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Research Article

DESIGNING FOR SUSTAINABILITY: THE ROLE OF WOODEN EARLY CHILDHOOD EDUCATION FACILITIES IN FOSTERING COMMUNITY AND EDUCATION IN JAPAN.

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ABSTRACT

In alignment with the United Nations Sustainable Development Goals (SDGs)—specifically Goal 4 (Quality Education) and Goal 11 (Sustainable Cities and Communities)—Japan has witnessed a burgeoning interest in sustainable, child-centered educational environments. A primary focus of this movement is the integration of wood and natural materials in early childhood education (ECE) facilities, catalyzed by national policies such as the 2010 Act on the Promotion of Use of Wood in Public Buildings and the 2015 "Wooden School Initiative". This study investigates how wooden architecture in ECE facilities contributes to sustainable development and high-quality, inclusive education through a focused qualitative case study of a wooden kindergarten in Japan. The research employs the original conceptual framework of "Community-Co-Created Educational Design," which positions educational space as an interface between architecture, pedagogy, and local resource systems. Methodologically, the study draws on a semi-structured interview with a senior facility manager, supplemented by stakeholder interviews with the facility's designer and play equipment manufacturer to ensure data triangulation. The findings demonstrate that wood-based design transcends aesthetics to become a socio-material vehicle for local sustainability, intergenerational learning, and social cohesion. While the study acknowledges the inherent representational limitations of a single primary informant, it provides foundational insights for global discourse on ecological awareness and child-friendly urban planning. Furthermore, identified challenges—including limited subsidy awareness, maintenance demands, and policy-practice gaps—highlight the necessity for implementation-oriented strategies to sustain these environments. This research offers critical insights for policymakers and designers aiming to integrate children's well-being with sustainable community development.

1. Introduction

In recent years, increasing attention has been directed toward environmental sustainability and community co-creation in the design and operation of educational facilities. Early childhood education (ECE) settings play a particularly influential role in shaping

children's development while functioning as local hubs for sustainable social practices. These trends align with the United Nations Sustainable Development Goals (SDGs), especially Goal 4 (Quality Education), Goal 11 (Sustainable Cities and Communities), and Goal 13 (Climate Action), highlighting the transformative potential of learning environments.

In Japan, policies promoting wood utilization—such as the 2010 Act on Promotion of Wood Utilization in Public Buildings and its 2021 amendment—have accelerated the adoption of regionally sourced timber in public architecture. Within this context, wood-based ECE facilities have emerged not merely as architectural alternatives but as educational environments integrating pedagogical, environmental, and regional values.

Previous research has established the psychological and physiological benefits of natural and wood-based environments. Studies indicate that natural play settings support attention restoration and stress reduction (Faber Taylor et al., 2001; Wells & Evans, 2003), while visual, tactile, and olfactory contact with wood promotes autonomic stabilization and emotional comfort (Tsunetsugu et al., 2007; Azuma et al., 2016; Ikei et al., 2017, 2018). Reviews further confirm the stress-reducing effects of indoor wooden environments (Burnard & Kutnar, 2015, 2019), and recent studies report increased psychological comfort in wood-rich spaces (Zhu et al., 2023; Ojala et al., 2023). However, research examining the broader educational and socio-regional implications of wood-based ECE facilities remains limited. While natural materials are associated with creativity, autonomy, and social development, integrated analyses linking educational practice, institutional systems, and community co-creation are scarce.

Accordingly, this study investigates educational practice and community collaboration within a wood-based ECE facility in Japan. Specifically, it aims to: (1) examine the effects of wooden environments on children's behavioural and sensory learning; (2) analyse how wood-based design informs pedagogical philosophy and daily practice; (3) explore mechanisms of community co-creation through regional timber use and wood-education (Mokuiku); and (4) identify institutional constraints and propose strategies for sustainable implementation.

Conceptually, the study frames wood-based environments as socio-material systems that integrate educational practice, community engagement, and environmental ethics. Through the lens of Community-Co-Created Educational Design, educational space is understood as an interface linking architecture, pedagogy, and local resource networks, thereby positioning wood-based ECE facilities as active contributors to sustainable community development.

2. Research Method

2.1 Research Subject and Selection Criteria

The focal point of this study is M Kindergarten, a preeminent example of wood-based early childhood education (ECE) facilities in Japan. The facility is characterized by its structural and interior use of regionally sourced cedar and cypress wood, and the holistic integration of "Mokuiku" (wood education) into its pedagogical framework. The "Wood Education Room" (Figure 1) was developed through a strategic partnership between the facility, an expert non-profit organization (NPO) specializing in wood education, and a local construction firm, focusing specifically on the sensory qualities of wood, such as texture and aroma. This collaborative model, involving local timber suppliers and forestry cooperatives, aims to achieve a sustainable circulation of regional resources through the childcare environment.

This study adopts a focused qualitative case study approach to examine how wooden spatial environments are interpreted within educational practice. This methodology prioritizes analytical depth over statistical generalization, facilitating an intensive investigation of context-dependent educational settings. The primary analysis centers on an in-depth interview with a senior manager directly overseeing the facility's pedagogical and operational activities (Table 1). While the study relies on a single-informant perspective for primary narrative analysis, this focus allows for a nuanced exploration of pedagogical decision-making and spatial interpretation. To ensure data triangulation and interpretive validity, supplementary interviews were conducted with the space designer and the play equipment manufacturer. These broader stakeholder perspectives serve to cross-verify the primary findings, though their exhaustive analysis is reserved for subsequent comparative publications. The study acknowledges these representational limitations and frames the findings as exploratory insights designed to inform future multi-stakeholder research.

The subject facility was selected based on the following rigorous criteria:

- Utilization of wood as the primary structural and interior material.
- Substantial use of regionally sourced (domestic) timber.
- A documented commitment to community collaboration and local resource utilization.
- Participation in prior questionnaire surveys and a confirmed commitment to longitudinal research cooperation

Source: Photographed and created by the first author

Figure1: The Wood Education Room as a Hub for Community-Co-Created Design. This space was developed under the pedagogical supervision of a certified NPO promoting the national "Wood Education" (Mokuiku) initiative, realized through the integration of designer concepts and construction using locally sourced solid timber. It exemplifies the **socio-material interface** where national policy, regional forestry, and childcare practice converge

Table 1: Semi-structured Interview Protocol

Category	Key Interview Questions
1. Expectations of Woodification	Anticipated effects on children's behavior; potential gaps between expectations and reality; utilization of institutional support programs.
2. Educational Practice	Influence of wooden spaces on daily play; observed socio-emotional changes in children; stakeholder (staff/parent) responses.

3. Community Collaboration	Evolution of regional relationships; procurement dynamics; future vision for community-integrated education.
4. Staff and Workplace	Impact on staff pedagogical philosophy; workplace atmosphere; challenges in community engagement.

Source: Created by the first author

2.2 Data Collection and Analysis

Data were collected through semi-structured interviews. The primary interview with the educational manager was conducted on June 16, 2025, lasting approximately 50 minutes. Audio recordings were transcribed using the AI-based tool "Notta" and subsequently verified by the researcher to ensure textual accuracy.

Analysis was performed using MAXQDA 24, employing a hybrid approach of AI-assisted thematic extraction and manual coding refinement. The initial coding system was reconstructed to align with the research objectives, involving the exclusion of redundant codes and the consolidation of similar themes. This process resulted in a final coding hierarchy comprising seven primary categories (Table 2). Interpretive validity was maintained through iterative reviews of the coding system and alignment with existing theoretical frameworks in educational design.

This research was conducted with the formal approval of the Faculty of Arts Research Ethics Review Committee at the University of Tsukuba. All participants provided informed consent following a comprehensive explanation of the study's objectives and data handling protocols.

Table 2: Qualitative Coding Hierarchy and Frequency

Primary Category	***Sub-category***	***Coded Segments***
1. Children's Behavior and Learning	Emotional Stability	**5**
	Changes in Learning Behavior	**8**
	Barefoot Play	**1**
	Sensory-Rich Experiences	**6**
	Calming Experiences	**6**
2. Practitioners' Perspectives	Policy Sharing	**2**
	Wood Education Curriculum Implementation	**9**
3. Community Relations	Regional Identity	**9**
	Collaboration and Participation	**8**
	Local Material Use	**3**
4. Sustainability and Policy	Contribution to Sustainability	**18**
	Maintenance Issues	**7**
	Support Awareness	**5**
5. Design and Environment	Aesthetics and Material Preferences	**3**
6. Challenges and Constraints	Material-related Practical Challenges	**10**
7. Vision and Future Outlook	Strategic Sustainable Goals	**2**

Source: The first author created using MAXQDA 24's "Code Matrix Browser"

3. Results and Discussion

3.1 Analysis Overview: The Socio-Material Significance of Wood-Based ECE Facilities

This chapter elucidates the educational effects and regional significance of wood-based ECE facilities through a MAXQDA-supported qualitative analysis of practitioner interviews. The coding architecture comprises seven primary categories: (1) Children's Behavior and Learning, (2) Practitioner Perspectives, (3) Community Relations, (4) Sustainability and Institutional Frameworks, (5) Design and Environment, (6) Challenges and Constraints, and (7) Future Vision. These categories are profoundly interdependent, suggesting that wood-based design constitutes an integrated socio-material practice rather than a static architectural intervention.

Three overarching trends emerged: (1) the alignment of pedagogical philosophy with spatial design, (2) the nexus between regional resources and educational content, and (3) the friction between institutional support and onsite implementation. To ensure interpretive rigor, core findings regarding the "Wood Education Room" and community initiatives were cross-verified with designers and supervisory stakeholders. This triangulation confirms the coherence between educational intent and spatial realization.

3.2 Impact on Children's Behavior and Learning

The analysis identified five key sub-concepts: sensory-rich experiences, emotional stability, calming effects, pedagogical behavioral changes, and barefoot play. Under "Sensory-Rich Experiences," children developed an embodied understanding of local ecology through tactile engagement with wood—such as sanding and crafting. This correlates with Burnard & Kutnar's (2015) assertion that tactile stimulation catalyzes creative learning.

Wooden environments further provide psychological grounding, aligning with prior research (Azuma et al., 2016) indicating that wood scent and spaces promote psychological stability. Respondents emphasized that "emotional stability was the primary objective" of wood integration, noting that it fosters a "relaxed state of mind" for both children and staff. Furthermore, the material properties of wood—warmth and softness—modulated physical behaviors, encouraging children to play barefoot and adopt calm, unconstrained postures.

Consequently, wood-based design is not merely a stylistic choice but constitutes the foundation of an educational environment that supports children's sensory integration, emotional regulation, and independent learning. As conceptualized in Figure 2, wooden materiality functions as a mediating layer that translates environmental qualities into these specific pedagogical behaviors, reinforcing the interpretation that spatial material design plays an active role in shaping educational experience.

Source: Created by the first author

Figure2: Conceptual Model Illustrating Wooden Materiality as a Mediating Layer for Sensory Engagement and Learning Behavior.

3.3 Practices and Perspectives of Childcare Workers

This category elucidates how wooden environments are integrated into the professional practices and underlying philosophies of childcare workers. The analysis centers on three primary dimensions: the Continuous Implementation of the Wood Education Curriculum, Shared Childcare Philosophy and Parental Understanding, and Methods of Educational Practice. Table 3 organizes the representative codes and qualitative evidence illustrating how these perspectives are translated into daily pedagogical activities. Rather than functioning as isolated themes, these categories form an integrated framework where curriculum continuity, shared values, and the material environment mutually reinforce one another.

In implementing the Wood Education (Mokuiku) curriculum, the facility collaborates extensively with local woodworkers and volunteers, thereby anchoring the transmission of regional culture within the educational process. The kindergarten-run "Wood Education Room" and "Wood Education Caravan" serve as communal interfaces open to local residents, facilitating the social sharing of educational values. This ecological structure of community-collaborative education resonates with contemporary research on nature-based pedagogical practices (Coates & Pimlott-Wilson, 2019).

A defining characteristic of this practitioner perspective is a tolerant pedagogical stance, exemplified by the philosophy that "injuries are an integral part of growth". This attitude—viewing the inherent imperfections of wooden spaces (such as scratches or changes due to aging) as "opportunities for learning"— aligns with research by Torres-Begines (2025), which conceptualizes play environments as literacy spaces. Furthermore, the wooden environment is positioned as a "space for learning together," where the shared material setting fosters a co-educational relationship between practitioners and children based on equality and empathy. In this context, the space effectively functions as a "third teacher," guiding development through environmental interaction rather than top-down instruction.

Table 3: Core Concepts of Practitioners' Pedagogical Philosophy and Practice

Subcategory	Main Content	Qualitative Evidence (Related Examples)
Implementation of Wood Education (Mokuiku) Curriculum	Integration of regional culture via crafting (e.g., chairs, chopsticks) and the "Wood Education Caravan"	"Conveying the essence of wood through play"
Pedagogical Philosophy and Stakeholder Alignment	Prioritizing emotional stability; reframing minor injuries as developmental learning opportunities	"Non-life-threatening injuries are learning opportunities"
Methods of Embodied Educational Practice	Fostering collaborative environments; maintaining continuity between daily life and material learning	"Learning not through screens, but through direct play"

Source: Created by the first author

3.4 Synergies with the Local Community

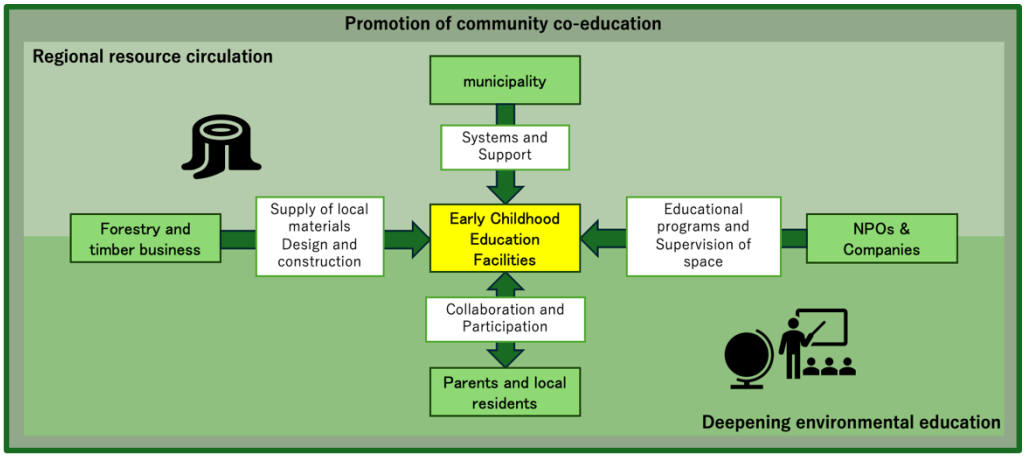
The synergistic relationship between the facility and the local community was elucidated across three primary dimensions: the Utilization of Local Resources, Cultivating Parental Trust and Understanding, and the Implementation of Community Co-educational Activities.

The strategic use of regionally sourced timber for the kindergarten's construction

embodies a design philosophy that harmonizes emotional stability with regional resource circulation. This material choice fosters an educational environment where "imperfections"—such as scratches and the natural patina of aging—are reframed as "part of the learning process," thereby embedding local culture and ecological perspectives into the children's daily lives.

Crucially, this pedagogical stance extends to the facility's collaboration with parents. By articulating that "minor injuries serve as evidence of developmental growth," the kindergarten secures parental alignment, ensuring consistency in educational policy. Establishing this foundation of trust is indispensable for the sustainable operation of a wooden environment, where material softness and risk-taking are intentional pedagogical elements.

Furthermore, through community-centric programs such as the "Wood Education Room" and "Wood Education Caravan," a robust "co-education community" is emerging, wherein local residents actively engage with the facility's mission. As illustrated in Figure 3, these initiatives demonstrate the transformative potential of ECE facilities to function as regional hubs for cultural revitalization, bridging the gap between localized education and broader regional development.



Source: Created by the first author

Figure 3: The Integrative Framework of the Regional Collaborative Wood Education Network: A Model for Community-Co-Education. This schematic illustrates the structural interactions among stakeholders—including forestry sectors, local residents, and educational practitioners—demonstrating how ECE facilities serve as mediating hubs for regional resource circulation and cultural revitalization

3.5 Sustainability and Institutional Frameworks

Sustainability within wood-based ECE facilities was evaluated across four key dimensions: Local Industry, Educational Activities, Maintenance and Management, and Institutional Support.

Regarding local industry, while the utilization of local timber facilitates regional resource circulation, practitioners reported significant structural barriers, including a decline in skilled woodworking artisans and escalating material costs. Conversely, pedagogical sustainability is maintained through the ongoing wood education curriculum, which actively fosters environmental values among children.

Operational maintenance represents a persistent challenge; the inherent material

properties of locally sourced wood—specifically its softness and susceptibility to wear—necessitate rigorous daily upkeep, leading to increased long-term cost burdens. From an institutional perspective, although national and municipal subsidy programs offer initial support, they are frequently perceived as inadequate in terms of both specialized human resources and sustained financial allocation.

Consequently, the long-term viability of wood-based facilities requires a transition toward a hybrid stewardship model. This model must integrate top-down institutional support with bottom-up community participation to ensure both material and social sustainability.

3.6 Design and Environment

From a design perspective, the aesthetic value and psychological comfort afforded by wood-based spaces were highly lauded. Qualitative evidence—including participant remarks that the material "does not feel intrusive" and "appeals to everyone"—suggests that wooden environments are perceived as both inherently natural and universally pleasant.

The specific visual and tactile characteristics of wood foster a pervasive sense of "security" and "inclusiveness" within the pedagogical space, playing a vital role in stabilizing the affective atmosphere and calming the relational dynamics between educators and children. This observation aligns with contemporary empirical research, notably the study by Ojala et al. (2023), which documents the psychological stabilizing effects inherent in wood-based environments.

3.7 Challenges and Constraints

While the benefits are significant, wood-based construction entails substantial practical and structural challenges, including maintenance burdens, a dearth of specialized craft labor, and elevated timber procurement costs. A salient theme identified in the interviews was the "disconnect between upstream (forestry) and downstream (educational settings)," which highlights the insufficient collaboration between educational facilities and the industrial sector as a primary barrier to long-term sustainability. These systemic issues underscore the necessity for enhanced institutional design and the reconstruction of regional collaboration frameworks.

These identified constraints yield critical practical implications for the field. Addressing maintenance demands necessitates the development of hybrid funding and shared stewardship models that distribute responsibility among diverse stakeholders. Furthermore, the shortage of specialized craft labor suggests the need for regional training initiatives that strategically bridge the forestry and education sectors. Finally, the prevailing policy-practice gaps emphasize the importance of transparent subsidy communication and sustained operational support. Translating these constraints into actionable implementation strategies is essential for improving the scalability and sustainability of wood-based educational environments.

3.8 Vision and Future Outlook

The study identified a strategic trajectory for educational facilities, with respondents envisioning a model of "child-centered community development" that positions the kindergarten as a pivotal regional hub. Within this framework, ECE facilities are reconceptualized not merely as isolated school buildings, but as dynamic centers for community revitalization. It is particularly significant that the networks emerging from wood-

based construction are already fostering multilateral synergies among the education sector, the forestry industry, and local residents. This collaborative ecosystem culminates in what this study defines as "Regional Co-Creation centered on education".

Looking ahead, the successful institutionalization of this model depends on establishing a robust regional collaboration framework. This necessitates a tripartite alignment where government authorities, educators, and industrial stakeholders operate in concert, utilizing wood-based educational spaces as a foundational infrastructure for social innovation. By integrating these diverse sectors, the facility transcends its traditional role, evolving into a socio-material platform that sustains both regional ecology and community well-being.

4. Conclusion

4.1 Educational and Social Impact of Woodification

This study elucidated the intricate nexus between educational practice and regional collaboration within wood-based early childhood education (ECE) facilities through a qualitative analysis of practitioner narratives. While grounded in a single, in-depth case study, the findings provide significant exploratory insights into how wooden environments catalyze community-oriented sustainability. These results serve as an indicative conceptual foundation for broader comparative research, acknowledging the inherent scope of case-based inquiry.

The analysis demonstrates that wood-based design transcends mere architectural aesthetics or environmental beautification; it constitutes a fundamental educational infrastructure that supports child development while mediating the inheritance of regional culture and social co-creation.

First, wooden environments induce profound behavioral and emotional modulations in children. The multisensory properties of wood—specifically its warmth, softness, and olfactory characteristics—enhance emotional stability and foster a deep-seated sense of security. Physical expressions such as floor-based play and barefoot activity characterize the space as a "free and calm learning environment". This provides empirical evidence for "embodied learning," confirming that wooden spaces function as a pedagogical medium that supports sensory integration and spontaneous agency.

Second, wood-based design serves as the material embodiment of a transformative pedagogical philosophy. Educators utilize wood to convey values of "coexistence with nature" and "learning through imperfection". The acceptance of material aging and the belief that "injuries are integral to growth" reflect a shift from an educational paradigm of "control" to one of "coexistence". Within this shared material setting, the relationship between educator and child evolves into a reciprocal "co-education," where the environment itself acts as a "third teacher".

Third, wooden architecture transforms ECE facilities into central regional learning hubs. Beyond the physical use of local timber, the active engagement of woodworkers and local volunteers fosters a cyclical interconnection between regional livelihoods and education. Initiatives such as "Wood Education Rooms" and "Wood Education Caravans" facilitate the emergence of "co-educational communities" supported by the broader society. These mechanisms function as social catalysts that promote resource regeneration and cultural inheritance, effectively repositioning educational facilities as vital social infrastructure for regional sustainability.

Fourth, the study identifies critical systemic challenges to the promotion of wood-based construction. While supporting regional circulation, practitioners face significant constraints, including maintenance costs, artisan shortages, and institutional limitations. Prevailing subsidy systems often lack the flexibility required by educational settings, highlighting a persistent "policy-practice gap". Addressing these barriers necessitates a hybrid support system that bridges top-down administration with bottom-up collaboration among diverse stakeholders.

Finally, the aesthetic and multisensory effects of wood elevate the quality of educational practice by creating a universally comfortable and inclusive environment. Consequently, wood-based design should be evaluated not merely as a material choice, but as a deliberate practice of environmental design that mediates human sensation and sociality.

4.2 Limitations and Future Directions

While this study successfully provided an in-depth exploration of the practical knowledge and values embedded within wood-based educational settings, it faces certain methodological limitations. Specifically, the scope was constrained by a focused sample size, regional specificity, and the diversity of architectural and institutional frameworks available for comparison. Furthermore, as the findings rely primarily on the subjective narratives of educators, a significant future challenge involves integrating these qualitative insights with quantitative environmental data—such as thermal and acoustic performance—and direct observations of child behavior.

To build upon these exploratory results, subsequent research should adopt a multi-stakeholder approach, incorporating the perspectives of designers, policymakers, parents, and local residents. Constructing a comprehensive analytical framework that intersects design intent, pedagogical practice, and institutional support will be vital for elucidating the broader social impacts of wood-based construction. Moreover, re-evaluating these findings from an international perspective is crucial. Comparative studies with Nordic practices, such as "nature-based education" and "outdoor childcare," will highlight both the unique cultural dimensions and the universal applicability of Japan’s wood-based ECE model.

Ultimately, while this study establishes wood-based construction as a "cultural practice connecting education and community", it necessitates further empirical validation grounded in diverse regional contexts. A primary future challenge is to visualize the dynamic role of educational facilities within regional circular structures—spanning forest resources, architecture, and regional revitalization—and to reconstruct this role through the conceptual lenses of Education for Sustainable Development (ESD) and Nature-based Education (NbE).

4.3 Comprehensive Conclusion

Synthesizing the aforementioned findings, wood-based early childhood education (ECE) facilities demonstrate profound educational and social impacts across four core dimensions: (1) fostering holistic child development, (2) cultivating a distinctive pedagogical culture, (3) driving community co-creation, and (4) advancing environmental and industrial sustainability. Based on these results, the utilization of wood in educational settings should be conceptualized not merely as an architectural choice, but as "Community-Co-Created Educational Design". This paradigm necessitates a deepening of interdisciplinary research and practice that bridges the domains of education, community engagement, and public policy.

"Community-Co-Created Educational Design" provides a novel practical foundation that integrates the spheres of education, community, and the environment. The construction and operation of ECE facilities using regionally sourced timber not only promote local production and consumption but also establish a sustainable, circular trajectory: Local Forests → Architecture → Education → Human Resource Development → Regional Revitalization. Reconceptualizing this entire process as an integral pedagogical component aligns seamlessly with the principles of Education for Sustainable Development (ESD) and Nature-based Education (NbE).

Japan's innovative wood-based construction practices serve as a pioneering global model with significant international value. This research offers a new trajectory for educational environment design, positioning wood-based construction as a critical catalyst for redefining "education that grows alongside its community". By theoretically and practically advancing this model of community co-creation centered on educational facilities, this study contributes to the broader realization of a sustainable and resilient future society.

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