The ANCHOR Framework: A Holistic Approach to Transdisciplinary and Regenerative Built Environment Education

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Abstract

This paper introduces the ANCHOR Framework, a transdisciplinary pedagogical model for Built Environment (BE) education, developed over a decade of iterative reflective practice (2020-2025). It addresses how conventional BE education, constrained by rigid, discipline-specific paradigms, leaves BE graduates ill-equipped for contemporary complex and systemic regenerative challenges. Utilising Schön's reflective practices, the framework integrates ontological reframing (e.g., "waste" to "discards"), Lean practices, and systems thinking to cultivate paradigm agility. Data from practioner-led reflective cycles, student artefacts, and institutional feedback demonstrate enhanced student performance and disciplinary maturity. This pedagogy promotes cross-skilling, collaborative and transdisciplinary inquiry, and increase in student motivation for advanced, discipline-adjacent topics like circular economy or regenerative design. The ANCHOR Framework aims to prepare Built Environment graduates to move from siloed disciplinary thinking to actively navigating 'wicked problems' in interdisciplinary teams within transdisciplinary learning environments. This outcome of ANHOR aims to bridging the academic-industry gap by fostering collective adaptive reasoning and leadership for sustainable transformations. This practitioner-led reflection also highlights the need for broader applicability testing and further development.

Keywords: transdisciplinary education, built environment education, paradigm agility, reflective practice, regenerative futures

1 Introduction

1.1 Implications of conventional BE education for transdisciplinary, regenerative practice

Conventional Built Environment (BE) education, constrained by rigid and discipline-specific paradigms, leaves graduates ill-equipped for the complexities of true sustainability challenges (Fry, 2009; Wiek et al., 2011). Many professionals struggle to integrate new sustainability frameworks (such as the circular economy) with established practice protocols (Geissdoerfer et al., 2017). Tackling complex, real-world problems requires teams that can learn from each other fast (cross-disciplinary), integrate diverse skills and perspectives (interdisciplinary), and, ideally, co-create innovative solutions with societal relevance (transdisciplinary) (Brown et al., 2010; Klein, 2021; Oliveira et al., 2022) see Table 1). Yet, BE education remains largely confined to disciplinary learning (Dorst, 2018; Oliveira et al., 2022), failing to provide new competencies that go beyond conventional BE education (including shared values, social engagement, and integrated cognitive adaptability), which are needed for a just and regenerative industrial transition (du Plessis, 2024; Wiek et al., 2011) While transdisciplinary research is widely discussed (Brown et al., 2010; B. C. K. Choi & Pak, 2007; Wardani et al., 2024), there is a critical lack of practical guidance for educators on how to implement transdisciplinary learning in BE higher education, where industry projects are inherently transdisciplinary yet teaching remains siloed (Dorst, 2018; Klein, 2010; Oliveira et al., 2022).

Table 1. Distinctions between various types of disciplinary learning.

Approach	Definition & Scope	Sources
Disciplinary	Single academic field, using its unique theories and methods.	Dorst (2018); Oliveira et al. (2022)
Cross-disciplinary	One discipline applies its perspective to another's topic, borrowing tools without integration.	Brown et al. (2010); Klein (2021)
Interdisciplinary	Integrating knowledge and methods from two or more disciplines to address a shared question.	Brown et al. (2010); Klein (2021); Oliveira et al. (2022)
Transdisciplinary	Creating new knowledge, transcending individual disciplines, integrating non-academic stakeholders.	Brown et al. (2010); Choi & Pak (2007); Wardani et al. (2024); Oliveira et al. (2022); Klein (2010)

A practical transdisciplinary BE education framework is needed to move from disciplinary mastery to collective adaptive reasoning, thereby addressing the complex 'wicked problems' of contemporary BE industry. This paper proposes a new BE pedagogy with emerging, practitioner-reported evidence of impact, using Schön’s (1983) reflective method to trace a decade-long evolution in my teaching in industry and higher education settings.

2 Method

This paper’s method utilizes Schön’s (1983) reflective practices, namely, reflection-in-action (real-time adjustments), reflection-on-action (post-activity analysis), and reflection-for-action (shaping future teaching iterations). Supported by principles of narrative inquiry (T. H. Choi, 2013; Ellic & Bochner, 1999; Wall, 2006), the analysis draws from a decade of experience as an industry and higher education educator, with a specific focus on the last five years (2020–2025) in a Global South Built Environment (BE) school. The reflections draw on classroom interactions, student performance, and external recognition to address the need for new educational models that equip students to tackle regenerative challenges in the BE collectively. The paper explores a central question:

How can a transdisciplinary Built Environment pedagogical framework cultivate the paradigm agility and competencies needed for systemic regenerative challenges?

This is investigated through three sub-questions:

1. SQ1: What pedagogical practices, shaped by industry and educational reflections, bridge the gap between conventional BE education and the needs of the contemporary BE industry?
2. SQ2: How could strategies from high-performing BE industry teams enable transdisciplinary learning environments in BE curricula?
3. SQ3: What evidence demonstrates that such a pedagogy has meaning or impact within and beyond the classroom?

3 Reflective analysis using Schön's framework

To perform the reflections, data were drawn from reflective practice cycles (journaling, peer engagement, curriculum review, direct teaching observations, and classroom dialogue), anonymised student artifacts (mapping exercises, open online exams, class projects, written motivations), and institutional feedback and public recognitions (external evaluations, teaching recognition). Materials were triangulated and reviewed qualitatively against three sub-questions to trace patterns in my pedagogical evolution, shifts in student framing ability, and the proposed pedagogical framework development over time.

3.1 SQ1 Reflection: Facilitating transdisciplinary BE classrooms on wicked-problems.

Drawing from reflective practice, particularly over the past five years, I have found a deep need for a shift in both mindset and pedagogy to address BE "wicked problems." (Brown et al., 2010; Rittel & Webber, 1973). This urgency stems from two intertwined challenges: the increasing societal pressure from emerging industrial paradigms (from 4th to 6th Industrial Revolutions) against the persistent rigidity of conventional BE educational models. The following reflections explore this through societal, educational, and industry contexts.

Societal context: challenges for integrative and regenerative BE education

BE challenges are complex "wicked problems" requiring more than technical fixes (Goel, 2019). The global construction sector illustrates this, accounting for 36% of final energy use, 39% of CO_2 emissions (Abam et al., 2023; Antunes et al., 2024) and raw material waste consuming up to 60% of extracted resources (Schützenhofer et al., 2022). With building energy consumption projected to reach 50% of global use by 2030 (Huyen Nguyen et al., 2024), regenerative and transdisciplinary solutions are critical. Addressing these challenges (from redefining waste to applying 4th–6th Industrial Revolution innovations) demands agile, systemic thinking and genuine transdisciplinary collaboration from BE professionals.

Educational context: BE learning structures reinforce paradigm rigidity

Traditional BE education emphasizes single-discipline mastery, with accreditation standards and assessment rubrics that prioritize technical proficiency and individual authorship over systems thinking and collaborative inquiry (Altomonte et al., 2014; Webster, 2008). This linear theory-to-application approach entrenches fixed paradigms and limits the integrative thinking essential for addressing complex sustainability challenges (Wiek et al., 2011), while cognitive research highlights that paradigm-switching demands up to 37% more mental effort (Kahneman, 2011). Thus, conventional BE education is generally poorly equipped to train students in the cognitive agility and integrative thinking necessary to tackle complex systemic challenges collectively.

Industry context: techniques of high-performance BE teams

Through reflective practice and industry experience, I noticed that high-performing BE teams use systems thinking, Language–Action (LAT) frameworks, Lean learning, and collective leadership to navigate "wicked problems". These approaches are critical for driving innovation, transdisciplinary collaboration, and informed decision-making. However, traditional BE education often neglects these competencies or isolates them within discipline-specific silos, leading professionals to acquire them informally, much late in their careers, and typically only through specialized organizational training.

3.2 Reflections on SQ1

The rigidity of conventional BE education and its neglect of high-performance team competencies has created a critical gap between what the industry demands to solve "wicked problems" and what BE education provides. To close this gap, I performed a critical practice reflection on shared issues from both settings.

Reflection-in-action: The importance of real-time facilitation through active language alignment

In both industry and education settings, the most important real-time adjustments in learning sessions involved translating terminology to build a shared understanding and align behaviours. I found that many high-performing teams use similar techniques but fail to recognise this due to differences in disciplinary language. A facilitator is therefore critical in redirecting the focus from competing definitions to collective action, ensuring attention remains on the common problem rather than disciplinary preferences.

Reflection-on-action: Shifting hesitation to embodied habit.

A key insight is that even experienced professionals, while readily adopting iterative practices and intuitive interdisciplinary communication, can still exhibit behavioural blind spots or hesitation without a facilitator. Conversely, students are often hesitant to respond in real-time due to fear of judgment, which inhibits learning and creativity. In both cases, regular real-time observation and feedback are essential to move from these mental hesitations to embodied practices, underscoring the critical role of active facilitation.

Reflection-for-action: Establish conceptual shifts early through LAT and Lean scaffolds

Early in my practice, I introduced full Lean innovation frameworks upfront, which often overwhelmed participants and diluted engagement. Over time, I began to build learning from the ground up instead, applying only foundational *Kaizen* principles to the learning process itself to sustain momentum that support open-ended, collaborative problem-solving. Similarly, instead of gradually introducing Language-Action Theory (LAT), I now begin with reframing shared issues from the start (for example, immediately replacing the word "waste" with "discards.") These adjustments have greatly improved clarity and engagement in both academic and professional settings.

Concluding reflection on SQ1

These reflections expose a critical gap between the BE industry's needs for addressing "wicked problems" and what conventional BE education delivers. Rigid, single-discipline BE pedagogy leaves graduates ill-prepared for the agile, collaborative solutions required in practice. Closing this gap demands a fundamental shift in educational practice, beyond simply adding new topics in curricula. Reflection-in-action showed me the value of translation between disciplinary languages to build shared understanding across diverse participants. Reflection-on-action revealed that student and professional hesitations can be overcome through real-time facilitation and demonstrations of intentional, embodied practice. Reflection-for-action led me to replace top-down practices with foundational principles. Early language reframing (e.g. shifting from "waste" to "discards") enabled quicker confidence and engagement from the outset. The reflections show that an effective transdisciplinary BE teaching framework must be deliberately scaffolded, actively facilitated, open, and iterative, converting theory into collaborative, embodied practice. This approach could shift students from passive recipients of siloed knowledge to active navigators of complex challenges, equipping them to better lead the transition toward a regenerative future.

3.3 SQ2 Reflection: Developing a transdisciplinary pedagogy in Built Environment education

Building on SQ1 reflections, I developed a transdisciplinary BE teaching framework integrating Language–Action Theory (LAT), Lean practices, and systems thinking. It aims to build paradigm agility, preparing students to work collaboratively in inter- and transdisciplinary teams on complex, real-world challenges. The following sections outline the framework's development and techniques.

Creating paradigm-agility through *LAT,* Lean learning, and systems thinking

The pedagogy unfolds over a multi-module (Table 2). Modules are formally implemented in a postgraduate architecture program with voluntary transdisciplinary participants (including engineering, urban planning, geography, real estate, quantity surveying, including engagement with professional and community stakeholders). Modules are in 6-week learning cycles, and sub-sections outline pedagogical tools used.

Table 2. Course design and teaching integration.

Module 1 (e.g. Urban Strategy Course)	Modules 2-4 (Postgraduate Research)
A collective design course focused on real-world challenges. Students use ontological reframing, fieldwork, and stakeholder engagement to develop creative, conceptual solutions.	An extension of Module 1 where students, both formal and voluntary, align their individual disciplinary research with a shared transdisciplinary challenge. This enriches individual outcomes with broader insights while maintaining disciplinary integrity.

While architecture students are formally enrolled, external students can attend without formal enrolment (Figure 1a). Students are encouraged to align their core disciplinary focus with the larger cohort's transdisciplinary problem, working with their own supervisors to achieve their pedagogical outcomes. This flexible structure removes the need to change modules, registrations, or curricula. It also allows international opportunities (Figure 1b), enabling students to work with peers abroad and participate remotely without restructuring their local modules (Davey, 2024).

Figure 1 a) Example of a transdisciplinary classroom environment, where architecture, engineering, geography, industry, and community stakeholders collaboratively explore a shared challenge and learn techniques together.

Figure 2 b) A flexible multi-module structure enables parallel international transdisciplinary collaboration, where diverse students can contribute to a common project remotely across disciplines without disrupting local modules or curricula.

Ontological reframing through Language-Action Theory *(LAT)*

Building on the principle that language shapes reality (Flores, 2012) the pedagogical process begins with ontological reframing through Language-Action Theory (LAT). To illustrate, this example presented here uses the conceptual idea of a "Zero Discard City" to address transdisciplinary challenges of circularity and waste recovery in the BE. Traditionally, urban waste is framed as a production or management issue, leading to fragmented, shallow solutions like "bigger landfills" or “faster recycling systems.” Such symptomatic and shallow solutions perpetuate the problem's wickedness. This limited perspective stems from entrenched language that treats "waste" as an external by-product and "someone else's problem" (Davey & Macomber, 2017; Liboiron & Lepawsky, 2022). In reality, waste is a holistic, systemic issue affecting all of society.

To address this, the pedagogy combines strategic language shifts with a structured goal-setting process that uses Lean practices like *Hoshin Kanri* and a simplified *Toyota Kata* (Davey & Macomber, 2017). Each learning cycle begins by introducing new language to redefine concepts and foster a shared commitment among diverse students. For instance, reframing "waste" as "discards" (Liboiron & Lepawsky, 2022) helps students see potential value where conventional paradigms see only by-products. This intentional shift challenges fixed assumptions, fostering creative, systemic, and regenerative problem-solving. This new shared lexicon also reframes other key concepts. For example, “Failure” becomes “Iteration” (redirecting emphasis from mistakes to continuous improvement), or “Demolition” becomes “Harvesting” (underscoring untapped potential in resource recovery). Table 3 demonstrates other teacher-facilitated LAT shifts.

Table 3: Example of contextual Language-Action (LAT) shifts.

Technique	Before	After
Ontological Reframing	Disciplinary assessment: "Waste" is a useless by-product of a project/industry/practice to be disposed of, with no inherent value to anyone.	Transdisciplinary declaration: "Discards" are materials-in-transition with latent value, creating possibilities for reuse for all.
Commitment Mapping	Conventional commitment: "*My* work/project is done once my disciplinary task is complete, regardless of the by-product/consequence. This is my commitment only.”	Integrated commitment: "*Our* work/project is done when *our* 'by-product/consequence’ from the project/discipline are passed on with its known latent value for the next project/discipline, creating a chain of commitments."
Trust Cultivation	Assessment that erodes trust: "Dealing with 'waste' is a burdensome cost on everyone, someone else’s problem, and reduces our economic efficiency."	Assessment that builds trust: "Repurposing 'discards' creates economic, systemic, and environmental opportunity, making us collectively more resourceful."

This new shared language aligned diverse students to one common goal, streamlined communication, reduced definitional conflict, and fostered the collective thinking needed for responses to complex challenges. By deploying targeted LAT to real-world contextual problems (see Table 3), students are encouraged to recognize inefficiencies and potential in all aspects of human activity. This challenges the idea that a complex systemic problem (“waste”) is an inevitable, external problem and promotes holistic solutions instead.

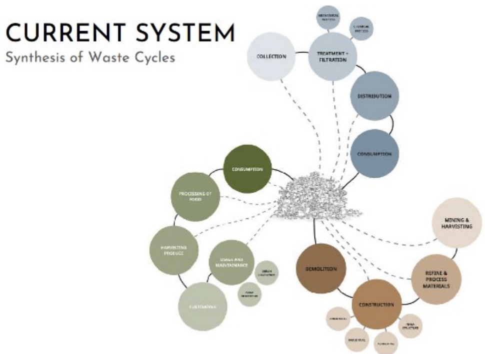

Figure 3a) student artifact showing initial grasp of disparate systems (team colours) and disciplinary contributions to the contextual problem.

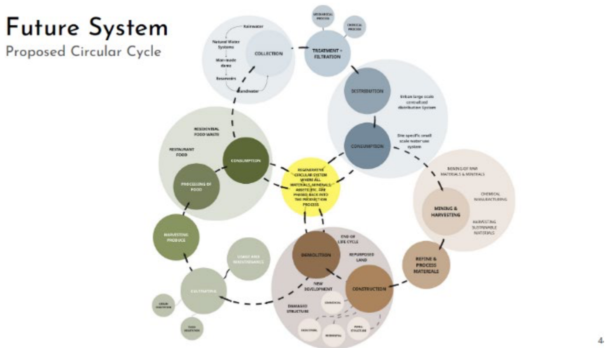

Figure 3b) 2025 student artifact showing final grasp of integrated, regenerative solutions (team colours) to the contextual problem.

This approach moves students from a paradigm of siloed 'waste-producers' to collective 'waste-finders' by reframing 'waste' as a shared challenge. This helps them transition from generating isolated, symptomatic solutions (Figure 3a) to identifying integrated, systemic root causes (Figure 3b). When reframing a shared challenge, students shift from proposing isolated, symptomatic solutions (Figure 3a) to addressing it by identifying integrated, systemic root causes (Figure 3b). Such a paradigm shift fosters transdisciplinary accountability and drives integrated, creative problem-solving (Davey & Macomber, 2017). Real-world stakeholders are invited to adopt this shared language, reinforcing collective commitment to addressing challenges and enabling a holistic environment for transdisciplinary, vicarious learning. As noted by Flores and others (Davey & Macomber, 2017; Flores, 2012; Spinosa et al., 1999), collective reframing is vital for cultivating a culture of continuous improvement and systemic innovation in organisations.

Holistic problem-framing with systems thinking and *Kaizen*

To deepen the learning process, I introduce systems thinking as foundational cognitive tool for holistic, contextual analysis. Students learn to deconstruct and frame complex problems through root-cause exploration, and recognize the interdependence of factors (such as competing stakeholder priorities, material flows, design or operational constraints) by creating systems maps together. This framing reinforces the “waste-finding” ontology and shifts student perspectives from “what is my disciplinary role” to “how can I contribute to solving the larger systemic problem” instead. Through weekly iterative development, guided by *Hoshin Kanri* and *Toyota Kata*, students cultivate a *Kaizen* mindset of continuous improvement. Regular reflection and adaptation cycles reinforce collective inquiry, adaptive learning, and systems-level engagement.

Strategic collective goal-setting with *Hoshin Kanri* and *Toyota Kata*

After initial *LAT* reframing, I use Lean-inspired goal-setting with *Hoshin Kanri* and simplified *Toyota Kata* (Davey & Macomber, 2017) to make wicked problems like urban waste actionable. *Hoshin Kanri* aligns broad transformative goals (e.g., a 'Zero Discard City') across disciplines, while *Toyota Kata* guides students’ day-to-day learning and solution development. For example, students are confronted with projections of a 70% urban waste increase by 2050 (Purohit, 2021). They then use a shared concept (e.g. “Zero Discard City”) as countermeasure to the real-world problem and set it as their global strategic imperative (Figure 4a). Following that, they translate this global objective into smaller, measurable target conditions that address real-world design and operational challenges in teams (Figure 4b).

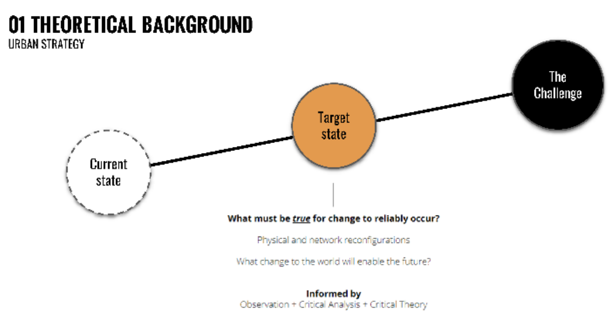

Figure 4a) 2024 Student artifact showing their theoretical understanding of *Toyota Kata* as a collective global strategic imperative.

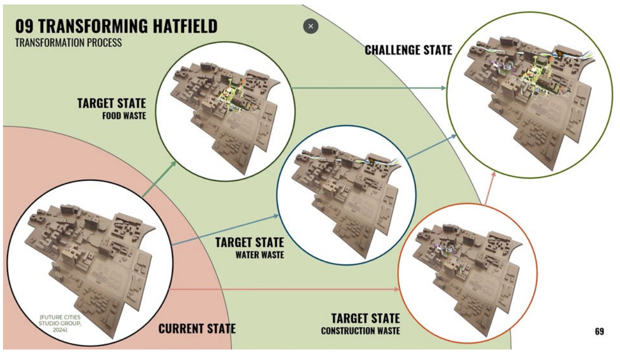

Figure 4b) 2024 Student artifact applying *Toyota Kata* to translate global objectives into measurable team targets for real-world design or operational challenges.

For example, instead of a vague goal like "society must reduce food waste," a student sub-team might target an "85% source-separated organic collection rate" for a specific urban district. This precision, emphasized in Lean leadership routines (Davey & Macomber, 2017) fosters concrete, disciplined planning while enabling flexible pathways to achieve the broader objectives central to *Hoshin Kanri*. Students continue to develop their own benchmarks based on observations and field data, balancing ambitious systems-level thinking with pragmatic, iterative improvements. Different disciplines and stakeholders contribute their unique skills and knowledge to solve the same problem, combining aspirational leadership visions with disciplined, data-informed action.

Cultivating continuous improvement with *Kaizen*

Weekly *Kaizen* coaching fosters continuous, iterative learning, showing students that ambitious targets require both individual initiative and collective wisdom. With a Socratic style, I introduce Lean improvement *Katas* such as "Go See" (direct observation), "Make One Small Change" (incremental improvements), and "Ask Why Five Times" (root-cause analysis) (Davey & Macomber, 2017). These Lean techniques help students develop technical solutions and the leadership behaviours needed for systemic change. Weekly stand-up meetings and peer coaching sessions allow them to refine strategies as new project data emerge, reinforcing the *Hoshin Kanri* and fostering leadership, creativity, and adaptability.

3.4 Reflections on SQ2

Reflection-in-action: Embed *Kaizen* through practice rather than terminology

Early in my practice, I introduced *Kaizen* through the classic Demings' *Plan–Do–Study–Act/Check* cycle (Davey & Macomber, 2017; Moen, 2009), believing that explicit verbalizing and strict structure would make such techniques easier to learn. I tended to focus on the dominant discipline in the room (often, architecture). However, this approach created cognitive overload, both for architecture and especially non-architectural students. I responded by phasing out explicit terminology and instead embedded Lean techniques through guided in-class Socratic questions, allowing students to engage more intuitively from their own perspective.

Reflection-on-action: Evolve collective goal-setting strategies for transdisciplinary creativity

I reviewed student engagement and module outcomes through formal quarterly and annual reviews. Each year, I introduced a new thematic challenge to observe student responses to applied teaching techniques. Between 2018 and 2022, I used *Toyota Kata* goal-setting method only, but found it too rigid for complex systemic problems. In response, I gradually shifted to a more flexible combination of *Hoshin Kanri, Toyota Kata*, and *Kaizen*, while also formally introducing systems thinking to the course. This combined toolset better supported transdisciplinary creativity and overall problem-solving.

Reflection-for-action: Deploy deliberate speech transformation acts to build common ground

From 2020, I began slowly incorporating *LAT* by modelling deliberate speech acts. Initially too subtle, this approach gained most traction by 2023–2025 when I focused on making this practice narrow and explicit Instead of focusing on a broader vocabulary, I started focussing only on one transformative language shift (for example, from *"waste"* to *"discard.")* This, alongside the introduction of *Hoshin Kanri,* greatly improved student creativity, focus, and commitment. These shifts directly informed the development of this papers' proposed teaching framework, which centres on cultivating paradigm agility and regenerative competencies within transdisciplinary learning environments.

Concluding SQ2 Reflections

The pedagogical shifts emerged through iterative refinement. Early use of explicit Lean terminology caused cognitive overload and was too rigid for solving complex problems. A flexible combination of *Hoshin Kanri, Toyota Kata,* and *Kaizen*, alongside systems thinking, proved more effective. Focusing explicitly on a single transformative language shift (e.g., "waste" to "discard") was more impactful than subtle language reframing. Reframing a "Wasteful City" as a "Zero Discard City" and applying a strategic process for collective goals helps students move from isolated objectives to shared, actionable targets. This approach fosters interdisciplinary collaboration and cross-skilling, developing BE graduates' adaptive, systemic thinking and preparing them to drive regenerative change in industry.

3.5 SQ 3: Outcomes, student engagement and real-world relevance

The positive impact of this pedagogical approach is evidenced by enhanced student performance, higher-quality academic research, and recognition both within and outside the university. The following reflections are reflection-on-action only.

3.6 Reflections on SQ3

Academic performance and external examination feedback

From 2022 to 2025, students consistently achieved an average external exam score of 75% (academic A), reflecting sustained engagement and mastery of complex transdisciplinary concepts. Annual reviews by external industry examiners confirmed the pedagogy's academic and real-world value. The recent 2025 external examiner report confirmed the pedagogy's value, noting that students were "significantly prepared for the world" and "were able to demonstrate inquiry into some complex topics" and "really engaged with the subject and the process" (Department of Architecture, 2025).

Transdisciplinary learning environments fosters disciplinary maturity, collaboration, cross-skilling, and mutual respect

This approach guides students from a shared, transdisciplinary starting point to focused, enriched disciplinary outcomes. These pedagogical scaffolds support their first encounters with learning beyond their own fields, helping them build core competencies without being overwhelmed. This foundation enables joint fieldwork, collaborative inquiry, and network building, mirroring real-world industry projects. When returning to their home disciplines, students produce work that is richer, more relevant, and better contextualised, informed by an understanding of their own value within the larger effort in solving complex transdisciplinary problems. The approach's positive trajectory is illustrated by architecture student feedback and subsequent research choices. Following a transdisciplinary mapping activity on construction waste, many students pursued advanced research beyond conventional architectural practice, demonstrating a newfound confidence and motivation in discipline-adjacent topics. Student feedback (2025) confirms this, indicating their experience ignited interest in new topics like circular economy, material innovation, or regenerative design (Table 4).

Table 4. Student motivations for joining advance research units (Department of Architecture, 2025).

Student Interest	A sample of excerpt from student responses
BE Circularity	*"…As I developed my understanding of the implications of our waste patterns, my appreciation for our decision-making and intentionality around materials and systems has grown significantly…"*
Material Innovation	*"…collaboration between agriculture and the built environment is a compelling prospect, as both fields may help resolve each other's dilemmas. To utilize agricultural byproducts as construction materials is an exciting possibility that I would enjoy researching and applying in future studies and practice. Regenerative thinking is essential for the future development of both fields…"*
Technology & Systems	*"My participation in the [2025] class…ignited my interest in advancements in technology, shifts in production, and evolving ways of living that shape the built environment…"*
Waste-to-Resource	*"… focus on mapping existing material flows and exploring opportunities for integrating agricultural outputs into construction and urban development strongly aligns with my interest in transforming waste systems into a circular, net-zero model. My current research into construction waste and insights from the biomass waste group have sparked my interest in converting waste into a resource and product. I am eager to explore this framework further to advance my understanding…"*
Advanced Futures	*"…I am keen to contribute to a more sustainable, technologically advanced future — whether through research or practice. The systems thinking and research done [in class] have been incredibly informative… I feel as though I already have a springboard to embrace this new research…"*
Ecological Integration	*"…I have become fascinated by ecological integration and the potential of bio-based materials... I believe I am well-suited to engage with this research due to the skills and passions I have developed through my experience [in class], which has provided me with a strong foundation in systems thinking."*
Regenerative Design	*"…by participating in this research field, we can lead the shift toward regenerative design…redefining how cities are built and how they interact with surrounding ecosystems… incredibly interesting to research not only ways to reduce harm and waste but also how to create a built environment that actively restores. This transformative area…would be an honor to participate in."*

This teaching approach naturally fosters genuine transdisciplinary collaboration and peer-led learning. For example, in 2023, architecture and engineering students initially struggled to translate field data into digital BIM models (Figure 5a).

Figure 5 a) Architecture, engineering, and geography students collaborated with industry and heritage stakeholders to translate material reuse from the field into BIM model.

Figure 5 b) Student-led, multidisciplinary "flipped classroom" where quantity surveying students voluntarily joined the project and remained actively involved throughout the year.

Driven by curiosity, quantity surveying students voluntarily joined the module, contributing cost estimation and Life-Cycle Assessment expertise that deepened the group's rigor and built mutual respect through cross-skilling (Figure 5b). Their collaborations spontaneously evolved into a "flipped-classroom" model, where students taught each other core disciplinary concepts. Rather than using separate digital disciplinary models, students started integrated shared tools and plugins into one common model to address common questions (e.g., combining design, costing, and structural assessment). This cross-skilling reshaped disciplinary perspectives, enhancing critical thinking and problem-solving for all participants, including observing industry professionals and the teaching team.

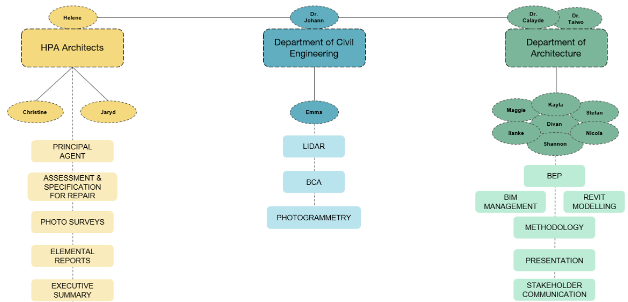

Figure 6a) 2023 Student artifact: Week 1 flowchart showing their understanding of roles within a conventional, siloed, and vertical project structure with missing stakeholders.

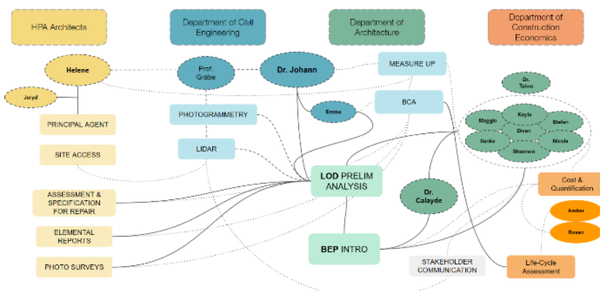

Figure 6b) Student artifact: Week 3 flowchart showing students' shift to a value-driven, skill-sharing lateral structure that dissolves traditional disciplinary silos, and includes missing stakeholders.

Initially, students viewed their contributions through disciplinary silos, as reflected in their original work structure (Figure 6a). However, this understanding evolved into an integrated, value-driven flowchart (Figure 6b), demonstrating the dissolution of disciplinary boundaries. This shift resulted directly from the transdisciplinary learning environment, which fostered genuine collaboration through learning-by-doing-together. Developing a deep respect for their peers' specialized knowledge, students actively sought and integrated multidisciplinary insights to a transdisciplinary problem, producing work that more accurately reflected the complexities of real-world practice.

Institutional impact, recognitions and real-world response.

The success of this approach is reflected in local and international teaching recognition, including Faculty and University *Institutional Teaching Awards* and the *2023 Quanser Global Sustainability Award for Engineering Education.* These recognitions affirm the framework's practical relevance and its capacity to prepare BE professionals for real-world challenges. The teaching process also influenced the university itself, for example, prompting updates to waste policies in line with zero-waste tactics and restructuring operational BIM practices to support integrated workflows.

Concluding SQ3 Reflections

This teaching approach creates a safe-to-fail, experimental transdisciplinary environment for BE education, incubating transferable skills and generating value beyond the classroom. It enables students to move from theoretical inquiry to applied practice and research, retaining core disciplinary competencies while adding collaborative problem-solving skills. This results in more mature disciplinary outcomes and graduates equipped to drive sustainable, regenerative change in industry.

4 Synthesis of all reflection cycles

The result of these reflective cycles is the ANCHOR Framework (Table 5), a pedagogical framework that dismantles conventional BE education silos. ANCHOR prepares graduates for real-world complexity by offering structured, scaffolded learning to integrates towards regenerative practices in transdisciplinary contexts, while supporting core disciplinary competencies. Designed for 6-week cycles, the framework is adaptable to longer-term projects. ANCHOR integrates five pedagogical practices rooted in professional innovation techniques and reflective practice cycles, fostering adaptive skills development through weekly, student-centred activities.

Table 5. The ANCHOR Framework for Transdisciplinary and Regenerative Built Environment Education.

	Component	Pedagogical Method (teacher practice)	Strategic Tool (student activity)	Learning / Thematic Theory	Core Theorists
A	**Actionable Language**	Teach students to frame speech acts as commitments, not just descriptions	**(re) Frame** learning, through new language, as commitments	Language–Action Theory (LAT) - use language as performative act	Fernando Flores, Terry Winograd
N	**Narrative Reframing**	Surface and challenge hidden assumptions in established concepts (produce ontological shifts)	**(re) Frame** established assumptions; use metaphor analysis or counter-narrative exercises	Ontological/Transformative learning: shifting assumptions and worldviews	Peter Senge, Jack Mezirow, Chris Argyris,
C	**Continuous Improvement**	Promote fast, iterative improvement rather than perfection	**(re) Run** Weekly *Kaizen* loops	Experiential/ Constructivist learning: knowledge through iterative practice and reflection	Taiichi Ohno, Shigeo Shingo, W. Edwards Deming, D. A Schön
H	**Hoshin Kanri**	Facilitate collective goal alignment (whole class) towards a shared "True North"	**(re) Align** with whole class's "True North" (*Hoshin Kanri,*)	Strategic/Organizational learning: aligning goals through dialogue and shared vision	Yoji Akao, W. Edwards Deming
O	**Open** systems thinking	Encouraging holistic, interconnected views and ripple-effect awareness (even when competing views are present)	**(re) Check** systemic ripple-effects and against *Hoshin Kanri,*	Systems & Complexity: interdependence, feedback, and emergence	Donella Meadows
R	**Regenerative outcomes**	Guide student outcomes in delivering adaptive capacity for complex real-world challenges	**Deliver** incremental, improved, regenerative, systemic, and net-positive outcomes	Resilience & Regenerative learning: adaptive, net-positive outcomes for holistic living systems	Fritjof Capra, Du Plessis

5 Conclusion

This paper presents a transdisciplinary pedagogical framework that moves BE education beyond conventional constraints. By integrating intentional language reframing, Lean practices, and systems thinking, the model cultivates the paradigm agility necessary for regenerative outcomes. Enabled by a flexible Architecture postgraduate program with low student-staff ratios that allows open disciplinary participation, this approach retains existing BE modules while aligning diverse disciplinary interests around a shared 'wicked problem,' enhancing its transferability. The framework offers educators a practical, adaptable tool for existing curricula and transforms students into active, integrative problem-solvers equipped with the mindsets essential for the contemporary workplace. For industry, this pedagogy narrows the gap between academic training and professional practice, producing graduates ready to contribute to complex real-world projects. As a reflective practice of a single educator, the findings are context-specific, providing deep, situated insight while highlighting the need for further research to test its broader applicability. Key future directions for the ANCHOR framework include:

- **Situate ANCHOR within broader educational theory:** evaluate and position ANCHOR within a unifying educational theory.
- **Contextual validation:** Test ANCHOR across diverse institutions and BE disciplines to assess adaptability and identify necessary modifications.
- **Longitudinal analysis and post-intervention tracking:** Track graduates' careers to evaluate participation in transdisciplinary projects, progression, and preparedness for complex challenges.
- **Industry–Academia partnerships:** Engage BE firms to apply the same framework in professional development, creating a feedback loop between education and industry needs.

Ultimately, this work advocates a shift in BE pedagogy: from producing single-domain experts to cultivating agile, integrated navigators of complex systems. Embedding these practices within BE learning empowers a new generation to lead sustainable, regenerative transformations from the start of their careers.

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