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From Curriculum to Construction: Mapping a Landscape of Transdisciplinary Practice in European Architecture and beyond

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Abstract
This study explores how transdisciplinary approaches in architectural education manifest in built outcomes at the building scale in Europe. Using a structured set of 13 case studies across three typologies - Transdisciplinary Learning Laboratories, Participatory Housing & Community Prototypes, and Circular Design & Educational Studios - it maps the trajectory from curriculum-based pedagogies to real-world construction. Through comparative analysis, this study reveals patterns in knowledge co-production, stakeholder integration, and spatial realization. Key findings include the emergence of a curriculum-construction continuum, where student learning extends from conceptualization to implementation. In addition, the redefinition of students' roles as co-researchers and mediators across institutional boundaries and the importance of long-term partnerships between academia, municipalities, and industry. Furthermore, challenges in aligning academic timelines with construction processes and sustaining stakeholder engagement necessitate flexible regulatory mechanisms and new evaluation metrics for transdisciplinary work. This study contributes to ongoing debates in architectural education by demonstrating how transdisciplinary logic can be operationalized from curriculum to construction. It argues for a paradigm shift in architectural pedagogy towards more socially engaged, ecologically literate, and epistemologically reflexive approaches. The paper concludes by outlining future research directions, including longitudinal impact studies and the development of meta-analytical tools for assessing transdisciplinary studios' effectiveness. Using a structured set of case studies, it maps the trajectory from curriculum-based pedagogies to real-world construction, categorized into three typologies: learning laboratories, participatory housing, and circular design studios. Through comparative analysis, this study reveals patterns in knowledge co-production, stakeholder integration, and spatial realization, offering a conceptual and empirical contribution to the discourse on transdisciplinary architecture.

Keywords: Transdisciplinary design practices, architectural education, co-production, collaborative learning environments

1. Introduction

Educational paradigms in architecture are increasingly aligned with the challenges of climate change, urban inequality, and sustainability transitions. As traditional disciplinary boundaries prove insufficient, a growing body of scholarship emphasizes the need for transdisciplinary pedagogies, where architectural students engage collaboratively with engineers, scientists, local authorities, and citizens to co-produce- knowledge (García-Hernández et al., 2020; Tejedor et al., 2020). Within architectural education, the design studio has emerged as more than a pedagogical core—it is becoming a transdisciplinary laboratory. Notably, Panayi, Roussou, and Charalambous (2023) describe a Co-creation- Design Studio at the University of Cyprus, where students, faculty, residents, and municipal bodies collaborated over multiple years to co-design urban commons. This study demonstrates how studios can scaffold resident participation and systems-level thinking, transforming students into active mediators between theory and civic engagement. Complementing this, the conference paper "Architectural Design Studio: Embracing a Transdisciplinary Approach" further highlights how sustained interaction with civil society elevates the role of students from passive recipients to civic co-designers (Panayi et al., 2023). Parallel scholarship on Urban Living Labs emphasizes the role of designed spaces as experimental platforms for participatory innovation. This line of research underscores the significance of reflexivity, stakeholder co-creation, and long-term engagement, which are theoretical elements that support pedagogical models in architectural studio practice (Puerari et al., 2018; Huning et al., 2021). To situate these advances within the architectural research context, studies such as García-Hernández, García-Mayor, and Suárez (2020) offer critical insights into how team-based, stakeholder-inclusive design projects can cultivate critical thinking, systems competency, and collaborative agency among architecture students. Similarly, Zhuang, Chen, and Wang (2024) demonstrate how inquiry-based, experiential learning in thermal science courses significantly improves architecture students' problem-solving skills and engagement with sustainability. Another contribution, by Lotfabadi and Iranmanesh (2025), employs the analytic hierarchy process (AHP) to determine how ecological building design methods are incorporated into architecture curricula. This study emphasizes the value of multi-criteria decision-making tools for prioritizing sustainable strategies in pedagogy. Despite these pedagogical explorations, a critical gap remains: how does this transdisciplinary pedagogy materialize into actual built outcomes. Most literature addresses studio experiments or policy discourse, but few trace the full trajectory from architectural curriculum to realized architecture or to prototypes. This study addresses this gap through the guiding question: How does transdisciplinary architectural education manifest in built outcomes at the European building scale? It further asks what typologies of curriculum interventions are emerging across European architectural programs. What pedagogical, institutional, and stakeholder mechanisms facilitate this trajectory? To answer this question, this study employs a structured case study methodology, analyzing 13 European architecture projects that satisfy four key criteria: (a) physical construction at building or prototype scale, (b) curricular linkage to architecture programs, (c) evidence of stakeholder and disciplinary collaboration, and (d) documentation in peer-reviewed or institutional literature.

The cases are organized into three typologies: Transdisciplinary Learning Laboratories; Participatory Housing & Community Prototypes, and Circular Design & Educational Studios. This structured typology enables a comparative analysis of curriculum integration, knowledge co-production, and spatial realization. This study synthesizes emerging patterns in student and stakeholder roles, educational frameworks, and design outcomes. Key contributions include extending the discourse on transdisciplinary architecture beyond theory to include built artifacts generated via pedagogical practice and presenting a framework of curriculum-driven typologies that inform design education reform. Furthermore, identifying institutional conditions, such as partnerships, studio formats, and sustainability focus, that support successful curriculum-to-construction translation is essential. In doing so, this research reframes architectural education as an arena of built knowledge production, demonstrating how European architecture programmes actively construct transdisciplinary design within material and social landscapes.

2. Conceptual Framework: Transdisciplinarity in Architecture

Transdisciplinarity is increasingly acknowledged as a critical paradigm for addressing "wicked problems" that exceed the capacities of individual disciplines. It involves not only the integration of academic disciplines but also the inclusion of non-academic knowledge systems, such as those of local communities, policymakers, and practitioners, in a collaborative process of knowledge co-production (García-Hernández et al., 2020; Nowotny et al., 2011). Within architectural education, transdisciplinarity challenges the traditional separation between design theory and professional practice by engaging diverse actors and value systems in real-world, often constructed, outcomes. The concept of a curriculum–construction continuum describes a pedagogical model in which student learning extends beyond conceptual design into actual implementation, often at full scale. This reframes the architectural curriculum as a driver of real-world transformation rather than merely a preparatory stage for practice. This echoes the shift from representational to performative education, where architectural knowledge is tested and refined through material realization. Learning laboratories, especially in the form of urban living labs, are emerging as key environments where academic, civic, and technical actors collaborate in situated experimentation. These labs serve as testbeds for urban innovation, participatory governance and sustainable development (Puerari et al., 2018). In the architectural context, design studios or design–build courses can function as living labs when they are embedded in real communities, use feedback loops, and engage with external actors to inform iterative design. The term stakeholder co-design refers to participatory design practices that involve diverse societal actors—such as residents, NGOs, municipalities, and engineers—as co-creators rather than passive clients. In architectural pedagogy, this approach introduces complex negotiation and reflexive learning, wherein students learn to balance social, technical, and aesthetic concerns through collaborative inquiry (Panayi et al., 2023; Till & Schneider, 2007). Philosopher and physicist Basarab Nicolescu frames transdisciplinarity as a response to the fragmentation of knowledge, introducing three key axioms: (1) the existence of multiple levels of reality; (2) the logic of the included middle, which allows contradictory systems to coexist and interact; and (3) the principle of complexity (Nicolescu, 2002). This framework is particularly relevant to architecture, where the material, social, and symbolic dimensions of space interact across scales and disciplines. The logic of the included middle provides an epistemological basis for negotiating design intentions, stakeholder input, and environmental constraints. The concept of Mode 2 knowledge production, developed by Gibbons, Nowotny, and colleagues, describes knowledge created in the context of application, marked by heterogeneity, reflexivity, transdisciplinarity, and social accountability (Gibbons et al., 1994; Nowotny et al., 2011). In contrast to Mode 1 (disciplinary, university-based research), Mode 2 occurs in hybrid spaces, often involving non-academic partners. Architectural education that engages in real-world design–build studios, participatory housing projects, or circular prototyping labs can be seen as operating under Mode 2 logic, producing not only academic knowledge but also socially robust solutions. Jeremy Till and Tatjana Schneider argue for the architectural profession to embrace co-production, where outcomes emerge from dynamic interactions between designers and users. Their work challenges hierarchical authorship and calls for design as a negotiated and reflexive process, particularly in educational settings (Till and Schneider, 2007). Similarly, Donna Haraway's concept of situated knowledge rejects universal objectivity in favor of partial, embodied perspectives that acknowledge positionality and interdependence (Haraway, 1988). Together, these perspectives advocate for architectural pedagogy that prioritizes negotiation, empathy, and epistemic humility— the central tenets of transdisciplinarity. Architectural methods aligned with transdisciplinarity include design–build studios, urban living labs, and stakeholder-centered co-design workshops. In these contexts, students are active agents of both learning and transformation. The ENaQ project in Oldenburg, for instance, featured semester-long student collaborations with city officials and technical consultants to co-develop site-specific prototypes for energy-efficient neighborhoods (Brandt et al., 2022). Such models embody both Nicolescu's "logic of the included middle" and Mode 2 epistemology. Reframing the design studio as a transdisciplinary laboratory involves engaging with multiple knowledge systems and framing uncertainty as productive.

Panayi et al. (2023) demonstrate this in their "Co-creation Design Studio," where students facilitated urban regeneration workshops with local citizens and municipal partners. Through iterative feedback and embedded action, the studio became a platform for civic agency rather than merely architectural representation. Transdisciplinary research in architecture requires methods that support ongoing reflection, stakeholder responsiveness, and systemic learning. Schön's (1983) "reflective practitioner" model is foundational, but in transdisciplinary contexts it is expanded through post-occupancy evaluations, user ethnography, and feedback-driven adaptation. Huning et al. (2021) outline the success conditions for such real-world labs: long-term framing, institutional support, and balanced scientific-practical aims—all increasingly relevant in architecture schools seeking to produce meaningful built interventions. Transdisciplinarity in architecture is more than just a methodological choice. This represents a fundamental change in how knowledge is generated, disseminated, and utilized in constructed environments. Drawing from Nicolescu's multi-level ontology, Mode 2 theory, and feminist epistemologies, this framework enables architectural education to move beyond disciplinary confines and become a site of transformative knowledge production. This framework underpins the selection and analysis of European case studies that follow, each illustrating diverse operationalizations of transdisciplinary logic from curriculum to construction.

3. Methodology: Case Study Selection Process

This chapter outlines the process through which the case studies were selected to support the investigation of transdisciplinary practice in architecture, with particular emphasis on the continuum from architectural education to built realization. Recognizing that transdisciplinarity in architecture is often discussed at a conceptual or theoretical level, this study seeks to ground such discourse in empirical cases that manifest transdisciplinary collaboration through physical interventions—structures, buildings, or prototypes— in a European context. The guiding question for the case study selection was: *How are transdisciplinary processes in architecture enacted through educational settings and translated into real-world building-scale outcomes?* This question builds on the assumption that transdisciplinarity involves not merely the interaction of different academic disciplines, but also the active co-production of knowledge with non-academic actors—communities, institutions, industries, and policymakers. Furthermore, transdisciplinary practice in architecture often unfolds across both epistemological and material dimensions, making built projects rich sites for analysis. In line with the scope of this study, the selection aimed to identify projects where architectural pedagogical activity was a significant driver in the conceptualization, design, or realization of a built outcome. This necessitated a multidimensional selection process that combined spatial, educational, institutional, and documentary criteria. The case studies were selected using five interdependent criteria: geographic scope, scale and materiality, transdisciplinary engagement, educational integration, and documentation and verifiability of the results. To maintain cultural, regulatory, and institutional comparability, this study was limited to the European region. Europe offers a wide array of architectural education models, such as Bologna-compliant degree structures, design studios, and technical universities, making it an appropriate terrain for comparative analysis. Moreover, numerous EU-funded programs, such as Horizon 2020 and Erasmus+, explicitly encourage transdisciplinary and cross-sectoral collaboration, particularly in the built environment sector. A critical component of this study was the requirement for physical manifestations. Each selected case resulted in a constructed intervention at the building or prototype scale, whether permanent or temporary. This criterion was essential for anchoring the inquiry in tangible architectural outputs, ensuring that the analysis extended beyond planning concepts or policy discourse into realized spatial and material practices in the built environment. The heart of the selection process lay in identifying cases that involved multiple knowledge domains and actor groups beyond the traditional architecture curricula. Each case had to demonstrate transdisciplinarity through the integration of external stakeholders, such as engineers, environmental scientists, sociologists, local government officials, or community members, into the design or construction process. Projects were prioritized where collaboration was not incidental but structurally embedded in the project's logic. In

alignment with the paper's focus, this study only included cases with clear pedagogical components. This includes design-build studios, research-driven seminars, and thesis-based projects where architecture students engage with real-world clients, systems, or users. Projects initiated entirely outside educational institutions were excluded unless they included formal or sustained collaborations. Finally, projects were included only if adequate documentation was available in the form of peer-reviewed articles, theses, technical reports, or academic conference proceedings. This ensured that each case could be rigorously described and analyzed using established methods. The availability of this literature also indicates a degree of reflection and evaluation, suggesting that the case had both practical and scholarly value. The selection process began with an exploratory search of academic databases (Google Scholar, Scopus, Springer, MDPI) and gray literature (institutional reports, theses, architectural blogs). The keywords included combinations such as *transdisciplinary architecture*, *design-build studio*, *living lab*, *participatory housing*, and *architecture education*. An initial pool of over 30 cases was created. Each case was then evaluated using the five criteria described above. Cases that failed to meet at least three of the core criteria, particularly those lacking a built output or formal curricular link, were excluded. This filtering process produced a final set of 13 case studies, which were then categorized into three typologies. The first typology, called „Transdisciplinary Learning Laboratories, ' includes projects centered around university living labs or R&D environments, integrating education, research, and physical prototyping. The second typology, Participatory Housing and Community Prototypes," summarizes built environments co-produced with citizens or stakeholders, often emphasizing governance, inclusivity, and cooperative design. The third and final typology, labelled Circular Design and Educational Studios, contained architecture school projects focused on material innovation, sustainable design, and modular or adaptive reuse. Each project was further tagged for documentation level from peer-reviewed to gray literature, curriculum linkage, specifically direct vs. indirect, and building type, such as residential, educational, experimental, etc.. This provided a structured analytical matrix, enabling both thematic comparison and typological synthesis. While the chosen methodology ensured academic robustness and relevance, it also introduced some limitations. Some potentially compelling cases, particularly those involving long-term community engagement, were excluded due to a lack of accessible documentation or unclear curricular links. Similarly, non-European but pedagogically significant projects, such as the Muir Commons in California, were acknowledged but not included for consistency. Nonetheless, the curated sample captures a diverse range of approaches and contexts, offering a robust platform for evaluating the evolving role of transdisciplinarity in architectural education and practice in the future.

4. Case Studies

This chapter presents a curated selection of case studies exemplifying transdisciplinary approaches across diverse pedagogical and practical contexts. Each case provides insight into how education engages with real-world complexitythrough participatory processes, circular design frameworks, or experimental learning environments that link curriculum to construction. The cases are organized into three analytical typologies: Transdisciplinary Learning Laboratories, Participatory Housing & Community Prototypes, and Circular Design & Educational Studios. These groupings allow for comparative analyses while respecting the distinct methodological, spatial, and institutional frameworks of each project. Rather than offering a comprehensive survey, this chapter prioritizes cases with clear educational relevance, demonstrable design outcomes, and documented engagement across disciplines and stakeholders. Emphasis is placed on projects where transdisciplinary methods—such as co-design, material prototyping, systems thinking, and civic co-production—play an integral role in shaping both the process and product.

4.1 Transdisciplinary Learning Laboratories

In architectural education, the integration of transdisciplinary learning has gained increasing significance as institutions respond to complex social, ecological and technological challenges. One

particularly effective model for operationalizing this shift is the Transdisciplinary Learning Laboratory—an educational typology that links design pedagogy with real-world experimentation, often through built interventions, sensor-integrated environments, or participatory co-design. These laboratories blur the boundaries between academic curricula and professional practice, offering students, faculty, researchers, and external stakeholders collaborative platforms for inquiry, prototyping and innovation. They are typically situated at the nexus of architecture, engineering, urban planning, and social sciences, promoting systems thinking, stakeholder engagement, and iterative feedback. Transdisciplinary Learning Laboratories are also notable for generating measurable outputs, such as buildings, urban installations, or governance models, while embedding academic rigor through research, documentation, and evaluation.

This section explores selected case studies exemplifying this typology, analyzing their pedagogical structures, actor networks, and implementation processes. It further identifies the methodological innovations and operational challenges that define these spaces as hybrid environments for design education and social transformation. Through this lens, this chapter contributes to a broader understanding of how architectural curricula can extend beyond the studio to become agents of spatial, social, and environmental change.

KTH Live-In Lab (Stockholm, Sweden)

The KTH Live-In Lab, hosted by the Royal Institute of Technology (KTH) in Stockholm, serves as a full-scale educational infrastructure in which student housing functions as a real-time research and pedagogical platform. Students inhabit and study experimental apartments equipped with extensive sensor arrays to measure air quality, thermal comfort, and user behavior. The pedagogical setup integrates architecture, engineering, and behavioral sciences into student-led experiments on energy efficiency and human-building interaction. The actor network includes KTH faculty, students, private sector partners, and building technology firms. The design and construction were informed by flexible reconfiguration principles, enabling iterative redesigns by users. The transdisciplinary methodologies employed include long-term monitoring, data-driven control systems, and participatory co-design between users and researchers. Challenges include ethical concerns regarding data privacy, balancing residential use with research needs, and institutional alignment of academic schedules with project implementation (). The project exemplifies a curriculum-to-construction continuum, in which architecture students gain hands-on experience in system integration, user-centric design, and environmental analytics (Molinari et al., 2020; Russo et al., 2021; Fontan et al., 2023).

LOW3 Solar House (Barcelona, Spain)

The LOW3 Solar House, developed by the Universitat Politècnica de Catalunya (UPC), originated as an entry for the Solar Decathlon Europe 2010 and evolved into a living laboratory for sustainability education. It integrates photovoltaic and thermal systems, low-impact materials, and real-time building performance monitoring as pedagogical tools. The setup includes design studios and monitoring courses involving architecture, engineering, and environmental science students. The actor network features students, faculty, sustainability experts and competition organizers. The design and construction processes emphasized collaborative prototyping, interdisciplinary planning, and hands-on building engagement. Transdisciplinary approaches include simulation-based energy analysis, post-occupancy evaluations, and learning-by-doing in real-world contexts. The challenges included maintaining the house as a long-term infrastructure for teaching, managing evolving technical systems, and adapting research questions over time. LOW3 illustrates the potential of integrating competition-driven innovation with institutionalized learning and built-in experimentation (Masseck, 2013; Masseck, 2017).

Smart Living Lab (Fribourg, Switzerland)

The Smart Living Lab is a research and teaching platform co-developed by the École Polytechnique Fédérale de Lausanne (EPFL), University of Fribourg, and University of Applied Sciences and Arts Western Switzerland Fribourg (HEIA-FR). It is part of the BlueFACTORY innovation district and

supports interdisciplinary education in architecture, engineering, and environmental sciences. Students engage in design studios, competitions, and research projects on sustainable construction, digital technologies, and building performances. The actor network involves university partners, municipal planners, industrial collaborators and design researchers. The design and construction processes integrate openBIM technologies, participatory modeling, and sensor-rich systems for real-time environmental data collection. Transdisciplinary approaches include collaborative design workshops, digital twin implementations, and lifecycle performance tracking. The challenges include coordinating multiple academic and municipal stakeholders, balancing experimental goals with building regulations, and managing evolving data infrastructures. The Smart Living Lab exemplifies how pedagogy, policy, and construction intersect in a research-driven architectural environment (Jusselme et al., 2019; Smart Living Lab, 2019).

ENaQ Living Lab (Oldenburg, Germany)
The ENaQ Living Lab, part of the Energy-efficient Neighborhoods for the Quarter initiative, is based in Oldenburg and is led by the Carl von Ossietzky University of Oldenburg. The lab functions as an educational, participatory, and urban development platform in which students, researchers, municipal authorities, and residents co-design neighborhood-scale interventions. Pedagogically, the lab involves seminars and studios in which students directly engage in site-based design and prototyping. The actor network includes university faculty, city planners, citizen groups, and energy experts. This process features co-design workshops, prototype fabrication, and public exhibitions. Built outputs, such as energy-efficient furniture, public space modules, and shading systems, are tested in situ with community input. Transdisciplinary tools include stakeholder mapping, participatory evaluation, system integration, and iterative testing. Challenges arise from aligning municipal, academic, and citizen timeframes, navigating urban regulations, and sustaining that engagement. The ENaQ provides a clear example of how curriculum and community design processes intersect within a transdisciplinary framework (Brandt et al., 2022).

WISE Building (Machynlleth, Wales, UK)
The Wales Institute for Sustainable Education (WISE), operated by the Center for Alternative Technology (CAT) in Machynlleth, Wales, is a pedagogical and research facility designed using ecological building principles. It serves as a full-scale learning environment for postgraduate programs in sustainable architecture and in renewable energy. The building uses low-carbon materials, such as rammed earth, hempcrete, and timber, with passive design and solar strategies integrated into its architecture. The actor network includes CAT educators, postgraduate students, engineers, and local artisans. The building process involved community consultation, eco-material testing and sustainability assessments. Students contribute to the building's ongoing monitoring and use it for environmental systems analysis and research designs. The transdisciplinary elements include lifecycle analysis, participatory design, and embedded environmental education. Challenges include maintaining technical systems, balancing teaching use with comfort, and continuous performance monitoring of students. The WISE Building exemplifies how sustainable construction and architectural pedagogy can converge in an immersive live-infrastructure context (CAT 2010).

4.2 Participatory Housing & Community Prototypes

Amid the pressing crises of affordability, social fragmentation, and ecological degradation, participatory housing and community-led spatial practices have emerged as critical alternatives to conventional development. In architectural education and research, such initiatives offer unique opportunities to examine how built environments can be co-produced through collaborative design, inclusive governance and adaptive spatial typologies. This chapter focuses on Participatory Housing & Community Prototypes as a category of real-world case studies that reflect diverse transdisciplinary entanglements between citizens, designers, municipalities, and academia. These prototypes vary in form and scale, from cooperative housing blocks and cohousing initiatives to ephemeral urban pavilions and

modular micro-communities. While some projects involve direct student participation, others are retrospectively analyzed within academic curricula or contribute to institutional research projects. Common across these examples is an ethos of social embeddedness and architectural experimentation, wherein users are not passive end recipients but co-authors of space. By analyzing these cases through the lens of actor networks, pedagogical structures, and construction processes, this chapter highlights the pedagogical relevance and systemic potential of participatory models. It further interrogates how such prototypes inform the curriculum–construction continuum, offering insights into how transdisciplinary methodologies—such as co-design, spatial ethnography, and urban prototyping—can support more inclusive, context-sensitive, and future-oriented modes of architectural learning and practice.

Kalkbreite Genossenschaft

The Kalkbreite Genossenschaft is a non-profit cooperative housing development in Zurich that emerged from a civic participatory process that transformed a former tram depot into a mixed-use residential complex. Design workshops with volunteer residents and urban planners informed the conceptual vision, which led to an architectural competition in 2009. Müller Sigrist Architekten won the commission, and construction took place from 2012 to 2014, with occupancy beginning in mid-2014 (De Jorge-Huertas, 2020; Platform, 2019). Although not student-led-, Kalkbreite features prominently in academic curricula and planning seminars as a model of democratic housing and cooperative governance. The actor network includes cooperative members, municipal authorities, philanthropic lenders and architects. Its built form integrates shared intermediate spaces, rooftop gardens, commercial and cultural uses, and flexible apartment types to foster age- and income-diversity. Transdisciplinary methodologies include participatory workshops, longitudinal ethnographic observation, and comparative policy analysis (De Jorge-Huertas, 2020). Challenges involve negotiating consensus among diverse stakeholders, translating cooperative values into built environment norms, and maintaining affordability while accessing public and private financing. Kalkbreite exemplifies how community-initiated- housing can intersect with academic research and pedagogical reflection, forming a prototype of embedded curriculum construction-- discourse with indirect academic linkages (De Jorge-Huertas, 2020; Platform, 2019.

Casa Malta Cohousing

Casa Malta is a multigenerational cohousing project in Helsinki developed by the Finnish association “Koti Kaupungissa” (Home in the City) through resident-led planning and participatory workshops starting in 2007. Completed in 2013, it represents the first high-rise cohousing community in Finland and has been extensively studied for its collaborative spatial design and social integration strategies (De Jorge-Huertas, 2020). Academia engages with Casa Malta through design studio analyses, ethnographic post-occupancy studies and sustainable housing coursework. The project actor network includes future residents, cooperative facilitators, architects, and municipal planners of the project. Participatory design sessions shaped decisions regarding the layout, communal amenities, privacy, and accessibility for aging residents. The documented methodologies include human-centered design workshops, spatial ethnography, and multigenerational co-design evaluation. Challenges include reconciling diverse resident needs within shared spaces, institutional constraints on accessibility features, and bridging abstract design ideals with pragmatic governance. Casa Malta offers a rich case for examining how social science and architectural pedagogy meet in real-world collective living spaces, furnishing reflective design insights that travel through the curriculum as scholarly exemplars rather than direct design engagement (De Jorge-Huertas, 2020).

Furnish Project Prototypes (Multiple EU Cities)

The FURNISH (Fast Urban Responses for New Inclusive Spaces and Habitat) project, funded by the EU Horizon 2020 program, implemented temporary urban prototypes across cities such as Barcelona,

Ljubljana and Milan during the COVID-19 pandemic. It mobilized interdisciplinary design teams—including students, researchers, urban planners, and local stakeholders—to co-create micro-installations for reimagining public spaces under the constraints of physical distancing. The pedagogical setup was framed through short-term intensive workshops (e.g., "sprints") hosted by design schools and research institutes. Student teams collaborated with city authorities and local communities to develop and prototype interventions, such as pop-up pavilions, modular benches, and shading structures. These designs were then fabricated and installed in real-world settings for public use and feedback collection. The transdisciplinary methods included design thinking, digital fabrication, urban prototyping, and citizen engagement. The challenges involved compressed timelines, navigating permitting with municipal bodies, and ensuring the durability of installations. The FURNISH project exemplifies curriculum-to-construction pathways through direct student involvement in ephemeral but high-impact interventions, serving as a scalable model for community-responsive design-build learning (Nicolau et al., 2021).

Concept House Village (Rotterdam, Netherlands)
The Concept House Village in Rotterdam is a sustainable housing test site developed by the Delft University of Technology (TU Delft) in collaboration with housing corporations, construction firms, and municipalities. Situated in the Heijplaat district, the project allowed architecture and engineering students to co-design and construct full-scale housing prototypes while exploring energy neutrality, prefabrication, and material experimentation. Pedagogically, the initiative is integrated into TU Delft's curriculum through interdisciplinary design-build studios and thesis research. Student teams develop experimental housing units from conceptual design to onsite realization under the supervision of faculty and technical advisors. The actor network includes academic departments, public housing providers, technology companies, and local residents. The project employs transdisciplinary methods, including performance modeling, stakeholder design charrettes, and life-cycle impact assessments. Design iterations were tested on-site, with feedback informing subsequent prototypes. The challenges included scaling academic schedules to accommodate construction timelines and maintaining regulatory compliance while pursuing experimental methods. Concept House Village is a clear example of sustainability labs integrated into architectural education, where students participate in the full value chain of design, testing, and habitation, linking academic experimentation to tangible urban development (Kieft & Visscher, 2015; Silvester et al., 2017).

BlueCity Circular Lab (Rotterdam, Netherlands)
BlueCity, located in a repurposed swimming complex in Rotterdam, functions as a circular economy hub, incubator, and maker lab supporting urban transitions to regenerative design. Although not initiated as a university project, it has hosted numerous workshops, theses, and design collaborations with institutions such as Rotterdam University of Applied Sciences and TU Delft. Its pedagogical role lies in providing an experimental testbed for circular design principles, where students and young entrepreneurs can prototype systems for material reuse, upcycled architecture, and closed-loop resource flows. Actor networks include start-ups, waste material suppliers, local governments, and academics. BlueCity also operates educational programs, such as the BlueCity Lab Fellowship for young professionals. Transdisciplinary methods involve biomaterial prototyping, cradle-to-cradle design, urban metabolism modeling and stakeholder co-innovation. Challenges arise in aligning entrepreneurial goals with educational pacing, managing shared maker resources, and translating experimental ideas into a durable system. Although its engagement with architectural curricula is often indirect, BlueCity represents a maker–research nexus where pedagogy, entrepreneurship, and civic innovation converge, offering an immersive environment for testing circular architectural logics in a real-world adaptive-reuse setting (de Jong et al., 2020).

4.3 Circular Design & Educational Studios

As architecture faces escalating demands for climate responsibility, resource scarcity, and lifecycle accountability, circular design has emerged as a transformative paradigm in both practice and education. This chapter examines how architectural studios and experimental projects have begun to adopt circular principles—not merely as technical constraints but as pedagogical frameworks for systemic innovation. It focuses on Circular Design & Educational Studios, where students, educators, and external collaborators engage in the co-creation of built environments designed for disassembly, reuse, and regenerative impact, extending beyond conventional teaching models by embedding material experimentation, lifecycle assessment, and stakeholder engagement into the design-build process. Projects range from modular campus pavilions and upcycled maker spaces to city-sponsored testbeds that prototype and reuse infrastructures. While some are embedded directly within design curricula, others serve as living extensions of academic inquiry, offering students immersive exposure to material flows, supply chains and socio-technical systems. By analyzing these case studies, this subchapter highlights how circularity becomes not only a design goal but also a transdisciplinary method that reshapes architectural learning. This underscores the challenges and potential of aligning educational timelines with fabrication realities, balancing design ambition with resource ethics, and cultivating circular literacy as a core competency for future spatial practitioners.

TU Braunschweig Study Pavilion (Braunschweig, Germany)

The Study Pavilion at TU Braunschweig, designed by Gustav Düsing and Max Hacke, is a flexible modular campus building conceived through an architecture-student competition initiated by the university and the city's architecture association. Serving as an interdisciplinary hub, it hosts seminars, exhibitions, and informal learning for all faculty members. Pedagogically, architecture students led the design process in collaboration with faculty and appointed engineers. The Pavilion features a design-for-disassembly concept: a steel–wood- hybrid structure on a 3 × 3 m grid designed for modular reuse. Constructed using sustainable materials, its form reflects co-design and future adaptability principles. Transdisciplinary methodologies include student–city collaboration, material reuse strategies, and flexible spatial planning. The challenges included meeting public-use requirements, integrating regulatory approvals, and balancing innovative design with durability. The Pavilion embodies circular architectural education: a student-generated design influenced by circular economy principles materializes in a built flexible space, integrating campus pedagogy and community usage into a durable architectural prototype (ArchDaily, 2023; TU Braunschweig, 2023).

Turin City Lab (Turin, Italy)

Turin City Lab, evolved from the 2016 Turin Living Lab initiative, is a municipal innovation platform that extends across the city, enabling companies, research centers, citizens, and public agencies to pilot urban solutions—including circular economy experiments. The pedagogical aspect arises indirectly—university students engage through associated living lab projects, sustainability coursework, and research linked to urban experiments. Actor networks include city administrators, local firms, university departments, NGOs and citizens. The methodologies employed include structured living-lab co-creation, surveys, scenario workshops, and circular sharing-economy pulses via the AXTO suburbs project. The challenges include navigating permits, scaling pilot projects, and sustaining citizen engagement over time. The Turin City Lab exemplifies curriculum-to-construction pathways diffused through public living labs: academic projects leverage urban testbeds to prototype sustainable and circular systems, embedding education within municipal innovation infrastructures (Tanda & De Marco, 2021; Ascione et al., 2021).

SmarterLabs Network (Multiple EU Cities: Maastricht, Graz, Brussels, Bellinzona)

The SmarterLabs Network, coordinated by Maastricht University in collaboration with Graz University, Vrije Universiteit Brussel, University of Applied Sciences and Arts of Southern Switzerland (Bellinzona), and municipal partners, implemented smart city *Living Lab* experiments from 2016 to

2019 under the JPI Urban Europe framework. The initiative aimed to pilot and evaluate inclusive smart mobility solutions in real urban contexts. Pedagogical integration occurred through interdisciplinary master's seminars and research modules, where students in architecture, urban planning, transport engineering, and social sciences co-designed mobility interventions for Station Square in Maastricht or cycling infrastructure in Graz and Brussels. Students participated in live workshops, stakeholder panels and prototype co-development. The actor network encompasses academics, municipal officials, transport agencies, citizens, NGOs, and private-sector innovators. The design and construction process involved participatory focus groups, web-based co-design tools, and real-world pilot installations. Transdisciplinary methodologies included anticipatory design, focus group diagnostics to avoid social exclusion of non-"smart" citizens, multi-stakeholder co-creation, benchmark reporting, and upscaling toolkits developed for smart city governance. Challenges included aligning academic timelines with urban decision cycles, ensuring the inclusion of digitally underserved populations, and translating pilot outcomes into policy changes. SmarterLabs exemplifies a decentralized curriculum-to-construction model in which student-led experimentation is embedded within municipal testbeds, highlighting how urban Living Labs can operationalize transdisciplinary education and prototype systemic urban change (JPI Urban Europe, 2019; Maastricht University, 2023a; Maastricht University, 2023b).

5. Cross-Case Synthesis

The 13 case studies examined in this research span a wide spectrum of geographic, institutional, and disciplinary contexts, yet collectively articulate a robust framework for transdisciplinary architectural practice. Grouped into three overarching typologies—Transdisciplinary Learning Laboratories, Participatory Housing and Community Prototypes, and Circular Design and Educational Studios—these projects offer critical insights into how architectural education can be extended beyond the representational confines of the design studio towards realized, socially embedded, and ecologically attuned built outcomes. This chapter offers a comparative synthesis of the cases, identifying the recurring strategies, typological distinctions, systemic challenges, and epistemological shifts that characterize contemporary transdisciplinary architectural education. The study concludes with reflections on the pedagogical and societal implications of these findings for future curriculum development and institutional transformation.

5.1 Recurring Patterns Across Typologies

A significant pattern across the cases is the presence of a curriculumconstruction continuum, whereby student engagement extends from early conceptual stages to physical construction and post-occupancy evaluation. Projects such as the Concept House Village in Rotterdam and the EU-funded FURNISH initiative exemplify this model of collaboration. In these instances, students participate in full-scale prototyping through interdisciplinary design studios, often supported by thesis research and in collaboration with academic staff and external stakeholders to develop a prototype. A particularly advanced iteration of this continuum is seen in the KTH Live-In Lab in Stockholm, where students not only co-design experimental housing units but also reside in them, thereby closing the feedback loop between the design intent and lived experience. The integration of sensors and data analytics supports longitudinal studies on energy efficiency, indoor air quality, and user behavior, reinforcing the lab's role as a research-driven pedagogical platform. External stakeholder engagement is a cornerstone of transdisciplinary practice across all typologies. Projects such as ENaQ (Oldenburg, Germany) incorporate utility providers, urban planners, and local residents into the design and implementation process, forming multi-actor constellations that challenge the traditional hierarchies in architectural production. Similarly, in Casa Malta (Helsinki) and Kalkbreite (Zurich, Switzerland), housing cooperatives and elderly residents are directly involved in designing their domestic environments, thereby reshaping conventional client-designer dynamics. In the BlueCity Circular Lab,

transdisciplinarity is enacted through the convergence of architecture students, social entrepreneurs, and circular economy start-ups in a former swimming complex repurposed as an innovation hub. These networks not only enhance the relevance of educational outcomes but also function as living ecologies for mutual learning and experimentation. The pedagogical structures enabling these projects are equally diverse, yet they share common commitments to integrative thinking, systems literacy, and collaborative authorship. The Smart Living Lab in Switzerland incorporates lifecycle assessment (LCA) tools, real-time energy modeling, and cross-disciplinary faculty teams into its studio culture. SmarterLabs, a JPI Urban Europe initiative, advances anticipatory governance methodologies and reflexive pedagogies that help students engage with complexity, uncertainty, and ethical dilemmas in urban innovation. Together, these approaches mark a departure from siloed, discipline-specific instruction, moving instead towards what Nicolescu (2002) describes as "the logic of the included middle"—a methodological orientation that embraces contradiction, multiplicity, and interdependence as central to knowledge production.

5.2 Typological Divergences

Although unified by a commitment to transdisciplinary pedagogy and built experimentation, the case studies examined in this research exhibit meaningful divergences based on their typological positions. Transdisciplinary Learning Laboratories, such as WISE, KTH Live-In Lab, and the Smart Living Lab, tend to be embedded within long-standing institutional frameworks that support sensor-based monitoring, post-occupancy evaluation, and design-build integration. These projects often involve robust academic infrastructures that facilitate continuity across research, teaching, and implementation, allowing for iterative testing and evidence-based refinement of design solutions.In contrast, Participatory Housing and Community Prototypes—including Kalkbreite in Zurich, Casa Malta in Helsinki, and ENaQ in Oldenburg—foreground civic collaboration, social governance, and long-term inhabitant engagement. These cases often emerge from cooperative housing movements or municipal initiatives, with academic institutions participating indirectly or through research partnerships. Their emphasis is less on technological innovation and more on social transformation, exploring how spatial design can be co-produced with residents to foster inclusive, adaptable, and democratic living environments. Meanwhile, Circular Design and Educational Studios, such as the TU Braunschweig Pavilion, BlueCity Circular Lab, and Turin City Lab, emphasize material innovation, infrastructural reuse, and lifecycle design awareness. These initiatives often operate as temporary installations or demonstrator projects, serving as testbeds for circular economy principles and design-for-disassembly methods. They provide opportunities for students and researchers to explore sustainable construction practices in situ, often under time-constrained and resource-limited conditions. Together, these typological distinctions reveal the breadth of approaches to transdisciplinary architectural education, shaped by varying institutional priorities, socio-technical contexts, and the degree of integration between academia and practice.

5.3 Operational Challenges and Systemic Barriers

While each case study demonstrates the potential of transdisciplinary collaboration, they illuminate a series of systemic challenges that constrain its implementation and scalability. A recurring issue is the temporal misalignment between academic calendars and construction or community-engagement timelines. Projects such as the TU Braunschweig Pavilion and Concept House Village encountered difficulties in synchronizing teaching schedules with design-build execution, resulting in fragmented participation or reliance on post-studio continuation through research or volunteer work. Legal and regulatory frameworks also pose significant hurdles, particularly for projects situated in public spaces or subject to urban governance protocols. The FURNISH project and Turin City Lab both struggled with zoning, safety, and administrative approvals, which delayed implementation or necessitated extensive negotiations with municipal authorities. These experiences underscore the need for flexible

regulatory mechanisms that can accommodate experimental and educational interventions. Another critical challenge is sustaining stakeholder engagement beyond the duration of academic involvement. In ENaQ and SmarterLabs, the success of participatory frameworks depended on long-term trust building and institutional anchoring, often exceeding the scope or resources of a single research grant or studio cycle. Without mechanisms for continuity, such as embedded facilitators or co-governance agreements, there is a risk of stakeholder fatigue and erosion of the collaborative momentum. Resource limitations were also prevalent, particularly in projects that emphasized material prototyping and low-tech innovation. Initiatives such as BlueCity and LOW3 encountered constraints related to funding, fabrication facilities, and logistical support, which limited the scale and durability of their interventions. These barriers point to a broader structural issue: the undervaluation of design-build and transdisciplinary work within traditional academic evaluation systems, which often prioritize publications over built experiments.

5.4 Epistemological and Pedagogical Shifts

Collectively, the case studies analyzed in this research suggest an epistemological transformation in architectural education. Rather than viewing knowledge as abstract, disciplinary, and top-down, these projects embrace a paradigm of situated, collaborative, and performative learning that is more holistic. The design studio is reconceptualized as an infrastructure for social learning, where knowledge is co-produced through engagement with real-world constraints, diverse actors and feedback-rich environments. This shift aligns with the theoretical framework of Mode 2 knowledge production, as articulated by Gibbons et al. (1994), in which research emerges from applied, interdisciplinary and problem-oriented contexts. Architecture students no longer function solely as learners or designers but as co-researchers, facilitators, and mediators across institutional boundaries. Their role is reflexive, responsive, and relational, requiring skills in negotiation, translation, and systems thinking. This transformation is further reinforced by adopting methodologies rooted in transdisciplinary theory. The logic of the “included middle” (Nicolescu, 2002) is operationalized in studios that hold together contradictory demands: environmental performance and aesthetic expression, user participation and technical precision, and academic rigor and societal relevance. The presence of reflexivity, both individual and institutional, is essential for navigating this complexity. Projects such as ENaQ and SmarterLabs exemplify how built experimentation can serve as a lens through which students and researchers can reflect on their positionality, assumptions, and impacts. Moreover, these shifts resonate with feminist and critical epistemologies, notably Donna Haraway’s (1988) concept of “situated knowledges.” By acknowledging partial perspectives and embracing complexity, these studios cultivate a more inclusive and accountable approach to architectural education, one that is attuned to both the sociopolitical and ecological dimensions of design practice.

5.5 Contributions to Architectural Education and Societal Engagement

The findings of this comparative study contribute meaningfully to ongoing debates in architectural education, particularly regarding its relevance, adaptability, and societal engagement. One of the most salient insights is the importance of long-term partnerships among academic institutions, municipalities, and industry stakeholders. Projects supported by enduring collaborations, such as those at the EPFL or TU Delft, tend to demonstrate greater continuity, impact, and institutional learning. These partnerships provide stability for experimentation, allowing for iterative development of design and pedagogical approaches. Equally critical is the adoption of open-ended pedagogical formats that allow flexibility and responsiveness to emerging challenges. Design-build studios, inter-institutional fellowships, and student-led research initiatives offer alternative modes of learning that transcend conventional studio models. By embedding real-world constraints, including budgetary, material, and logistical limitations,

these pedagogies foster resilience, creativity, and system awareness among students. Furthermore, the integration of embedded feedback mechanisms, such as post-occupancy evaluation, stakeholder review sessions, and data analytics, enhances the iterative nature of learning and grounds design decisions in empirical evidence. These tools not only improve the quality of built outcomes but also strengthen the capacity of students and educators to engage in reflective and adaptive practices. In summary, the case studies analyzed in this research exemplify a reimagined role for architectural education: one that is socially engaged, ecologically literate, and epistemologically reflexive. They demonstrate how the boundary between academia and society can be reconstituted through shared experimentation, co-production, and mutual learning. As architectural education continues to evolve in response to planetary and societal urgencies, the insights derived from these transdisciplinary practices offer a compelling blueprint for future curriculum and institutional innovation.

6. Discussion

The findings of this study reaffirm and extend the argument that architectural education is undergoing paradigmatic transformation driven by transdisciplinary imperatives. A detailed examination of 13 European case studies mapped across three distinct yet interconnected typologies demonstrates that architecture is no longer solely concerned with representation practices or formal aesthetics. Instead, it increasingly functions as a platform for the co-production of situated knowledge, social innovation, and ecological experimentation. This redefinition echoes calls by scholars such as Nicolescu (2002), Nowotny et al. (2011), and Till and Schneider (2007) to shift architectural pedagogy towards relational, reflexive, and transformative modes of inquiry. Central to this transformation is the operationalization of what we have termed the curriculum–construction continuum, whereby student learning is embedded within real-world design-build processes and is supported by long-term institutional and community partnerships. Unlike traditional pedagogical models, where conceptualization is decoupled from execution, the cases examined in this study show that transdisciplinary architectural education is most effective when design decisions are tested, refined, and evaluated through built experiments. This mode of pedagogy mirrors what Gibbons et al. (1994) describe as Mode 2 knowledge production, wherein knowledge emerges through iterative processes involving diverse societal actors and is grounded in applied contexts. Importantly, this continuum is not simply a logistical or methodological feature but a philosophical shift that repositions architectural education as an agent of societal change. The case studies also reveal that transdisciplinarity is not an abstract ideal but a lived condition that presents both opportunities and tensions for researchers. On the one hand, collaborative frameworks, such as Living Labs, cooperative housing prototypes, and circular design studios, cultivate new skills in negotiation, systems thinking, and stakeholder engagement. On the other, they introduce significant operational complexity, such as temporal misalignments, regulatory challenges, and resource constraints. The projects analyzed—particularly ENaQ, KTH Live-In Lab, and SmarterLabs —demonstrate that success in these contexts hinges on institutional flexibility, embedded facilitation, and iterative feedback loops. These findings align with those of Bergmann et al. (2021) and Huning et al. (2021), who argue that real-world experimentation requires balancing scientific rigor with societal responsiveness. A critical insight emerging from this synthesis is the redefinition of the student's role within transdisciplinary pedagogy. No longer passive recipients of expert knowledge, students become reflexive practitioners and co-designers whose contributions carry material, social and epistemological weight. This shift resonates with Haraway's (1988) concept of situated knowledge, which rejects the myth of objectivity in favor of positional, embodied, and dialogical understanding. In architectural education, this translates into a pedagogy that values uncertainty, partial perspectives, and collective authorship—qualities that are essential for navigating the "wicked problems" of urbanization, climate change, and social inequity. Furthermore, the typological distinctions developed in this study contribute to a nuanced understanding of how transdisciplinary goals manifest across different institutional and spatial configurations. Learning Laboratories emphasize data-driven innovation and post-occupancy evaluation, whereas

Participatory Housing Prototypes prioritize social governance and civic empowerment. Circular Design Studios focus on material experimentation and lifecycle thinking. These variations suggest that while transdisciplinarity offers a shared ethos, its implementation is contextual and contingent on local ecosystems of knowledge, funding, and policy. These findings have profound implications for architectural education. First, they underscore the need for curricular reform that goes beyond adding interdisciplinary content to embrace a structural reorganization of learning environments. This may include re-thinking credit systems, accreditation metrics, and faculty roles to support long-term, open-ended, and socially embedded design projects in the curriculum. Second, they point to the importance of institutional alliances with municipalities, NGOs, and industry partners, not as peripheral stakeholders but as co-educators and co-researchers. Third, they invite the recalibration of academic evaluation, recognizing process, participation, and impact as valid scholarly outputs alongside more traditional deliverables. Finally, this study advocates reframing architectural education as a transdisciplinary infrastructure for societal transformation. Rather than treating design as a solutionist endeavor, these projects position architecture as an iterative, relational, and situated practice. In doing so, they contribute to a broader epistemic shift in higher education towards knowledge that is interdisciplinary and applied, as well as ethical, inclusive, and accountable to the communities it serves.

7. Conclusions and Outlook

This study explored the intersection of architectural education and transdisciplinary practice through an in-depth analysis of 13 European case studies. Drawing from theoretical perspectives, including Mode 2 knowledge production, Nicolescu's "logic of the included middle," and feminist epistemologies, this study articulated a conceptual and empirical framework for understanding how transdisciplinarity is operationalized within architecture. The typologies of Transdisciplinary Learning Laboratories, Participatory Housing Prototypes, and Circular Design Studios demonstrate the diverse modalities through which academic curricula can be translated into socially embedded, materially realized, and ecologically conscious built outcomes. The case studies confirm that transdisciplinary architectural education fosters a curriculum–construction continuum, wherein students become active agents in the co-production of knowledge and space. Through participatory design, data-driven experimentation, and embedded stakeholder collaboration, these educational settings exceed the boundaries of traditional studio cultures. They enact new forms of civic engagement, institutional collaboration and environmental stewardship. In doing so, they challenge the longstanding divisions between theory and practice, academia and society, and design and use. However, this research also underscores persistent challenges. Regulatory barriers, misaligned institutional calendars, and fragile stakeholder relationships frequently constrain such initiatives. Moreover, despite their transformative potential, many of these projects remain under-recognized in conventional academic and professional evaluation systems. To fully realize the promise of transdisciplinary education, structural reform is needed within curricula, funding models, and accreditation standards to legitimize and sustain experimental, participatory, and built pedagogical approaches. Future research must address the long-term impacts of these educational models. How do students trained in transdisciplinary settings influence professional practice, institutional culture, and spatial policy after graduation? What measurable environmental, social, and economic outcomes do these projects produce over time? Longitudinal studies and post-occupancy evaluations are essential to answer these questions and establish the empirical credibility of transdisciplinary pedagogy. Moreover, comparative studies beyond the European context are needed to understand how transdisciplinarity in architecture responds to different cultural, institutional and ecological conditions. In the Global South, where informal settlements, resource constraints, and governance complexities intersect with urgent spatial needs, transdisciplinary approaches may adopt radically different forms. Cross-cultural research can illuminate novel methodologies and ethical frameworks that further expand the discourse and applicability of transdisciplinary architecture. There is also a pressing need to develop meta-analytical tools and indicators capable of assessing not only the

academic merit of transdisciplinary studios but also their systemic relevance. These tools should encompass both qualitative and quantitative dimensions and evaluate design quality, stakeholder satisfaction, environmental performance, and institutional learning. Only through such comprehensive evaluation mechanisms can the discipline begin to mainstream transdisciplinary logic into architectural curricula and policy frameworks. In conclusion, the integration of transdisciplinary logic from curriculum to construction marks not only pedagogical innovation but also paradigmatic realignment of architectural education. This realignment compels institutions to reimagine their epistemological foundations and societal responsibility. This demands that architecture schools become facilitators of change, educating practitioners who can mediate across knowledge systems, navigate complexity, and design with humility, equity, and sustainability at their core. As architectural education confronts the intertwined crises of climate change, social inequity, and urban fragmentation, transdisciplinary practice offers not a panacea but a pathway that is iterative, inclusive, and situated. The case studies analyzed in this paper stand as both prototypes and provocations, inviting further experimentation, critique, and institutional transformation. They signal that the future of architecture lies not merely in form, but in relation between disciplines, communities, ecologies, and futures.

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Informed Consent Statement
Not applicable, as the study did not involve human subjects or personal data that required informed consent.

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Conflicts of Interest
The author declares no conflict of interest.

References

[1] Andersen, M., & Rey, E. (2019). Exploring: Research-driven building design. Smart Living Lab design documentation. Park Books.
[2] ArchDaily. (2023, May 23). *Study Pavilion TU Braunschweig / Gustav Düsing + Max Hacke*. ArchDaily.
[3] Ascione, G. S., Cuomo, F., Mariotti, N., & Corazza, L. (2021). Urban Living Labs, Circular Economy and nature-based solutions: ideation and testing of a new soil in the city of Turin. *Circular Econ. and Sustainability, 1*, 545–562. https://doi.org/10.1007/s43615-021-00011-6
[4] Brambilla, A., Nyffeler, C., Gasnier, H., Le Tiec, J.-M., & Misse, A. (2019). Low-carbon thermal inertia for sustainable building performance. In Exploring: Research-driven Building Design.
[5] Brandt, H., Rammert, M., & Kuhn, K. (2022). Participation in Living Labs: From planning to implementation in the ENaQ project. In *Urban Complexity and Sustainability Transitions* (pp. 135–152). Springer. https://doi.org/10.1007/978-3-031-03866-3_9
[6] Brandt, H., Rammert, M., & Kuhn, K. (2022). Participation in living labs: From planning to implementation in the ENaQ project. In Urban Complexity and Sustainability Transitions (pp. 135–152). Springer. https://doi.org/10.1007/978-3-031-03866-3_9

[7] Brandt, H., Rammert, M., & Kuhn, K. (2022). Participation in Living Labs: From planning to implementation in the ENaQ project. In Urban Complexity and Sustainability Transitions (pp. 135–152). Springer. https://doi.org/10.1007/978-3-031-03866-3_9

[8] CAT researchers (2011). Post-occupancy- evaluation of WISE: Indoor environment quality, embodied energy and user responses. CAT research bulletin [Technical report].

[9] Centre for Alternative Technology. (2010). The WISE Building [Technical report]. Centre for Alternative Technology.

[10] de Jong, T. M., van Bueren, E. M., & Zandvoort, H. (2020). Circular development in BlueCity: Lessons from Rotterdam's upcycling ecosystem. Sustainability, 12(18), 7404. https://doi.org/10.3390/su12187404

[11] De Jorge-Huertas, V. (2020). *Collaborative designing of communities: Helsinki and Zurich pioneers* [Article]. ACE: Architecture, City and Environment, 15(43). https://doi.org/10.5821/ace.15.43.9012

[12] Fontan, A., Farjadnia, M., Llewellyn, J., Katzeff, C., Molinari, M., et al. (2023). Social interactions for a sustainable lifestyle: The design of an experimental case study. arXiv. https://doi.org/10.48550/arXiv.2309.11310

[13] García-Hernández, C., García-Mayor, C., & Suárez, R. (2020). Experiences in transdisciplinary education for the sustainable development of the built environment: The ISAlab workshop. *Sustainability, 12*(3), 1143. https://doi.org/10.3390/su12031143

[14] Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. Sage.

[15] Haraway, D. J. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies, 14*(3), 575–599.

[16] Huning, S., Räuchle, C. & Fuchs, M. (2021) Designing real-world laboratories for sustainable urban transformation: addressing ambiguous roles and expectations in transdisciplinary teams. Sustain Sci 16, 1595–1607. https://doi.org/10.1007/s11625-021-00985-0

[17] Jarvenpää, M. (2017). Community housing and spatial well-being: A study of Casa Malta in Helsinki. Master's thesis, Aalto University School of Arts, Design and Architecture. https://aaltodoc.aalto.fi/handle/123456789/27161

[18] JPI Urban Europe. (2019). *SmarterLabs – improving anticipation and social inclusion in Living Lab experiments for smart city governance*. https://jpi-urbaneurope.eu/project/smarter-labs/

[19] Jusselme, T. B. P., Antunes Fernandes, P., Rey, E., & Andersen, M. (2019). Design guidance from a data-driven life-cycle assessment (LCA) based design method and tool prototype. 16th IBPSA Building Simulation Conference, Rome, Italy. https://doi.org/10.26868/25222708.2019.210403

[20] Kieft, A., & Visscher, H. (2015). Concept House Village: Student and researcher collaboration in sustainable housing innovation. World Sustainable Building Conference Proceedings, 1–9.

[21] Lang, R., Mullins, D., & Novy, A. (2021). Governing cooperative housing: Comparing multi-level policy frameworks in Zurich and Vienna. Urban Research & Practice, 14(1), 28–51. https://doi.org/10.1080/17535069.2020.1749827

[22] Lotfabadi, P., & Iranmanesh, A. (2025). Evaluating the incorporation of ecologically conscious building design methods in architectural education. *Buildings, 15*(8), 1339. https://doi.org/10.3390/buildings15081339

[23] Maastricht University. (2023a). *Toolkit SmarterLabs: Anticipating constraints on upscaling and inclusion in urban Living Lab experiments* [Institutional report]. https://www.maastrichtuniversity.nl/research/msi/research-output/toolkit-smarterlabs

[24] Maastricht University. (2023b). Living Lab experiment Maastricht: Smart & Future-proof Station Square [Institutional case overview]. https://smarterlabs.uni-graz.at/en/project-overview/living-lab-experiment-maastricht
[25] Masseck, T. (2013). Teaching sustainability through living labs in architecture: The case study of the UPC-LOW3 prototype. EESD-13 Conference Proceedings.
[26] Masseck, T. (2017). Living Labs in architecture as innovation arenas within higher education institutions. Energy Procedia, 115, 383–389. https://doi.org/10.1016/j.egypro.2017.05.166
[27] Molinari, M., Rolando, D., & Pallard, W. M. (2020). Using living labs to tackle innovation bottlenecks: the KTH Live-In Lab case study. BuildSIM-Nordic 2020 Selected Papers.
[28] Nicolau, J., Manzoni, A., & Gausa, M. (2021). Temporary tactical interventions as drivers for urban innovation: The case of the FURNISH project. In Proceedings of the International Conference on Urban Planning and Architectural Design for Sustainable Development. https://doi.org/10.4995/UP2021.2021.13453
[29] Nicolescu, B. (2002). *Manifesto of transdisciplinarity* (K. C. Voss, Trans.). SUNY Press.
[30] Nowotny, H., Scott, P., & Gibbons, M. (2011). *Re-thinking science: Knowledge and the public in an age of uncertainty*. Polity Press.
[31] Panayi, C., Roussou, E., & Charalambous, N. (2023). Architectural design studio: Embracing a transdisciplinary approach. In *Proceedings of the EAAE Annual Conference* (Vol. 1, pp. 96–97). European Association for Architectural Education. https://doi.org/10.1344/annual_conference.2023.186
[32] Platform Space. (2019). *Housing beyond and within the market, Part 2: Cooperative conditions in Zurich*. Platformspace.net.
[33] Puerari, E., De Koning, J. I. J. C., von Wirth, T., & Loorbach, D. (2018). Co-creation dynamics in urban living labs. In V. M. Bueren, H. van den Bosch, & J. Frantzeskaki (Eds.), *Urban living labs* (pp. 157–178). Springer. https://doi.org/10.1007/978-3-319-99472-3_9
[34] Rolando, D., Mazzotti Pallard, W., & Molinari, M. (2020). Long-term evaluation of comfort, indoor air quality and energy performance in buildings: The case of the KTH Live-In Lab testbeds. BuildSIM-Nordic 2020 Selected Papers.
[35] Russo, A., Molinari, M., & Proutiere, A. (2021). Data-driven control and data-poisoning attacks in buildings: The KTH Live-In Lab case study. arXiv. https://doi.org/10.48550/arXiv.2103.06208
[36] Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.
[37] Silvester, S., Hooijer, B., van Oosterhout, R., & van der Kemp, F. (2017). Concept house village: A next step in the development of sustainable housing in the Netherlands. In *Living Labs: Design and Assessment of Sustainable Living* (pp. 371-384). Springer. https://doi.org/10.1007/978-3-319-33527-8_28
[38] Tanda, A., & De Marco, A. (2021). A review of an urban Living Lab initiative: the Torino Living Lab experience. *Review of Policy Research, 38*(3), 370–390. https://doi.org/10.1111/ropr.12419
[39] Tejedor, G., Olmos-Gómez, M. D. C., Riley, D., Lönngren, J., & Tan, M. (2020). Transdisciplinarity in higher education for sustainability: A literature review and future research agenda. *Education Sciences, 10*(2), 40. https://doi.org/10.3390/educsci10020040
[40] Till, J., & Schneider, T. (2007). Flexible housing: The means to the end. In *Field: A Free Journal for Architecture* (Vol. 1, No. 1, pp. 23–40).
[41] TU Braunschweig. (2023). *Study Pavilion on the campus of the Technical University of Braunschweig*. TU Blog.
[42] Zhuang, J., Chen, C., & Wang, J. (2024). Redesigning building thermal science education through inquiry-based experiential learning. *Buildings, 14*(11), 3455. https://doi.org/10.3390/buildings14113455