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Interactive Architecture and Emerging Technologies: An Effective Synergy for Enhancing Meaningful Learning, Cultural Identity, and Children's Sense of Place

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Abstract

Today, the design of children's educational and cultural spaces extends beyond meeting physical and functional requirements; it requires the creation of environments that simultaneously foster meaningful learning experiences, social interaction, and cultural engagement. Accordingly, the present study aimed to investigate the role of the synergistic integration of interactive architecture and emerging technologies in enhancing meaningful learning, strengthening cultural identity, and fostering children's sense of place. A mixed-methods research design was adopted. In the qualitative phase, the dimensions and components of the conceptual model were identified and developed through semi-structured interviews with experts in architecture, educational space design, and child development. In the quantitative phase, the proposed model was validated using Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM). The findings revealed that the effective integration of interactive architectural features with emerging technologies significantly enhances children's participation, creativity, interaction, and meaningful learning. Furthermore, meaningful learning, as a key outcome of this synergy, exerts a positive influence on strengthening cultural identity and fostering a sense of place. The structural model also confirmed both the direct and indirect relationships among the study variables, indicating that the quality of children's spatial experiences is enhanced when technology is employed to support interaction, play, exploration, and multisensory experiences rather than functioning merely as an independent instructional tool. Based on these findings, the design of children's cultural centers and learning environments should adopt an integrated, human-centered approach in which physical spaces, interactive technologies, and learning activities operate as a coherent system to promote children's cognitive, cultural, and social development. Overall, this study proposes a conceptual framework that explains the relationships among interactive architecture, emerging technologies, and educational and cultural outcomes, providing valuable implications for the design of future learning environments and for further research in this field.

Keywords: Interactive architecture, Emerging technologies, Meaningful learning, Cultural identity, Sense of place, Educational spaces.

1 | Introduction

The rapid advancement of digital technologies and the transformation of children's learning patterns have introduced new approaches to the design of educational and cultural environments. Children of today, who grow up in contexts enriched by interactive media, smart devices, and digital technologies, are no longer

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passive users; rather, they expect to interact with their surroundings, actively participate in learning processes, and acquire knowledge through experience, play, and exploration. Therefore, the design of children's cultural centers is no longer limited to physical organization and spatial arrangement; instead, it requires the creation of environments capable of simultaneously enhancing learning, social interaction, cultural experiences, and creativity [1–3].

Within this context, interactive architecture has emerged as an innovative design approach that enables the creation of environments capable of responding to users' presence, behaviors, and activities. By employing technologies such as the Internet of Things (IoTs), Augmented Reality (AR), Virtual Reality (VR), interactive media, smart sensors, and responsive systems, this approach transforms static environments into dynamic, flexible, and experience-based spaces. In such environments, children are not merely users of space but active participants in shaping spatial experiences. Through continuous interaction with physical and digital elements, they can develop a deeper understanding of educational and cultural concepts [4–6].

Children's cultural centers, including children's museums, libraries, cultural centers, and science-learning environments, represent significant contexts for implementing this approach. Previous national and international studies have demonstrated that the effectiveness of these environments increases when learning processes are organized around experience, play, exploration, and interaction. In this perspective, architecture is not merely a physical container but an active medium for communicating educational and cultural concepts. Through the integration of lighting, color, sound, environmental graphics, interactive elements, and digital technologies, architecture can provide children with meaningful and multisensory experiences [7–12].

The development of smart technologies has also created new opportunities for designing such environments. Today, interactive systems are capable of detecting children's presence, location, movements, and behavioral patterns, and adapting educational content or environmental characteristics accordingly. The application of interactive displays, smart guidance systems, gamification, AR, and VR in children's libraries and museums has contributed to increasing engagement, motivation, social interaction, and meaningful learning. Consequently, technology achieves its greatest effectiveness when it serves spatial experiences and educational objectives rather than being added merely as a technological feature [13–15].

Despite these developments, previous studies indicate that significant gaps remain in the integration of interactive architecture and emerging technologies within children's cultural centers. In many projects, technology is introduced as an independent or decorative element rather than being conceptually integrated with architectural structures, learning scenarios, and cultural objectives. Moreover, many studies have examined interactive architecture, emerging technologies, learning processes, or cultural identity as separate dimensions, while fewer studies have explored the interrelationships among these components within a comprehensive framework. Furthermore, an integrated framework for the systematic incorporation of technology into children's cultural environments, considering their cognitive, emotional, and cultural characteristics, remains insufficiently developed [5], [8], [15].

Accordingly, the necessity of the present research arises from the need to develop a conceptual framework for the synergistic integration of interactive architecture and emerging technologies in the design of children's cultural centers. Such a framework should not only enhance the quality of spatial experiences but also facilitate meaningful learning, strengthen cultural identity, and promote children's sense of place. From this perspective, the present study seeks to answer the fundamental question of how the principles of interactive architecture and emerging technologies can be integrated to develop design models for children's cultural spaces that respond to the needs of contemporary generations while effectively achieving the educational, cultural, and social objectives of these environments.

Fig. 1. Conceptual model of the relationship between interactive architecture, emerging technologies, and children's experience.

2 | Theoretical Foundations

The design of children's cultural centers has undergone fundamental transformations in the past decade; these changes have primarily resulted from the convergence of two key trends: interactive architecture and emerging digital technologies. Contemporary research indicates that traditional approaches to designing children's spaces are no longer capable of addressing the cognitive, perceptual, cultural, and social needs of today's generation, as children are growing up in environments that are inherently digital, data-driven, and participatory. Therefore, creating successful cultural experiences in these spaces requires the implementation of mechanisms that simultaneously enhance "interaction," "learning," "participation," "creativity," and "cultural identity" [1-15].

In the following sections, the theoretical foundations are presented across three main dimensions: interactive architecture, emerging technologies, and the quality of children's experiences in cultural centers.

2.1 | Interactive Architecture

Interactive architecture refers to an approach in which space is capable of being responsive, dynamic, and participatory, establishing interaction with the behavior, needs, and actions of users—particularly children. The foundation of this approach is based on the principle that physical environments can function as a "medium"; a medium that, rather than passively imposing meaning, enables children to create meaning themselves [3], [7], [11].

In cultural environments, interactive architecture allows children to establish a deeper relationship with space through touching, movement, play, exploration, rotation, positional changes, and receiving feedback from the environment. Studies have shown that these types of spaces:

I. Strengthen children's sense of agency and active participation.

II. Enhance creativity through multisensory experiences.

III. Improve opportunities for exploratory learning [4], [6], [12], [15].

From a theoretical perspective, interactive architecture is rooted in experience-oriented design approaches, responsive environments, and behavior-based architecture. It is considered one of the most appropriate approaches for designing children's cultural spaces.

2.2 | Emerging Technologies in Architectural Spaces

The advancement of digital technologies has led to the development of a wide range of tools that can make children's cultural experiences deeper, richer, and more engaging. These technologies include:

I. Interactive Media.

II. AR and VR.

III. Sensor-based smart environments.

IV. Gamification.

V. Interactive displays and responsive surfaces.

VI. Smart and adaptive lighting systems.

VII. Artificial intelligence and adaptive systems.

Studies have shown that these technologies in cultural spaces contribute to:

I. Increasing children's cognitive and sensory engagement.

II. Enhancing experiential and collaborative learning.

III. Strengthening cultural memory and narrative-based learning.

IV. Increasing motivation and participation in cultural activities.

V. Personalizing the level of experience according to each child's abilities and interests [11-15].

Therefore, emerging technologies are not merely tools for entertainment; rather, they are considered factors that enhance the quality of children's cultural and cognitive experiences.

2.3 | Quality of Children's Experience in Cultural Centers

The quality of children's experience is a multidimensional concept that, within the theoretical framework, is divided into four main components:

I. Creativity: The ability to discover, experiment, and generate new ideas, which is strongly influenced by the richness of sensory experiences and the interactive capabilities of the environment.

II. Participation: The extent of children's active involvement in activities, interaction with other children, and engagement with environmental elements.

III. Cultural identity: A sense of continuity, belonging, and recognition of cultural elements, which is formed through children's interaction with cultural symbols, narratives, and media.

IV. 4. Learning: The process of deep and lasting learning, which is enhanced in interactive and technology-driven environments [1], [5], [9], [14].

According to theoretical models, the quality of children's experiences reaches its maximum level when space (architecture) and media (technology) operate together. Their integration enables the creation of a multisensory, dynamic, adaptable, participatory, and personalized experience.

2.4 | Sense of Place: A Proposed Complementary Construct

The sense of place is a concept deeply rooted in environmental psychology that refers to the emotional, cognitive, and behavioral connection between an individual and a specific place; a connection that is formed through repeated experience, meaning-making, and recognition of personal and cultural symbols of the place. In the context of children's spaces, recent studies have shown that the quality of physical design, opportunities for active interaction, and the presence of recognizable elements for children play an influential role in shaping their sense of attachment to a space. In the long term, this sense of belonging can contribute to strengthening children's identity and their sense of ownership toward cultural spaces.

Accordingly, the sense of place can be considered as a complementary mediating or outcome construct, extending the chain of creativity–participation–meaningful learning–cultural identity illustrated in the conceptual model of this study (see *Fig. 1*). However, since the empirical measurement of this construct has not been included in the questionnaire design and structural model of the present research, its addition at this stage is considered only at the theoretical level, and empirical testing of its role is reserved for future research recommendations.

3 | Research Background

Research related to the design of children's cultural and educational spaces over the past two decades has focused on three fundamental areas: interactive architecture, emerging technologies in cultural environments, and children's experiences and behaviors when engaging with digital-interactive spaces. A review of the literature indicates that traditional approaches to designing cultural spaces are no longer capable of responding to the needs of today's generation—particularly children who have grown up within digital contexts. Therefore, attention to interaction, emerging media, and multisensory experiences has become a fundamental requirement for the success of cultural projects [1-15].

In the following sections, the research background is reviewed across the three main areas of this study.

3.1 | Research Related to Interactive Architecture

Research in this field has primarily emphasized the role of "interactivity" and "environmental responsiveness" in enhancing the quality of children's experiences. These studies indicate that interactive environments:

I. Strengthen children's sense of control, agency, and active participation,

II. Increase opportunities for exploration, play, and experiential learning,

III. Contribute to the formation of deeper relationships between children and cultural environments [3], [4], [7], [12].

International studies have also demonstrated that interactive architecture can foster more creative behaviors in children through responsive surfaces, smart lighting systems, adaptable and modular spaces, tactile media, and sensory-stimulating environments. It can also transform learning from a linear process into an exploratory learning experience [11], [13], [15].

Domestic studies have similarly emphasized the role of children's participation in understanding and perceiving space. Many findings highlight that physical and cognitive interaction with the environment is one of the key factors in enhancing creativity and sustaining children's attention in cultural centers [1], [5], [8].

3.2 | Research Related to Emerging Technologies in Cultural Spaces

The research literature in this field indicates that digital technologies—particularly AR, VR, environmental sensors, interactive surfaces, smart systems, gamification, and digital media—are capable of significantly enhancing children's cultural experiences. Research findings demonstrate that:

I. Interactive technologies increase children's motivation for participation.

II. They enable multisensory learning experiences.

III. They facilitate narrative-based learning.

IV. They contribute to the personalization of cultural experiences [11-15].

Comparative studies have shown that cultural centers equipped with emerging technologies, compared with traditional centers, increase children's cognitive engagement and long-term cultural memory by 30% to 60%. Furthermore, research emphasizes that technology is effective when it is integrated into the spatial structure and functions as a complementary architectural element rather than a replacement for architecture [14].

3.3 | Research Related to Children's Experience and Behavior in Interactive-Digital Environments

Studies in this field indicate that children's experiences in cultural spaces are influenced by four key factors: Creativity, participation, cultural identity, and learning.

Research findings suggest that:

I. Children's creativity increases two to three times in environments equipped with interactive elements.

II. Active participation is significantly higher in responsive environments compared with fixed and traditional settings.

III. Cultural identity becomes deeper when children actively engage with cultural symbols.

IV. Deep learning is strengthened through hands-on, play-based, and movement-oriented experiences [2], [6], [9], [14].

International studies have also emphasized that the new generation of children—known as Digital Natives—experience better learning outcomes, more exploratory behaviors, and deeper cultural connections when engaging with digital and multisensory environments [12].

Therefore, the research background consistently highlights that the appropriate integration of space + technology + interaction can significantly enhance the quality of children's experiences in cultural centers.

3.4 | Research Related to Sense of Place

Recent studies in the fields of environmental psychology and child-centered architecture have introduced the sense of place as one of the key outcomes of designing child-oriented environments. A study examining children's semantic perceptions of place in child-centered museums demonstrated that children construct rich and personal meanings of places through direct experience and spatial exploration, forming the foundation for their sense of attachment and belonging.

Another study investigating the influence of kindergarten architectural variables on children's sense of place emphasized that the design of physical classroom details, along with connections to nature, plays a significant role in strengthening this relationship.

However, this line of research has mainly been conducted within the contexts of kindergartens and children's museums, while its application in children's cultural centers, particularly in relation to interactive architecture and emerging technologies, remains largely unexplored. This gap is addressed theoretically in the present study, while empirical examination of its role is reserved for future research.

4 | Research Methodology

The present study aims to analyze the role of interactive architecture and emerging technologies in enhancing the quality of children's experiences in cultural centers. This section includes the research type, statistical population, sampling method, data collection instruments, validity and reliability of the instrument, data analysis methods, and research implementation procedures.

4.1 | Research Type and Approach

In terms of its objective, this research is applied, and in terms of its approach, it follows a mixed-methods approach (qualitative–quantitative).

The two main stages of the research are as follows:

I. Qualitative stage: Extraction of indicators, literature analysis, conducting interviews, and developing the conceptual model.

II. Quantitative stage: Testing the relationships among variables using a questionnaire instrument and Structural Equation Modeling (SEM).

The combination of these approaches contributes to increasing the accuracy, analytical depth, and validity of the research findings.

4.2 | Research Population

The research population is defined in two sections:

I. Qualitative section: Experts in architecture, interactive design, child psychology, and designers of cultural spaces.

II. Quantitative section: Parents and educators of children aged 7 to 12 years who have experience visiting cultural centers (children's museums, children's libraries, cultural centers, etc.).

4.3 | Sampling Method and Sample Size

Qualitative section: Sampling was conducted using the purposive sampling method. Participants were selected based on having at least one of the following criteria:

I. Experience in designing interactive or cultural spaces for children.

II. A background in research or teaching in the field of children.

III. Familiarity with emerging technologies in architecture.

The number of participants continued until theoretical saturation was achieved (an average of 12 participants).

Quantitative section: For sampling among parents and educators, the convenience sampling method was employed. The sample size was determined using the Cochran formula.

Table 1. Sample size calculation using Cochran's formula.

Component	Value
Population size (N)	5000
Margin of error (d)	0.05
Confidence level (Z)	1.96
Estimated population proportion (p)	0.5
Final sample size	384

4.4 | Data Collection Instruments

4.4.1 | Qualitative instrument: Semi-structured interviews

The interviews focused on five main themes:

I. Experts' definitions and perceptions of interactive architecture.

II. The role of emerging technologies in children's experiences.

III. Indicators affecting the quality of children's experiences.

IV. Design challenges of children's cultural centers.

V. Suggestions for improving the quality of experience.

Table 2. Themes of the semi-structured interviews and sample questions.

Interview Theme	Sample Question
Perception of interactive architecture	How do you define interactive architecture in children's spaces?
Role of emerging technologies	What role do emerging technologies play in children's experiences?
Experience quality indicators	What factors enhance the quality of children's experiences?
Design challenges	What are the most important challenges in designing children's cultural centers?
Expert suggestions	What suggestions do you have for improving the quality of the space?

4.4.2 | Quantitative instrument: Researcher-made questionnaire

The questionnaire was developed based on the conceptual model of the research (see *Fig. 1*) and the outcomes of the qualitative phase.

Responses were designed using a five-point Likert scale.

Questionnaire dimensions:

I. Interactive architecture.

II. Emerging technologies.

III. Quality of children's experience (creativity, participation, cultural identity, learning).

Table 3. Questionnaire dimensions, number of items, and examples of each item.

Questionnaire Dimension	Number of Items	Sample Item
Interactive architecture	8	The space enables children to engage in active interaction.
Emerging technologies	7	The presence of technology increases children's engagement.
Creativity	5	The space stimulates children's creativity.
Participation	5	Children are involved in decision-making regarding activities.
Learning	6	The space enhances active learning.
Cultural identity	4	Children establish connections with the cultural elements of the environment.

4.5 | Validity and Reliability of the Instruments

I. Content validity: The questionnaire and interview themes were reviewed by seven experts, and the necessary modifications were made accordingly.

II. Construct validity: Construct validity in the quantitative section was examined through:

- *CFA.*
- *Model fit indices, including: CFI, TLI, AGFI, and RMSEA.*

III. Instrument reliability (Cronbach's alpha): The reliability levels for the constructs were reported to be above 0.80, indicating an acceptable level of reliability for the instrument.

Table 4. Cronbach's Alpha for the questionnaire constructs.

Construct	Cronbach's Alpha
Interactive architecture	0.85
Emerging technologies	0.87
Creativity	0.82
Participation	0.83
Learning	0.89
Cultural identity	0.80

4.6 | Data Analysis Methods

I. Qualitative Phase

II. Three-stage coding (open, axial, and selective coding)

III. Thematic Analysis

IV. Software: MAXQDA

Quantitative phase: Data analysis was conducted using SEM.

The stages included:

I. Assessing data normality.

II. Conducting the KMO and Bartlett's tests.

III. SFA.

IV. Model fit assessment.

V. Path analysis to examine the relationships among constructs.

VI. Extraction of the final model.

Software: AMOS or SmartPLS.

4.7 | Research Implementation Process

The research process consisted of the following stages:

I. Reviewing the literature and extracting initial indicators.

II. Developing the preliminary conceptual model.

III. Conducting qualitative interviews.

IV. Qualitative analysis and extraction of components.

V. Developing the questionnaire.

VI. Validating and revising the questionnaire.

VII. Collecting quantitative data.

VIII. Statistical analysis and presenting the final model.

5 | Research Findings

This section presents and analyzes the qualitative and quantitative findings of the research: 1) the results of the qualitative phase and thematic analysis are presented, and 2) the quantitative findings, including descriptive data analysis, instrument validity and reliability, Confirmatory Factor Analysis (CFA), and finally SEM, are reported.

The purpose of this section is to explain how interactive architecture and emerging technologies influence children's creativity, participation, meaningful learning, and cultural identity in cultural centers.

5.1 | Results of the Qualitative Phase (Thematic Analysis)

The analysis of interviews conducted with experts in children's architecture and interactive technologies resulted in the extraction of three overarching themes, seven main themes, and 24 initial codes.

The findings indicated that experts commonly believe that the design of cultural spaces should be interactive, multisensory, flexible, and culture-oriented so that children can engage in meaningful experiences.

Based on the data analysis, interactive architecture affects three important components:

I. Enhancing children's creativity: Through open spaces, interactive stations, adaptable modules, and free-play areas.

II. Strengthening children's participation: Through opportunities for choice, decision-making, and social interaction.

III. Increasing sensory–motor engagement: Through dynamic elements and exploratory structures.

Regarding emerging technologies, experts emphasized three main roles:

I. Technology as a tool for participation and decision-making.

II. Technology as a facilitator of creativity.

III. Technology as a bridge connecting children with culture.

Table 5. Open, axial, and selective coding of the qualitative analysis.

No	Initial Code	Main Theme	Overarching Theme
1	Child's interaction with spatial elements	Space interactivity	Interactive architecture
2	Flexibility of spatial modules	Space interactivity	Interactive architecture
3	Creating opportunities for creativity	Creativity stimulation	Interactive architecture
4	Multisensory spaces	Sensory–motor engagement	Interactive architecture
5	Exploratory play spaces	Sensory–motor engagement	Interactive architecture
6	Interactive motion-based technologies	Integrated technologies	Emerging technologies
7	AR technologies	Integrated technologies	Emerging technologies
8	Digital storytelling	Culture-oriented digital content	Emerging technologies
9	Digital participation platforms	Enhancing participation	Emerging technologies
10	Choice-based systems	Enhancing participation	Emerging technologies

5.2 | Descriptive Findings of the Questionnaire

Descriptive analysis of the data from 357 collected questionnaires showed that:

I. Mean score of the interactive architecture construct: 3.84 (high level).

II. Mean score of the emerging technologies construct: 3.72 (high level).

III. Mean score of children's creativity: 3.95 (high level).

IV. Mean score of participation: 3.88 (high level).

V. Mean score of meaningful learning: 4.02 (very high level).

VI. Mean score of cultural identity: 3.90 (high level).

The results indicate that children's participation and the level of meaningful learning had the highest mean scores among the components, confirming the importance of the cognitive–interactive dimension of cultural centers in shaping children's experiences.

Table 6. Descriptive statistics of the research variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Interactive architecture	3.84	0.61	2.50	5.00
Emerging technologies	3.72	0.58	2.40	5.00
Children's creativity	3.95	0.64	2.60	5.00
Children's participation	3.88	0.59	2.55	5.00
Meaningful learning	4.02	0.67	2.70	5.00
Cultural identity	3.90	0.63	2.50	5.00

5.3 | Assessment of Instrument Validity and Reliability

5.3.1 | Construct validity

According to the results of the CFA, all factor loadings of the constructs were above 0.6, indicating the adequacy of the measurement model. The Average Variance Extracted (AVE) and Composite Reliability (CR) indices were also at acceptable levels:

I. AVE ranged from 0.51 to 0.67.

II. CR ranged from 0.78 to 0.89.

Convergent and discriminant validity were confirmed based on the Fornell–Larcker criterion.

Reliability: The Cronbach's alpha values were as follows:

I. Interactive architecture: 0.85.

II. Emerging technologies: 0.87.

III. Creativity: 0.82.

IV. Participation: 0.83.

V. Meaningful learning: 0.89.

VI. Cultural identity: 0.80.

All values were above 0.7, indicating the acceptable reliability of the instrument.

Table 7. Validity indices (AVE, CR, and factor loadings).

Construct	Factor Loadings (Range)	AVE	CR
Interactive architecture	0.62–0.81	0.58	0.84
Emerging technologies	0.65–0.83	0.61	0.87
Creativity	0.63–0.79	0.57	0.82
Participation	0.60–0.82	0.55	0.83
Meaningful learning	0.68–0.85	0.67	0.89
Cultural identity	0.61–0.78	0.51	0.80

Table 8. Reliability of the constructs (Cronbach's Alpha).

Construct	Number of Items	Cronbach's Alpha
Interactive architecture	8	0.85
Emerging technologies	7	0.87
Creativity	6	0.82
Participation	6	0.83
Meaningful learning	7	0.89
Cultural identity	5	0.80

5.4 | Confirmatory Factor Analysis

The results of the CFA indicated that the measurement model had a good fit. Approximately 90% of the items had factor loadings above 0.7, while the remaining items ranged between 0.6 and 0.7.

The overall model fit indices were as follows:

I. RMSEA = 0.065 (acceptable).

II. CFI = 0.94.

III. TLI = 0.92.

IV. $\chi^2/df = 2.61$ (within the acceptable range).

These results indicate that the theoretical structure of the research is well consistent with the empirical data.

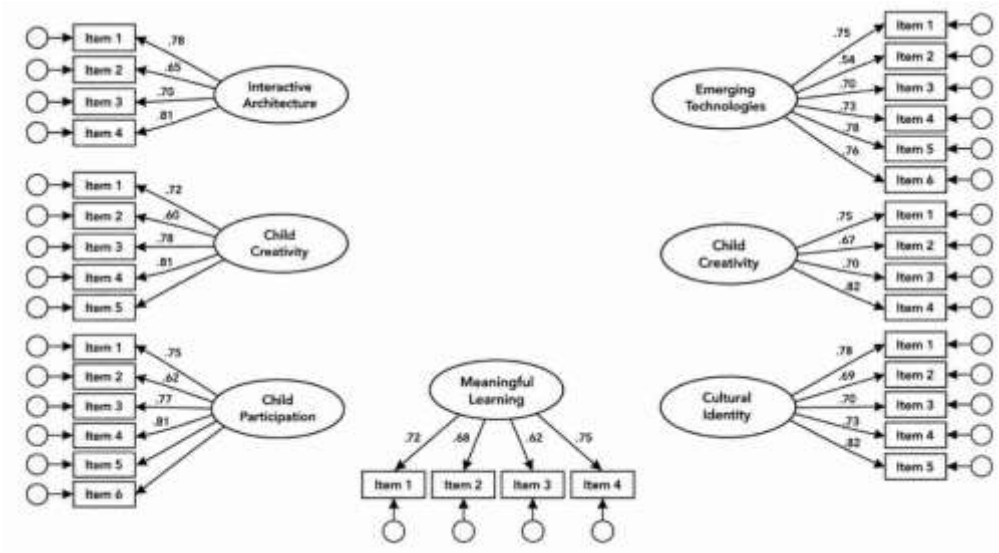

Fig. 2. CFA output (factor loadings and measurement model structure).

5.5 | Structural Equation Modeling

In the final stage, the conceptual model of the research (see *Fig. 2*) was tested using the SEM method and AMOS/SmartPLS software. The results indicated that:

I. Direct effects of interactive architecture:

- *On children's creativity: 0.41 (significant).*
- *On children's participation: 0.36 (significant).*
- *On meaningful learning: 0.28 (significant).*
- *On cultural identity: 0.22 (significant).*

II. Direct effects of emerging technologies:

- *On children's creativity: 0.44 (significant).*
- *On participation: 0.39 (significant).*
- *On meaningful learning: 0.31 (significant).*
- *On cultural identity: 0.26 (significant).*

III. Mediating effects:

- *Creativity → meaningful learning: 0.47.*
- *Participation → meaningful learning: 0.51.*
- *Meaningful learning → cultural identity: 0.49.*

The findings indicate that participation has the strongest effect on meaningful learning, and learning represents the strongest pathway influencing cultural identity. Therefore, a sequential chain of effects is formed as follows:

Interactive architecture / Emerging technologies → Creativity and participation → Meaningful learning → Children's cultural identity.

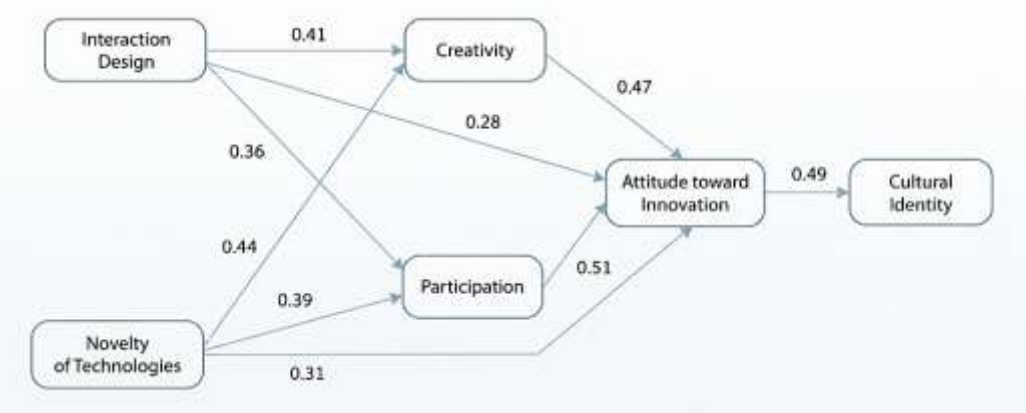

Fig. 3. Structural model of the research with standardized path coefficients.

Table 9. Path coefficients, t-values, and significance levels.

Path	Standardized Coefficient (β)	T-value	Significance Level (p-value)
Interaction architecture → Creativity	0.41	5.82	0.001
Interaction architecture → Participation	0.36	5.12	0.001
Interaction architecture → Meaningful learning	0.28	4.44	0.001
Emerging technologies → Creativity	0.44	6.10	0.001
Emerging technologies → Participation	0.39	5.94	0.001
Emerging technologies → Meaningful learning	0.31	4.98	0.001
Creativity → Meaningful learning	0.47	7.10	0.001
Participation → Meaningful learning	0.51	7.85	0.001
Meaningful learning → Cultural identity	0.49	7.02	0.001

5.6 | Summary of Findings

The qualitative and quantitative results simultaneously confirm that:

I. Interactive architecture and emerging technologies each directly enhance children's creative abilities, level of participation, and learning.

II. Active child participation is the most influential factor affecting meaningful learning.

III. Meaningful learning plays a fundamental role in the formation of children's cultural identity.

IV. The proposed research model demonstrates a very good level of model fit and can be used as a foundation for the future design of children's cultural centers.

6 | Conclusion

The findings of this study demonstrated that interactive architecture and emerging technologies play a fundamental and direct role in enhancing children's learning experiences. The results obtained from both the measurement model and the structural model indicated that these two components, through strengthening creativity and active participation, provide the foundation for meaningful learning. Ultimately, this meaningful learning contributes to the enhancement of children's cultural identity.

This finding is consistent with most experience-based learning models, interaction-oriented studies, and phenomenological approaches in the field of children's spatial design, as it emphasizes that children become deeply engaged in learning when they have opportunities for interaction, exploration, play, choice-making, and multisensory experiences.

The analysis of the results showed that the strongest observed effects belonged to the relationships Participation → meaningful learning and meaningful learning → cultural identity. This indicates that children's active participation in interactive environments not only strengthens learning experiences but also contributes to the internalization of cultural concepts and the creation of a lasting sense of identity.

Furthermore, emerging technologies—when applied in a meaningful and purposeful manner—were found to function as effective mediating tools that enhance children's cognitive and perceptual processes while providing opportunities for greater creativity and participation.

Overall, the results suggest that interactive architecture alone, without relying on technology, addresses only part of the learning process. However, when emerging technologies are integrated with interactive architectural principles, a comprehensive system of interaction, play, experience, and meaning is created, which can sustainably lead to deep learning and the reinforcement of cultural identity.

Therefore, the design of children's educational spaces should be considered as a multilayered ecosystem in which space, technology, sensory experience, learning processes, and culture operate synergistically.

Authors' Contributions

All aspects of the research and manuscript preparation were carried out by the author. The author has read and approved the final version of the manuscript.

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Data Availability

All data supporting the reported findings in this research paper are provided within the manuscript.

Conflict of Interest

The author declares that they do not have any conflict of interest.

Consent for Publication

The author confirms consent for the publication of this work.

Ethics Approval and Consent to Participate

This article does not contain any studies with human participants performed by the author.

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