)," *Museum Anthropology Review*, vol. 2, no. 1, pp. 44–46, 2008.
- [26] J. A. Fredricks, P. C. Blumenfeld, and A. H. Paris, "School engagement: Potential of the concept, state of the evidence," *Review of Educational Research*, vol. 74, no. 1, pp. 59–109, 2004. <https://doi.org/10.3102/00346543074001059>
- [27] J. F. Hair, Jr., M. Sarstedt, C. M. Ringle, and S. P. Gudergan, *Advanced issues in partial least squares structural equation modeling*. Thousand Oaks, CA: SAGE Publications, 2017.
- [28] S. P. Chand, "Methods of data collection in qualitative research: Interviews, focus groups, observations, and document analysis," *Advances in Educational Research and Evaluation*, vol. 6, no. 1, pp. 303–317, 2025. <https://doi.org/10.25082/AERE.2025.01.001>
- [29] J. Cohen, *Statistical power analysis for the behavioral sciences*, 2nd ed. Hillsdale, NJ: Lawrence Erlbaum, 1988.
- [30] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology*, vol. 3, no. 2, pp. 77–101, 2006. <https://doi.org/10.1191/1478088706qp063oa>

- [31] W. Singer, "Recurrent dynamics in the cerebral cortex: Integration of sensory evidence with stored knowledge," *Proceedings of the National Academy of Sciences*, vol. 118, no. 33, p. e2101043118, 2021. <https://doi.org/10.1073/pnas.2101043118>
- [32] A. K. Bhowmik, "Virtual and augmented reality: Human sensory-perceptual requirements and trends for immersive spatial computing experiences," *Journal of the Society for Information Display*, vol. 32, no. 8, pp. 605-646, 2024. <https://doi.org/10.1002/jsid.2001>
- [33] M. Gori, S. Price, F. N. Newell, N. Berthouze, and G. Volpe, "Multisensory perception and learning: Linking pedagogy, psychophysics, and human-computer interaction," *Multisensory Research*, vol. 35, no. 4, pp. 335-366, 2022. <https://doi.org/10.1163/22134808-bja10072>

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