

From Embodied Perception to Spatial Construction: Design and Practice of an Open-Source Spatial Education Curriculum at Taichung Green Museumbrary

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Abstract

In response to the pervasive lack of spatial literacy education in Taiwan and the uneven geographic distribution of cultural resources, this study examines the pedagogical mechanisms of an open-source spatial education curriculum designed around the Taichung Green Museumbrary—a landmark hybrid institution designed by the architecture firm SANAA. Adopting a Design-Based Research (DBR) framework, the project develops an adaptable, open-source curriculum package structurally aligned with the principles of Open Educational Resources (OER). The curriculum synthesizes two primary modalities: a situated sensory promenade based on Le Corbusier's concept of the architectural promenade, followed by a hands-on architectural design workshop. The guided spatial walk-through transforms SANAA's fluid and transparent architectural codes into primary school students' intuitive bodily awareness and embodied perception. Subsequently, modularized learning templates function as an interactive scaffolding, supporting students in transforming transient sensory experiences into coherent three-dimensional spatial compositions. Learning outcomes evaluated through the Generic Learning Outcomes (GLOs) framework reveal substantial advancements across spatial scale cognition, high-order design thinking, and critical social reflexivity concerning the publicness and inclusivity of civic spheres. The findings validate that lowering specialized professional barriers through open educational materials establishes a highly scalable pathway for art institutions to promote cultural equity, transformative museum learning, and democratic citizenship.

Keywords: spatial education, open educational resources, spatial walk-through, museum learning, meaning-making

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Introduction

Contemporary museums have evolved from repositories of cultural objects into dynamic sites of dialogue, participation, and meaning-making (Hein, 1998; Hooper-Greenhill, 2007). Within this context, museum architecture functions not merely as a container for exhibitions but as an active educational medium that shapes perception, interaction, and learning experiences. The Taichung Green Museumbrary, an innovative cultural complex integrating an art museum and a public library, exemplifies this transformation. Designed by SANAA in collaboration with Ricky Liu & Associates Architects + Planners, the building employs interconnected volumes, permeable boundaries, and fluid circulation routes to encourage openness, encounter, and public engagement.

In collaboration with the Taichung Museum of Fine Arts, SiSi. Learn by Space developed Opening the Museum, an open-source Spatial Education programme that translates the architectural characteristics of the Green Museumbrary into age-appropriate learning experiences for students from kindergarten to senior high school. Implemented during the museum's trial operation period, the programme invited students to experience the building as a learning environment through guided Spatial Walk-throughs and model-making activities. This study focuses on the elementary school curriculum and examines how embodied spatial experiences, supported by structured educational scaffolding, can be transformed into architectural understanding, design thinking, and civic awareness.

Research Background and Motivation

As Taiwanese cities continue to expand and transform, public participation in discussions concerning the built environment has become increasingly important. However, meaningful engagement with public space requires more than everyday experience; it depends upon the development of spatial literacy, including the ability to interpret, evaluate, and respond to architectural environments. Spatial Education addresses this need by positioning architecture as a form of lived knowledge closely connected to daily life. Through observation, exploration, and design activities, learners can develop spatial awareness, environmental understanding, and collaborative problem-solving skills.

Despite growing recognition of the importance of spatial literacy, access to Spatial Education remains uneven across Taiwan. Educational resources, cultural institutions, and architecture-related learning opportunities are concentrated in major urban centres, creating disparities between metropolitan and rural communities. To address this challenge, SiSi. Learn by Space adopted the framework of Open Educational Resources (OER) proposed by UNESCO (2019). By developing adaptable, accessible, and reusable educational materials, the project seeks to reduce barriers to participation and support the wider dissemination of Spatial Education in diverse educational contexts.

The project also reflects a strong connection between museum learning and Spatial Education. Constructivist museum education emphasises active participation, multi-sensory engagement, and Meaning-making rather than passive knowledge transmission (Falk & Dierking, 1992; Hein, 1998; Hooper-Greenhill, 2007). Similarly, Spatial Education encourages learners to understand their environment through direct experience, creative exploration, and design-based inquiry. By integrating these approaches, museums can expand their educational role beyond exhibition interpretation and become platforms for spatial literacy, civic awareness, and public learning.

This study examines the design and implementation of the Opening the Museum curriculum among elementary school students. Using a Design-Based Research (DBR) approach, the study investigates how Spatial Walk-through experiences and modular model-making activities support the development of spatial understanding, design thinking, and reflections on the social role of public architecture.

Research Objectives

Grounded in the principles of Open Educational Resources (OER), this study examines the design and implementation of a Spatial Education curriculum developed around the Taichung Green Museumbrary. Situated within a museum learning context, the study explores how elementary school students transform embodied spatial experiences into design understanding through guided observation, creative making, and educational Scaffolding.

The study aims to: First, examine how students translate sensory experiences gained during a Spatial Walk-through into structured spatial concepts and design decisions. Second, evaluate the effectiveness of modular open-source learning materials as Scaffolding tools that support spatial learning and creative expression. Third, investigate the educational outcomes of a hybrid curriculum model that combines embodied spatial exploration with model-making activities, particularly in relation to spatial literacy, design thinking, and awareness of public space.

Theoretical Framework and Curriculum Design Perspectives

Spatial Education and Embodied Perception

Spatial Education positions architecture as a form of lived knowledge that can be experienced, interpreted, and transformed through active engagement with the built environment. Rather than focusing solely on architectural form, Spatial Education encourages learners to explore the relationships between space, human behaviour, and social life. Through observation, movement, and creative making, students develop spatial awareness and learn to recognise how architectural environments shape everyday experiences.

Embodied Perception plays a central role in this process. Spatial understanding emerges not only through visual observation but also through bodily movement and sensory interaction. As learners move through architectural environments, experiences of scale, light, circulation, materiality, and spatial transitions become important sources of knowledge. These embodied encounters provide the foundation for later interpretation and design activity, allowing students to connect personal experiences with broader understandings of architecture and public space. The Spatial Walk-through approach adopted in this study is grounded in this perspective, treating movement through space as a form of inquiry that supports spatial literacy development.

Museum Learning and Meaning-Making

Contemporary museum education has shifted from a transmission-based model toward constructivist approaches that emphasise participation, interpretation, and Meaning-making (Hein, 1998; Hooper-Greenhill, 2007). Within this framework, learning is understood as an active process through which visitors construct personal meanings by connecting new experiences with prior knowledge and lived contexts.

Bruner (1996) argues that learning occurs through the construction and negotiation of meaning rather than the passive reception of information. Similarly, Falk and Dierking (1992) emphasise that museum experiences are shaped by the interaction between personal, social, and physical contexts. Museums therefore function not only as places for acquiring knowledge but also as environments that support exploration, dialogue, and reflection.

The educational design of this study reflects these principles by positioning the Green Museumbrary itself as a learning environment. Rather than delivering architectural knowledge through lectures or guided explanations, the curriculum encourages learners to investigate architectural phenomena through observation, movement, discussion, and creative production. Meaning-making emerges as students interpret spatial experiences and transform them into new understandings through design activities.

Open Educational Resources and Educational Equity

The integration of Open Educational Resources (OER) responds to the growing need for equitable access to educational opportunities. According to UNESCO (2019), OER refers to teaching, learning, and research materials that are openly available for adaptation, reuse, and redistribution. The OER movement seeks to reduce educational barriers associated with geography, institutional resources, and socioeconomic conditions.

Access to Spatial Education in Taiwan remains uneven, with architecture-related educational opportunities concentrated in urban cultural institutions and metropolitan areas. To address this challenge, the curriculum developed in this project was designed according to three key OER principles: accessibility, adaptability, and reusability. Learning materials employ low-cost and easily obtainable resources, enabling implementation in diverse educational settings without requiring specialised facilities or technical expertise.

By adopting an open-source structure, the curriculum extends beyond a single museum programme and becomes a transferable educational framework. This approach supports broader dissemination of Spatial Education while encouraging educators to adapt materials according to local needs and learning contexts.

SANAA, Spatial Experience, and Educational Scaffolding

The Taichung Green Museumbrary provides the physical and conceptual foundation for this curriculum. Designed by SANAA (Kazuyo Sejima and Ryue Nishizawa) in collaboration with Ricky Liu & Associates, the building reflects SANAA's commitment to openness, transparency, and social interaction (Sejima & Nishizawa, 2011). Through interconnected volumes, visual permeability, and fluid circulation systems, the architecture encourages movement, encounter, and informal social exchange.

These qualities make the Green Museumbrary particularly suitable as a site for Spatial Education. Students are able to experience architectural concepts such as openness, connectivity, accessibility, and publicness through direct engagement with the building rather than through abstract explanation alone.

The curriculum further incorporates Vygotsky's (1978) concept of Scaffolding. Learning activities are structured to support students in progressing from immediate sensory experiences toward increasingly complex spatial understanding and design thinking. The Spatial Walk-

through provides the initial embodied experience, while modular model-making activities offer tangible tools for organising observations into coherent spatial concepts. Through this progression, learners move from perception to interpretation and ultimately to creative spatial production. The combination of embodied experience, museum learning, and educational Scaffolding forms the theoretical foundation of the Opening the Museum curriculum.

Research Methodology and Curriculum Implementation

Design-Based Research Framework

This study adopted a Design-Based Research (DBR) approach to develop and evaluate an Open Educational Resources (OER)-based Spatial Education curriculum within a museum learning environment. DBR supports the iterative refinement of educational interventions in authentic contexts while generating practical and theoretical insights (Brown, 1992; Design-Based Research Collective, 2003). Through cycles of design, implementation, observation, and reflection, the study aimed to establish a transferable model for museum-based Spatial Education.

The curriculum was developed collaboratively by museum educators, spatial education practitioners, and researchers. Architectural concepts derived from the Taichung Green Museumbrary were translated into age-appropriate learning activities and modular teaching materials, with qualitative findings informing ongoing curriculum refinement.

Research Site and Participants

The study was conducted at the Taichung Green Museumbrary during its trial operation period. Participants consisted of twenty-four middle-grade elementary school students from Xitun Elementary School in Taichung City. The programme was delivered within a three-hour learning session that combined a guided Spatial Walk-through with a hands-on model-making workshop.

The morning session focused on experiential exploration of the museum environment, while the afternoon session engaged students in spatial creation activities using modular educational materials. This structure enabled students to connect embodied experiences with creative design processes.

Curriculum Design

The curriculum consisted of two interconnected learning phases: Spatial Walk-through and Modular Spatial Creation.

Spatial Walk-Through

The Spatial Walk-through was designed to encourage active exploration of architectural space through observation, movement, and sensory engagement. Rather than functioning as a conventional museum tour, the activity invited students to investigate spatial qualities such as scale, circulation, transparency, light, and spatial relationships. Learners moved through key areas of the Green Museumbrary, including the central atrium, circulation ramps, library spaces, rooftop terraces, and surrounding public areas.

Facilitators employed open-ended questions and guided observation strategies to encourage interpretation and discussion. Students were invited to consider how architectural design influenced movement, accessibility, encounter, and public use. Through these activities, architectural space became a source of embodied experience and inquiry.

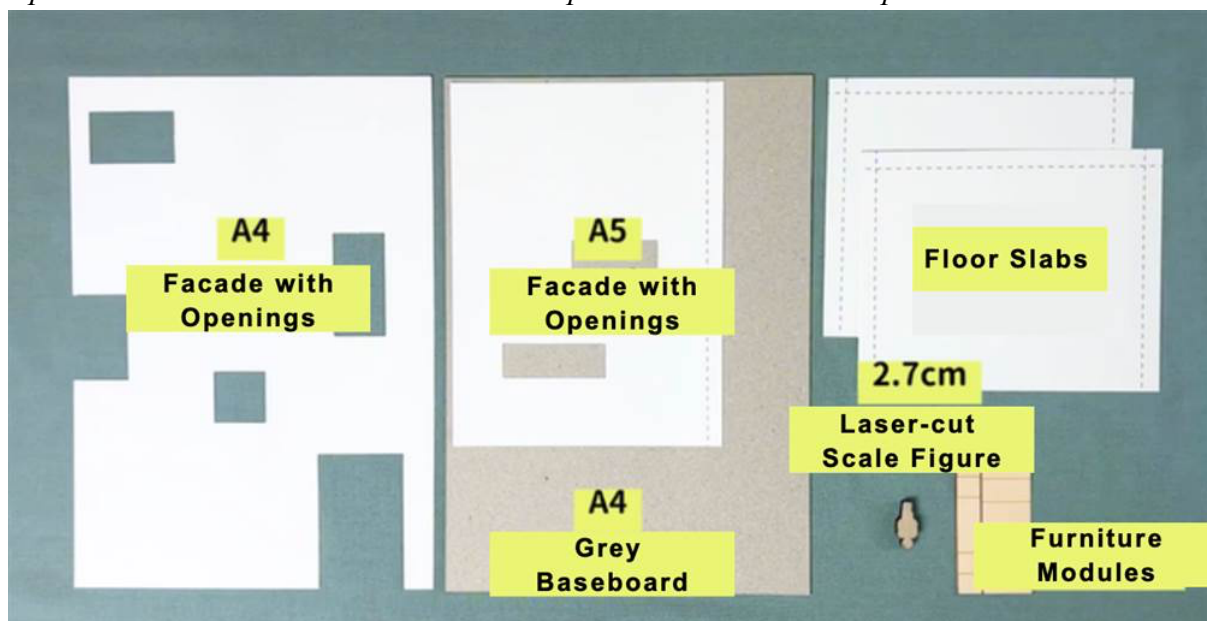
Modular Spatial Creation

Following the walk-through, students participated in a model-making workshop supported by a modular OER learning kit. The workshop was structured in three stages. First, students transformed pre-cut paper components into three-dimensional spatial volumes. Second, they introduced circulation elements and functional programmes while working with a 1:50 scale reference figure to consider spatial proportions and human experience. Finally, students collaboratively assembled individual structures into a larger museum complex, negotiating circulation systems, spatial relationships, and shared public spaces.

The modular design encouraged students to transform observations gathered during the Spatial Walk-through into tangible spatial proposals. As a form of educational Scaffolding, the materials reduced technical barriers while supporting creative experimentation and design thinking (Figure 1).

Figure 1

Open-Source Modular Toolkit Used in the Spatial Creation Workshop



Data Collection and Analysis

Data were collected using a qualitative triangulation strategy that combined participant observation, artefact analysis, and discourse analysis.

Participant observation was conducted throughout the programme by researchers and teaching assistants, who documented student engagement, spatial interactions, and learning behaviours. Artefact analysis focused on the completed models, examining how students translated spatial experiences into design decisions related to circulation, accessibility, openness, and spatial

organisation. Discourse analysis examined student conversations during collaborative activities to identify processes of negotiation, problem-solving, and Meaning-making.

The collected data were analysed thematically to explore how embodied spatial experiences, educational Scaffolding, and collaborative design activities contributed to the development of spatial literacy, design thinking, and awareness of public architecture.

Results and Discussion

The findings are presented according to the Generic Learning Outcomes (GLOs) framework, which examines changes in participants' knowledge and understanding, skills development, attitudes and values, inspiration and creativity, and behavioural progression. The analysis demonstrates how embodied spatial experiences, educational Scaffolding, and collaborative model-making contributed to the development of spatial literacy and civic awareness (Figure 2).

Figure 2

Student-Generated Spatial Models Demonstrating Openness and Encounter



Knowledge and Understanding

Analysis of student artefacts indicates that participants developed a sophisticated understanding of architectural openness, circulation, and spatial relationships. Rather than treating walls as fixed boundaries, many students used openings, connections, and visual corridors as active design elements. Their models demonstrated an emerging awareness of transparency, accessibility, and movement, reflecting key architectural concepts observed during the Spatial Walk-through.

Students frequently referred to light, visibility, and environmental connections when explaining their designs. These observations suggest that embodied encounters with the Green Museumbrary enabled learners to connect material qualities with broader ideas about openness and public accessibility. Architectural concepts that are often abstract in classroom settings became concrete through direct spatial experience.

Skills Development

The curriculum supported the development of practical design skills and spatial reasoning. The introduction of a 1:50 scale figure encouraged students to evaluate proportions from a human-centred perspective rather than relying on intuitive estimations. Students adjusted floor heights, circulation routes, and spatial functions according to human use, demonstrating an emerging understanding of scale and spatial organisation.

Collaborative design activities further strengthened problem-solving and communication skills. During the collective assembly phase, students negotiated circulation systems, shared public areas, and connections between individual structures. These discussions required participants to consider accessibility, visitor movement, and spatial coherence, indicating the development of both design thinking and collaborative decision-making abilities.

Attitudes and Values

The findings suggest a notable shift in students' perceptions of museums and public architecture. Prior to participation, museums were often described as formal and restrictive environments. Following the programme, students increasingly conceptualised museums as open, inclusive, and socially connected spaces.

One student explained that their proposed museum design intentionally removed barriers and encouraged access from multiple directions, reflecting an understanding of public space as a shared civic resource. Such responses indicate that the educational experience supported broader reflections on accessibility, inclusion, and the social responsibilities of cultural institutions.

Inspiration and Creativity

The open-ended structure of the modular learning materials encouraged students to generate highly original spatial solutions. Rather than reproducing existing architectural forms, participants adapted and extended concepts encountered during the walk-through to create new configurations.

For example, one group organised its structures around a large central public plaza designed for performances and community gatherings. The proposal demonstrated an ability to integrate circulation, visibility, and social interaction into a coherent spatial system. These outcomes suggest that the OER-based curriculum successfully balanced creative freedom with architectural reasoning, allowing students to explore alternative possibilities for public space.

Activity, Behaviour and Progression

Evidence of learning transfer was observed beyond the formal programme itself. Teachers reported that students continued discussing architectural features and public spaces after

leaving the museum environment. Learners began comparing surrounding buildings with architectural elements encountered during the walk-through and questioned how different design decisions affected visibility, privacy, accessibility, and public use.

This behavioural continuation suggests that students had moved beyond passive observation and developed a more critical awareness of the built environment. According to the GLOs framework, such transfer of learning into everyday contexts represents an important indicator of sustained educational impact.

Discussion

The findings demonstrate the educational potential of combining museum learning, Spatial Education, and Open Educational Resources within a single pedagogical framework. The Spatial Walk-through provided opportunities for Embodied Perception, enabling students to experience architectural concepts through movement and sensory engagement. The modular model-making activities subsequently functioned as Scaffolding, supporting the transformation of sensory experiences into tangible design outcomes.

The results align with constructivist perspectives proposed by Bruner (1996), Hein (1998), and Hooper-Greenhill (2007), which view learning as a process of active Meaning-making rather than passive information acquisition. Students did not simply learn about architecture; they interpreted, negotiated, and reconstructed architectural ideas through creative practice.

Furthermore, the OER structure proved effective in reducing barriers to participation. By utilising accessible materials and adaptable learning resources, the curriculum demonstrates how Spatial Education can be disseminated beyond specialised institutions and urban centres. The model therefore contributes not only to museum education but also to broader discussions of educational equity and cultural accessibility.

Overall, the findings suggest that the integration of Embodied Perception, Scaffolding, and OER can provide an effective pathway for cultivating spatial literacy, civic awareness, and design thinking among young learners. The Green Museumbrary functioned not only as a museum building but also as an educational medium through which students developed new ways of understanding, experiencing, and imagining public space.

Conclusion

This study employed a Design-Based Research (DBR) framework to develop, implement, and evaluate an open-source spatial education curriculum centred on the Taichung Green Museumbrary. By combining a Spatial Walk-through with modular model-making activities, the project examined how Open Educational Resources (OER) can support the development of spatial literacy, civic awareness, and design thinking among primary school students.

The findings indicate that Embodied Perception plays a crucial role in spatial learning. Through direct engagement with SANAA's architectural environment, students experienced concepts such as transparency, openness, circulation, and encounter through bodily movement and sensory observation. These experiences provided a foundation for Meaning-making, allowing learners to reinterpret architectural phenomena and transform sensory impressions into design decisions during the model-making process. Rather than functioning as passive visitors,

students became active interpreters of space and participants in the construction of architectural meaning.

The study further demonstrates the effectiveness of modular OER materials as a form of educational Scaffolding. The use of accessible materials and standardised templates reduced technical barriers and enabled students to focus on higher-order design tasks, including spatial organisation, circulation planning, and collaborative problem-solving. The adaptability, accessibility, and extensibility of the curriculum suggest that OER can provide an effective strategy for expanding access to spatial education beyond resource-rich urban contexts.

Beyond spatial cognition, the curriculum also contributed to the development of civic awareness and social responsibility. Students increasingly viewed museums and public architecture as inclusive civic spaces that welcome people with diverse backgrounds, interests, and needs, rather than as exclusive cultural institutions. Their design proposals frequently emphasized openness, flexibility, and opportunities for social interaction, reflecting an emerging understanding of architecture as a medium that supports diversity, encourages public participation, and fosters meaningful community engagement.

From the perspective of museum education, the findings support constructivist approaches proposed by Bruner (1996), Hein (1998), and Hooper-Greenhill (2007), which emphasise learning as an active process of interpretation and knowledge construction. The Green Museumbrary functioned not only as a cultural venue but also as an educational medium through which students connected personal experience, spatial observation, and creative production. The project therefore demonstrates how contemporary museums can activate architecture itself as a learning resource and a platform for public engagement.

Several limitations should be acknowledged. First, the large scale of the Green Museumbrary occasionally generated physical fatigue among younger participants, suggesting the need for shorter walk-through routes or additional rest intervals in future implementations. Second, although the modular kit effectively supported learning, its predefined structural logic may have limited opportunities for more experimental forms of spatial expression. Future iterations could incorporate a wider range of materials to encourage greater design diversity.

Overall, this study suggests that the integration of Spatial Education, Museum Education, and Open Educational Resources offers a promising framework for cultivating spatial literacy and civic imagination. By transforming architectural experience into an accessible educational process, the model provides a replicable pathway for museums seeking to expand public engagement and promote educational equity. Future applications may further extend this framework across diverse cultural institutions and community contexts, strengthening the role of spatial learning within contemporary arts and humanities education.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The authors declare that ChatGPT, a generative AI tool developed by OpenAI, was used in proofreading and refining the language used in the manuscript. The usage was limited to correcting grammatical and spelling errors and rephrasing statements for accuracy and clarity. The author further declares that, apart from ChatGPT, no other AI or AI-assisted technologies have been used to generate content in writing the manuscript. The ideas, design, procedures,

findings, analyses, and discussion are originally written and derived from careful and systematic conduct of the research.

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