

DOI: 10.5281/zenodo.12511065

DESIGNING SCALABLE ONLINE DESIGN THINKING PEDAGOGY FOR COMPULSORY CROSS-DISCIPLINARY HIGHER EDUCATION: A CONCEPTUAL FRAMEWORK FOR EXPERIENTIAL INTEGRITY AT SCALE

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Received: 01/12/2025

Accepted: 02/01/2026

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ABSTRACT

Design thinking has gained increasing prominence in higher education as a pedagogical approach for cultivating creativity, collaboration, problem-solving, and innovation capability. However, existing studies predominantly examine elective, small-scale, or face-to-face implementations, leaving limited conceptual guidance on how design thinking can be structured as a compulsory, fully online, and cross-disciplinary course in large public university settings. This paper develops a conceptual framework for scalable online design thinking pedagogy in higher education, drawing on literature in design thinking education, online learning, active learning, collaborative learning, and design-based educational research. The proposed framework positions pedagogical intent and methodological design as interdependent dimensions shaping learning engagement and innovation-oriented outcomes. It identifies three interrelated layers: (i) the pedagogical core, centred on the five design thinking stages and experiential learning principles; (ii) methodological enablers, including engagement-based attendance, peer leadership, artefact-based accountability, dialogic questioning, structured breakout cycles, and pre-class readiness activities; and (iii) expected learning outcomes, encompassing behavioural, cognitive, and collaborative engagement, design thinking application, and early-stage innovation capability. The paper further advances a set of design principles for implementing scalable online design thinking in cross-disciplinary contexts. By shifting attention from platform features to pedagogical architecture, this study contributes to a theoretically grounded and practically adaptable framework for institutions seeking cost-effective and scalable innovation education models. The paper concludes by outlining implications for higher education practice and directions for future empirical validation.

KEYWORDS: Framework; cross-disciplinary education; Design thinking pedagogy; online learning

1. INTRODUCTION

Higher education systems worldwide are being reconfigured by intensifying demands to prepare graduates for increasingly complex, uncertain, and innovation-driven futures. Rapid technological change, evolving labour market expectations, global socio-economic disruptions, and the growing interdependence of societal systems have placed renewed pressure on universities to move beyond discipline-bound knowledge transmission and cultivate broader transversal competencies. These include creativity, collaboration, empathy, problem-solving, adaptability, and opportunity recognition, capabilities widely recognised as critical for employability, innovation capacity, and long-term national competitiveness in knowledge-based economies.

In response to these shifts, design thinking has emerged as a prominent pedagogical approach in higher education. Rooted in professional design practice, design thinking foregrounds human-centred inquiry, iterative experimentation, collaborative problem-solving, and solution-oriented learning [6][7]. Its educational appeal lies in its ability to bridge analytical and creative modes of thinking while enabling learners to engage with ambiguity, user needs, and rapid cycles of ideation and refinement. Within university contexts, design thinking has increasingly been used to support innovation education, entrepreneurship development, interdisciplinary collaboration, and experiential learning.

A major strength of design thinking in educational settings is its structured yet flexible process, commonly articulated through the stages of Empathise, Define, Ideate, Prototype, and Test. This sequence offers learners a practical and accessible pathway for moving from problem discovery to solution development, while encouraging reflective and iterative engagement. As such, design thinking aligns closely with constructivist and experiential pedagogies that position students as active participants in knowledge creation rather than passive recipients of information.

Despite its growing adoption, the institutionalisation of design thinking in higher education remains uneven and insufficiently theorised. Much of the existing literature focuses on elective modules, short-term innovation bootcamps, co-curricular initiatives, or discipline-specific implementations in areas such as engineering, design, business, and teacher education. These settings often involve small cohorts, self-selected participants, or face-to-face studio environments. While such studies provide valuable insights into

student perceptions and localised learning outcomes, they offer limited conceptual guidance on how design thinking might be scaled institutionally as a compulsory pedagogical model across disciplinary boundaries.

This limitation becomes more significant in the context of online and digitally mediated learning. As higher education institutions increasingly expand online delivery, questions emerge regarding whether experiential pedagogies such as design thinking can retain their pedagogical integrity in virtual environments. On one hand, online platforms create opportunities for scale, flexibility, cross-disciplinary access, and cost-efficient delivery. On the other hand, design thinking depends heavily on interaction, dialogue, collaboration, feedback, and iterative application, elements often associated with physical studio or workshop settings. Consequently, concerns remain that online delivery may reduce engagement, weaken accountability, and produce superficial participation rather than meaningful experiential learning.

A substantial portion of existing work on online design thinking has focused on technological affordances, platform comparisons, or digital collaboration tools. Although such studies are useful, they can unintentionally overemphasise technology as the central determinant of learning quality. This risks conflating platform sophistication with pedagogical effectiveness. Broader online learning research suggests that meaningful learning outcomes are shaped less by digital tools themselves and more by instructional design, interaction structure, facilitation quality, and engagement mechanisms [18]. However, these insights have not yet been sufficiently translated into a coherent conceptual model for compulsory, large-scale, and cross-disciplinary online design thinking education.

This gap is particularly salient for large public universities, especially in developing and newly industrialised contexts. Such institutions face dual pressures: they must widen access and maintain cost sustainability while also responding to policy agendas that emphasise innovation, entrepreneurship, graduate employability, and future-ready capabilities. In these settings, embedding design thinking as a compulsory course is not merely a curricular decision but a strategic institutional intervention. Yet without a robust conceptual and pedagogical framework, compulsory design thinking risks being implemented as a symbolic addition rather than a transformative learning model.

More specifically, there remains limited conceptual understanding of how online design thinking can be structured to sustain engagement, accountability,

and applied learning in large, diverse cohorts. Questions persist regarding how attendance should be meaningfully reconceptualised in experiential online learning; how peer leadership and collaborative structures can support group coordination; how theory and practice should be sequenced in virtual environments; and how institutions can balance pedagogical quality with operational scalability. These issues point to the need for a pedagogy-first framework that moves beyond platform selection and instead theorises the methodological conditions under which online design thinking can function effectively at scale.

This paper addresses that need by developing a conceptual framework for scalable online design thinking pedagogy in cross-disciplinary higher education. Drawing on literature in design thinking education, active learning, online engagement, collaborative learning, and design-based educational research, the paper proposes a model that positions pedagogical intent and methodological design as interdependent drivers of learning quality. The framework is informed by a large public university context in which design thinking is delivered as a compulsory online learning experience across disciplinary domains, but the paper deliberately focuses on conceptual and methodological architecture rather than empirical outcome reporting.

This paper makes three interrelated contributions. First, it contributes conceptually by reframing design thinking not merely as a workshop method or innovation tool, but as a scalable pedagogical system whose effectiveness depends on the alignment between pedagogical intent, methodological architecture, and institutional feasibility. Second, it contributes theoretically by advancing the proposition that methodological enablers function as mediating mechanisms through which experiential integrity can be preserved in compulsory, large-scale, and digitally mediated learning environments. Third, it contributes practically and institutionally by offering a transferable set of design principles that may assist large universities in developing cost-effective, scalable, and cross-disciplinary models of innovation-oriented education.

The remainder of the paper is organised as follows. The next section reviews the literature on design thinking in higher education, online and digital design thinking pedagogy, and the role of engagement and accountability in large-scale collaborative learning. This is followed by a discussion of the theoretical foundations that underpin the proposed framework. The paper then presents the conceptual framework and associated design principles, before concluding with

implications for higher education practice and directions for future empirical validation.

2. LITERATURE REVIEW

Design thinking has become increasingly prominent in higher education as institutions seek pedagogical approaches capable of developing learners' creativity, collaboration, empathy, and problem-solving capabilities in complex and uncertain environments. Although originating in professional design practice, design thinking has evolved into a broader innovation-oriented mindset and process that can be adapted for educational purposes. Brown, 2008, 2009 popularised design thinking as a human-centred approach to innovation that integrates desirability, feasibility, and viability through iterative cycles of exploration and experimentation. In educational settings, this orientation has made design thinking especially attractive for teaching contexts that aim to foster student agency, innovation capability, and interdisciplinary engagement [6] [7].

As a pedagogy, design thinking differs from conventional lecture-centred instruction because it positions learning as an active, inquiry-driven, and solution-oriented process. Rather than emphasising content transmission alone, design thinking encourages students to identify user needs, frame meaningful problems, generate and test ideas, and refine solutions through feedback. This process orientation aligns strongly with constructivist and experiential learning traditions, in which knowledge is built through action, reflection, and interaction rather than passively received. In this sense, design thinking can be understood not merely as a problem-solving tool but as a pedagogical logic that integrates cognitive, affective, and social dimensions of learning.

A. Design Thinking as a Pedagogical Approach in Higher Education

The alignment between design thinking and experiential learning is particularly important. Kolb's, 1984 experiential learning theory conceptualises learning as a cyclical process involving concrete experience, reflective observation, abstract conceptualisation, and active experimentation. The widely used five-stage design thinking sequence, Empathise, Define, Ideate, Prototype, and Test, maps effectively onto this learning cycle. Empathising with users can be interpreted as a form of concrete experience and situated inquiry; defining the problem supports reflection and conceptual framing; ideation encourages divergent exploration; prototyping enables active experimentation; and testing invites

iterative feedback and renewed reflection. This structural compatibility helps explain why design thinking has been widely adopted as a pedagogical approach in innovation-oriented learning environments.

A growing body of scholarship reports positive educational outcomes associated with design thinking. Razzouk and Shute (2012) argue that design thinking supports complex problem solving by encouraging students to engage with ambiguity, iteration, and user-centred reasoning [19]. Luka (2014) similarly highlights the holistic value of design thinking in higher education, suggesting that it supports creativity, collaboration, and reflective learning while enabling students to connect theory with real-world problem contexts [15]. Henriksen et al. (2017) further position design thinking as a powerful educational mindset that helps learners and educators embrace experimentation, empathy, and flexible thinking in teaching and learning contexts [12].

At the same time, the literature also indicates that the benefits of design thinking are not automatic. Effective design thinking education requires more than simply introducing the language of innovation or asking students to brainstorm ideas. Its pedagogical value depends on how the learning experience is structured, facilitated, and sequenced. Students need opportunities to engage iteratively, receive feedback, work collaboratively, and move through multiple stages of inquiry and solution development. Without these conditions, design thinking risks being reduced to a superficial creativity exercise rather than a meaningful learning process.

Despite its promise, the higher education literature on design thinking remains contextually uneven. Many studies focus on discipline-specific implementations, particularly in engineering, design, business, or teacher education, where design-oriented or innovation-related tasks already have strong curricular alignment. Others examine short-term workshops, hackathons, or co-curricular programmes where participation is voluntary and learners are often already motivated or predisposed toward innovation-oriented activities. These contexts are important but limited. They do not necessarily provide insight into how design thinking functions when embedded as a compulsory element of mainstream undergraduate education, especially across diverse disciplinary populations.

This limitation matters because compulsory design thinking raises fundamentally different pedagogical questions. Unlike elective or enrichment-based settings, compulsory courses must accommodate students with varying levels of motivation, prior

exposure, disciplinary identity, and perceived relevance. They also require stronger alignment with institutional systems, assessment structures, and teaching capacity. Yet these dimensions remain relatively underexamined in the literature. As a result, while design thinking is increasingly celebrated as a future-oriented pedagogy, there is still insufficient conceptual clarity regarding how it should be designed when scaled institutionally and embedded across disciplines as part of the core curriculum. Recent scholarship further reinforces both the promise and the continuing design challenge of design thinking in higher education. A systematic review by Alvarado, 2025 confirms that design thinking is increasingly used as an active teaching methodology to strengthen creativity, critical thinking, and interdisciplinary collaboration, while also highlighting the ongoing need for stronger pedagogical scaffolding and implementation guidance across institutional contexts [3].

In this regard, design thinking should not be viewed solely as a content area or innovation technique, but as a pedagogical system whose effectiveness depends on deliberate methodological design. This insight becomes even more critical when design thinking is delivered online, where the pedagogical demands of interaction, accountability, and iterative collaboration must be reconfigured in digitally mediated environments.

B. Online and Digital Design Thinking Pedagogy

The expansion of online and digitally mediated learning has created both opportunities and tensions for experiential pedagogies in higher education. On the one hand, online learning offers scalability, accessibility, flexibility, and institutional efficiency. On the other hand, pedagogical approaches that rely heavily on interaction, collaboration, reflection, and iterative practice, such as design thinking, can be more difficult to enact meaningfully in virtual environments. This has prompted growing scholarly interest in how design thinking can be adapted for online and hybrid delivery without losing its experiential integrity.

More broadly, online learning research has established that digital environments are not inherently pedagogically inferior. Rather, the quality of online learning depends on how learning activities are designed, facilitated, and aligned with intended outcomes. Rapanta et al., 2020 argue that effective online teaching requires more than transferring content to digital platforms; it requires deliberate pedagogical redesign that supports interaction, cognitive engagement, and purposeful communication [18]. This insight is especially relevant for design thinking, where the learning

process depends less on content coverage and more on how students engage in inquiry, dialogue, iteration, and collaborative problem solving.

Active learning scholarship further reinforces this point. Prince, 2004 argues that active learning approaches consistently produce better outcomes than traditional lecture-based methods because they require students to participate meaningfully in the learning process [17]. Freeman et al. (2014), in a large meta-analysis of undergraduate STEM education, similarly show that active learning significantly improves performance and reduces failure rates compared to passive instruction [10]. These findings are important because they suggest that the success of online design thinking depends not primarily on the availability of digital tools, but on whether the online environment is structured to support participation, application, and interaction.

Nevertheless, the shift to online learning introduces distinct challenges for design thinking pedagogy. First, online environments can weaken social presence, making it more difficult for students to feel accountable to peers and instructors. Second, large online classes often make it harder for lecturers to monitor participation quality, particularly when learners can remain logged in without actively contributing. Third, design thinking tasks often involve ambiguity, discussion, and iterative collaboration, which may become fragmented when students are not carefully guided through structured interaction cycles. These challenges are amplified in compulsory courses, where not all students are intrinsically motivated or already invested in the learning process.

Much of the existing literature on online design thinking focuses on digital affordances such as breakout rooms, collaborative whiteboards, shared documents, or virtual prototyping spaces. These tools are certainly useful, and they have expanded the possibilities for remote collaboration. However, a tool-centred perspective can be analytically limiting. Bower et al., 2015 caution that digital technologies should be understood in relation to their pedagogical embedding rather than treated as self-sufficient solutions. In other words, technology may enable collaboration, but it does not guarantee engagement, accountability, or meaningful learning [5].

This distinction is particularly important because platform discussions often dominate practitioner discourse. Institutions may spend significant time comparing platforms or features, such as breakout room control, whiteboard capabilities, or integration functions, while paying less attention to how the learning process itself is structured. Yet broader educational research suggests that platform sophistication is less important than the coherence of

the pedagogical design. In online design thinking, this means the central question is not simply whether a platform can host breakout rooms or shared slides, but how lecturers use these affordances to sustain iterative, accountable, and applied learning.

The literature also indicates that online design thinking requires stronger intentionality in sequencing. If theoretical input is delivered as a long, uninterrupted lecture before students are asked to work independently, the experiential value of design thinking may diminish. By contrast, when theory and practice are interwoven, allowing students to learn a concept, apply it immediately, and return for feedback, online environments can better approximate the iterative rhythm of studio-based learning. This suggests that pedagogical flow and interaction design are central to preserving the integrity of design thinking online. This broader pattern is reinforced by recent post-pandemic review evidence [2] showing that online learning outcomes vary substantially depending on interaction quality, motivation, and engagement design rather than digital access alone. This supports the present paper's argument that scalable online design thinking should be understood less as a platform problem and more as a pedagogical architecture problem.

Although the literature on online learning and educational technology provides useful insights, there remains limited conceptual integration of these ideas into a coherent framework for scalable online design thinking pedagogy. Existing studies often focus on isolated tools, short-term interventions, or context-specific delivery experiences. Less attention has been paid to the broader methodological architecture needed to sustain engagement, collaboration, and accountability in compulsory, large-cohort, cross-disciplinary settings. Addressing this gap requires moving beyond platform-centric thinking toward a more explicit focus on how online design thinking should be pedagogically designed as a system.

C. Engagement, Accountability, and Collaborative Learning in Online Environments

Engagement has emerged as one of the most critical constructs in online learning research, particularly in contexts where learning quality depends on active participation rather than mere content exposure. In online design thinking education, engagement is not simply a desirable outcome; it is a precondition for meaningful learning. Because design thinking depends on inquiry, interaction, feedback, experimentation, and collaboration, disengaged participation undermines the very pedagogical logic of the approach. As such, any scalable model of online design thinking must

treat engagement as a central design concern rather than a secondary classroom management issue.

Contemporary scholarship conceptualises engagement as a multidimensional construct. Dixon, 2015 for example, emphasises that online student engagement encompasses behavioural, emotional, and cognitive dimensions. Behavioral engagement relates to participation in learning activities; cognitive engagement refers to attention, effort, and meaningful processing; and emotional or relational aspects shape students' willingness to remain involved and connected [9]. In design thinking contexts, these dimensions intersect strongly: students must show up, think deeply, contribute ideas, respond to peers, and stay committed across multiple stages of iterative problem solving.

Recent review evidence similarly reinforces the multidimensional and design-sensitive nature of student engagement in digitally mediated learning. De Bruijn-Smolanders and Prinsen, 2024 show that student engagement in blended and online learning environments is strengthened when activities are intentionally structured to support participation, interaction, and active involvement [8]. This is particularly relevant for compulsory online design thinking, where engagement must be deliberately produced through pedagogical design rather than assumed to emerge naturally from the use of digital tools. This is especially relevant in compulsory courses, where participation cannot be assumed to emerge naturally from intrinsic motivation. Instead, the learning design itself must actively produce conditions that encourage and sustain engagement.

This raises an important issue for online design thinking: the inadequacy of conventional attendance mechanisms. In many online classes, attendance is treated as a static administrative record, students log in, complete a form, or remain present in a virtual room. However, such measures are poorly aligned with experiential learning. A student may be technically "present" yet cognitively absent, socially detached, or behaviourally inactive. For pedagogies like design thinking, where value lies in participation quality rather than passive exposure, attendance needs to be reimagined as evidence of meaningful engagement.

Martin and Bolliger, 2018 provide useful insights here by demonstrating that learner engagement in online courses is strengthened when instructors deliberately design for student-student, student-instructor, and student-content interaction [16]. Their work suggests that engagement is not merely about motivating students to participate; it is about structuring interaction in ways that make participation pedagogically necessary and socially

visible. This has important implications for online design thinking, where collaborative dialogue, peer accountability, and applied tasks can function simultaneously as learning mechanisms and engagement evidence.

Collaborative learning literature adds further depth to this discussion. Hmelo-Silver et al., 2007 writing on inquiry-oriented and problem-based learning environments, emphasise that complex, student-centred learning requires scaffolding rather than minimal facilitation [13]. Students benefit when tasks are broken into manageable stages, roles are clarified, and instructor support is structured rather than absent. These insights are highly transferable to online design thinking, where learners often need clear sequencing, visible roles, and periodic intervention to sustain group momentum and prevent drift.

Accountability mechanisms also matter. In large online classes, particularly compulsory ones, the absence of accountability can lead to free-riding, silent attendance, or uneven contribution within groups. Authentic assessment theory offers a useful lens for rethinking this problem. Gulikers et al., 2004 argue that learning and assessment should be aligned with meaningful, real-world performance rather than disconnected administrative measures [11]. Applied to online design thinking, this suggests that evidence of learning should emerge through artefacts, collaborative outputs, presentations, discussion traces, and stage-based participation rather than isolated attendance logs. This position is further supported by recent review evidence indicating that authentic assessment in higher education is most effective when learning activities, evidence of performance, and capability development are coherently aligned, particularly in digitally mediated environments where participation quality must be made visible through meaningful outputs [20].

Taken together, the literature suggests that scalable online design thinking requires a shift from presence-based monitoring to engagement-based accountability. It also requires collaborative structures that support visibility, participation, and shared responsibility. Yet while these insights are individually present across online learning, active learning, and collaborative pedagogy literature, they have rarely been synthesised into a dedicated framework for compulsory, cross-disciplinary online design thinking education. This paper addresses that conceptual gap by proposing a pedagogy-first model in which engagement and accountability are not peripheral controls, but core methodological enablers of experiential learning at scale.

D. Literature Gap and Research Positioning

Synthesising the literature above reveals that design thinking has become increasingly recognised as a valuable pedagogical approach in higher education, particularly for developing creativity, collaboration, empathy, and innovation-oriented problem solving. However, the existing body of work remains fragmented in ways that limit its usefulness for institutions seeking to implement design thinking at scale. Three interrelated gaps are especially evident.

First, a contextual gap persists in the literature. Much of the scholarship on design thinking in higher education focuses on elective modules, discipline-specific courses, enrichment workshops, or short-term interventions. These studies provide valuable insight into local teaching practices, yet they offer limited conceptual guidance for institutions attempting to embed design thinking as a compulsory, cross-disciplinary learning experience across large undergraduate populations. The pedagogical demands of compulsory delivery are fundamentally different from elective participation because they involve more diverse student readiness, broader curricular integration, and stronger institutional coordination requirements.

Second, there is a pedagogical and methodological gap. Although online and blended learning research has established that instructional design matters more than platform features, studies on online design thinking frequently remain tool-centred or operationally descriptive. Existing discussions often highlight the use of breakout rooms, virtual whiteboards, collaborative documents, or synchronous meeting platforms, but pay less attention to the methodological architecture required to sustain meaningful experiential learning. In particular, there is insufficient conceptualisation of how engagement-based attendance, peer leadership, artefact-based accountability, structured interaction cycles, and pre-class cognitive readiness can function as pedagogical mechanisms rather than administrative techniques.

Third, a theoretical gap remains underexplored. While design thinking is often presented as an innovation pedagogy, it is less frequently theorised as a scalable educational system within large institutional contexts. Current scholarship has not sufficiently explained how pedagogical intent, methodological design, and expected learning outcomes can be integrated into a coherent framework for compulsory online implementation. This leaves a conceptual blind spot in the literature: universities may adopt design thinking rhetorically, yet lack a transferable model for enacting it in ways

that preserve experiential integrity while remaining operationally sustainable.

These gaps point to the need for a pedagogy-first conceptual framework that moves beyond platform comparisons and isolated teaching techniques. Rather than asking which digital tools are available, the more important question is how online design thinking can be deliberately designed as a structured, scalable, and institutionally viable learning system. Accordingly, this paper is positioned as a conceptual and methodological contribution. It does not seek to report empirical outcomes from a completed intervention; rather, it proposes a theoretically informed framework for understanding and designing scalable online design thinking pedagogy in compulsory cross-disciplinary higher education settings.

In doing so, the paper responds to a practical and scholarly need. Practically, it offers a structured design architecture for institutions seeking mainstream innovation-oriented learning across disciplines. Scholarly, it contributes to the literature by reframing design thinking not merely as a creative method or workshop format, but as a pedagogically designable and scalable educational model. This positioning also lays a foundation for future empirical validation, comparative institutional studies, and design-based refinement in subsequent research.

More fundamentally, the unresolved theoretical issue is not simply whether design thinking can be translated into online formats, but how its experiential integrity can be preserved when participation is compulsory, cohorts are large, and interaction is digitally mediated. Existing scholarship provides useful insights into tools, activities, and localised teaching practices, yet offers limited explanation of the pedagogical mechanisms through which experiential learning can remain visible, iterative, and accountable at scale. This paper therefore argues that scalability should not be treated as a logistical problem external to pedagogy, but as a pedagogically constitutive condition that reshapes how design thinking must be designed, facilitated, and evidenced in online higher education.

3. THEORETICAL FOUNDATION

This paper is grounded in design-based educational research (DBR), which offers a strong theoretical lens for examining pedagogical innovation in real educational settings. DBR is especially suitable for this study because it values contextual complexity, links theory with design decisions, and supports the development of transferable principles for scalable online design thinking pedagogy.

A. Design-Based Educational Research as the Primary Anchoring Lens

Theoretically anchored in design-based educational research (DBR), it provides a strong foundation for conceptualising and studying pedagogical innovations situated in authentic educational contexts. DBR is particularly relevant when the object of inquiry is not a single variable or isolated intervention, but a complex educational design that must function under real institutional constraints. Unlike experimental traditions that prioritise control and variable isolation, DBR is concerned with how theory-informed educational interventions are designed, enacted, refined, and translated into transferable principles for practice [4][21].

The suitability of DBR for the present paper lies in three reasons. First, DBR recognises that educational innovation is contextually embedded. A compulsory online design thinking course implemented across diverse disciplines in a large public university cannot be meaningfully understood outside the realities of institutional policy, student diversity, teaching capacity, digital infrastructure, and scalability constraints. This makes DBR particularly appropriate because it values contextual complexity rather than treating it as methodological noise.

Second, DBR explicitly foregrounds the relationship between theory and design. In this tradition, pedagogical interventions are not merely practical solutions; they are opportunities to test, extend, and refine theoretical understandings of how learning occurs. In the context of online design thinking, this means that methodological choices, such as how attendance is evidenced, how collaboration is structured, or how theory and practice are sequenced, should not be treated as operational details alone. Instead, they can be understood as theoretically meaningful design decisions that shape engagement, accountability, and learning quality.

Third, DBR is oriented toward the production of transferable design principles. Rather than aiming only to describe a single teaching context, DBR seeks to generate insights that can inform future implementations in similar settings. This aligns closely with the objective of the present paper, which is not to claim universal effectiveness, but to propose a conceptual framework that can guide scalable online design thinking pedagogy in higher education. The emphasis is therefore on design logic, not on deterministic causal proof.

Within the DBR tradition, pedagogical models are often viewed as iterative systems in which intended learning goals, activity structures, tools, facilitation

strategies, and contextual conditions interact dynamically. This perspective is highly relevant to design thinking education, where the quality of the learning experience depends on how different pedagogical and methodological elements are aligned. It also supports the central argument advanced in this paper: that scalable online design thinking should be understood not as a platform-dependent activity, but as a designed pedagogical system whose integrity depends on the coherence of its methodological architecture.

Accordingly, DBR serves as the primary analytical lens for this paper in two ways. First, it justifies the development of a conceptual framework grounded in real-world educational demands rather than abstract ideal conditions. Second, it supports the paper's broader ambition to contribute design principles that may be adapted, refined, and empirically validated in future institutional contexts. In this sense, DBR does not merely support the framework methodologically; it also shapes the paper's core epistemological stance that pedagogical innovation should be studied through the interplay of theory, design, and practical enactment.

B. Experiential Learning as the Pedagogical Logic

While DBR provides the overarching design-oriented lens, the pedagogical logic of the proposed framework is further grounded in experiential learning theory, particularly the work of Kolb, 1984. Experiential learning offers a powerful theoretical basis for understanding why design thinking functions effectively as an educational approach and why its online implementation must be carefully structured to preserve active, reflective, and iterative learning [14].

Kolb conceptualises learning as a cyclical process involving four interconnected phases: concrete experience, reflective observation, abstract conceptualisation, and active experimentation [14]. This cycle is especially relevant to design thinking because the widely used five-stage sequence, Empathise, Define, Ideate, Prototype, and Test, closely mirrors the movement between experiencing, reflecting, conceptualising, and acting. In other words, design thinking is not simply compatible with experiential learning; it can be understood as a practical enactment of experiential learning in innovation-oriented contexts.

The Empathise stage aligns with concrete experience and situated inquiry, where learners engage with user perspectives, contextual needs, or real-world problems. Define supports reflective observation and analytical framing, helping students synthesise information into meaningful problem

statements. Ideate encourages divergent and generative thinking, allowing learners to explore conceptual possibilities. Prototype corresponds to active experimentation, where abstract ideas are externalised into tangible or visual forms. Finally, the test creates a feedback loop that returns learners to reflection, evaluation, and refinement. This cyclical logic explains why design thinking is especially well suited to developing higher-order learning outcomes such as problem framing, creative reasoning, collaborative sense-making, and innovation capability.

Importantly, experiential learning also clarifies why design thinking cannot be reduced to a lecture topic or static content module. If learners are only told about design thinking without engaging in iterative application, the educational process becomes conceptually incomplete. The value of design thinking as a pedagogy lies in the movement between conceptual input and active doing. This insight has significant implications for online delivery. In virtual settings, the risk is that instructors may overemphasise theoretical explanation or platform navigation while under-designing opportunities for immediate practice, feedback, and iteration. When this occurs, the experiential core of design thinking is weakened.

For this reason, experiential learning theory supports the argument that online design thinking requires more than digital access; it requires intentional sequencing of theory and practice. Students must be able to move between explanation, collaborative application, reflection, and refinement within a coherent instructional rhythm. This is especially important in compulsory cross-disciplinary settings, where students may have varying levels of familiarity with innovation processes and therefore benefit from carefully scaffolded experiential progression.

Experiential learning also strengthens the rationale for the methodological enablers proposed later in this paper. Mechanisms such as structured breakout cycles, artefact-based accountability, dialogic questioning, and pitch-based closure are not merely management strategies. They can be understood as design features that preserve the experiential cycle in digitally mediated contexts. In this sense, experiential learning provides the pedagogical rationale for why methodological design matters: it is through these structures that the movement between action, reflection, and application is sustained online.

Taken together, DBR and experiential learning provide a complementary theoretical foundation for the present paper. DBR supports the development of a context-sensitive, design-oriented, and transferable pedagogical framework, while experiential learning

explains why design thinking must be enacted as an iterative process rather than delivered as a static body of knowledge. Combined, these perspectives justify the paper's central proposition that scalable online design thinking depends on the deliberate alignment of pedagogical core, methodological enablers, and intended learning outcomes.

Taken together, design-based educational research and experiential learning are not employed in this paper merely as supportive background theories, but as complementary analytical lenses for theory-building. DBR provides the design-oriented logic for understanding pedagogical innovation under authentic institutional constraints, while experiential learning explains why design thinking must be enacted through iterative cycles of application, reflection, and refinement rather than treated as static content. Combined, these perspectives support the paper's central proposition that scalability is not external to pedagogy; rather, it reconfigures the conditions under which experiential learning must be designed and sustained in online higher education.

4. PROPOSED CONCEPTUAL FRAMEWORK FOR SCALABLE ONLINE DESIGN THINKING PEDAGOGY

Building on the literature and theoretical foundations discussed above, this paper proposes a conceptual framework for scalable online design thinking pedagogy in cross-disciplinary higher education. The framework is designed to address a recurring limitation in existing scholarship: the tendency to treat online design thinking either as a set of isolated tools or as a simplified digital translation of face-to-face workshops. Instead, the framework advances a pedagogy-first model in which online design thinking is understood as a deliberately structured educational system.

A. Overview of the Framework

For conceptual clarity, the proposed model may be understood as a Scalable Experiential Pedagogical Architecture (SEPA) for online design thinking, emphasising that the preservation of experiential learning under conditions of scale depends on the coherence of pedagogical, methodological, and institutional design.

1. The proposed framework is organised around three interdependent layers:
2. Pedagogical Core – the foundational learning logic of design thinking and experiential pedagogy
3. Methodological Enablers – the specific design mechanisms that operationalise and sustain learning in online settings

Across these layers, the framework is further shaped by a set of scalability conditions, which represent the institutional and operational factors necessary for implementation in large public university contexts. These conditions do not replace pedagogy; rather, they determine whether the pedagogical model can be enacted consistently and sustainably across diverse cohorts.

The central proposition of the framework is that methodological enablers mediate the relationship between pedagogical intent and learning outcomes. In other words, the mere presence of design thinking content or access to online tools does not guarantee experiential learning. Instead, learning quality depends on whether the course is methodologically designed to translate design thinking into structured, visible, iterative, and accountable online learning processes.

This model challenges two assumptions that frequently appear in discussions of online innovation education. The first is the assumption that platform features are the primary drivers of pedagogical effectiveness. The second is the assumption that design thinking naturally produces engagement simply because it is interactive by nature. The framework rejects both views. It argues that design thinking becomes pedagogically powerful online only when supported by coherent methodological architecture.

Accordingly, the framework should be read not as a rigid protocol, but as a design architecture that can guide institutions in developing, adapting, and refining compulsory cross-disciplinary online design thinking experiences. It is intended to support future empirical validation, contextual modification, and design-based refinement across higher education settings.

B. Layer 1: Pedagogical Core

The first layer of the framework is the pedagogical core, which refers to the foundational learning logic that underpins the design of the course. At its centre is the five-stage design thinking process, Empathise, Define, Ideate, Prototype, and Test, which provides a structured yet flexible pathway for students to move from understanding problems to generating and evaluating solutions. This process is pedagogically significant because it makes innovation learning visible, staged, and iterative, rather than abstract or purely theoretical.

The pedagogical value of the design thinking stages lies in their ability to scaffold learning across multiple dimensions. The Empathise stage encourages students to attend to users, stakeholders, or contextual needs, thereby introducing human-centred inquiry as the starting point for innovation.

The Define stage supports analytical framing, helping students move from broad observations to more focused and meaningful problem statements. The Ideate stage invites divergent thinking and collaborative exploration, creating space for creativity and possibility generation. Prototype requires students to translate ideas into visible forms, which makes thinking tangible and discussable. Finally, Test reintroduces feedback, evaluation, and refinement, ensuring that the learning process remains iterative rather than linear.

This staged structure is strengthened by its alignment with active and experiential learning principles. Students are not merely learning about innovation; they are learning through the process of doing, reflecting, revising, and presenting. As such, the pedagogical core is designed to support not only knowledge acquisition, but also the development of applied capabilities such as problem framing, collaborative reasoning, communication, and early-stage innovation thinking.

A further component of the pedagogical core is the adoption of a studio-based online pedagogy. In traditional face-to-face settings, studio pedagogy is characterised by cycles of instruction, guided practice, critique, and revision. The proposed framework adapts this logic to online environments by emphasising the importance of sequencing theoretical input with immediate collaborative application. Rather than positioning theory and practice as separate phases, the pedagogical core assumes that students learn design thinking most effectively when conceptual explanation is followed quickly by active engagement in the corresponding stage.

This is particularly important in compulsory cross-disciplinary settings, where students may have limited prior exposure to innovation methodologies. A structured pedagogical core provides clarity, reduces ambiguity, and helps ensure that learners from different disciplinary backgrounds can participate meaningfully in a shared process. At the same time, the design thinking stages remain sufficiently flexible to accommodate diverse problem themes, contexts, and forms of prototype expression.

In short, the pedagogical core establishes what students are expected to experience and how the learning process is conceptually structured. However, the pedagogical core alone is insufficient in online environments. Without a corresponding methodological layer that makes participation visible, accountable, and coordinated, the experiential integrity of design thinking may weaken. For this reason, the second layer of the framework, the methodological enablers, is critical.

C. Layer 2: Methodological Enablers

The second layer of the framework comprises the methodological enablers that operationalise the pedagogical core in online environments. These enablers are the paper's most distinctive contribution because they reframe elements often treated as classroom management or delivery logistics as central pedagogical mechanisms. In the proposed framework, methodological enablers do not merely support instruction; they actively shape whether design thinking remains experiential, collaborative, and accountable when delivered at scale.

D. Layer 2: Methodological Enablers

1) Engagement-Based Attendance Verification

The first methodological enabler is engagement-based attendance verification, which reconceptualises attendance as demonstrated participation rather than static presence. In conventional online teaching, attendance is often reduced to a sign-in form, login record, or passive virtual presence. However, such measures are poorly aligned with experiential pedagogies like design thinking, where learning depends on visible and sustained contribution.

In the proposed framework, attendance is treated as an ongoing evidentiary process. Participation is made visible through discussion responses, stage-based contributions, artefact development, peer interaction, and authentic task completion. This shift aligns administrative accountability with pedagogical intent. Rather than separating "attendance" from "learning," the framework integrates them, thereby encouraging sustained behavioural engagement and reducing the likelihood of silent or superficial participation.

2) Peer Leadership and Distributed Group Coordination

The second enabler is peer leadership, implemented through deliberate role allocation within student groups. In large, cross-disciplinary online classes, collaborative learning can easily become uneven if coordination is left entirely informal. Assigning a group leader or rotating coordination role helps create localised accountability, clarify responsibility, and support group momentum during complex or multi-stage tasks.

This mechanism is particularly relevant in design thinking because groups must navigate ambiguity, manage time, synthesise perspectives, and progress through multiple stages of innovation work. Peer leadership supports these processes while also contributing to the development of early leadership,

coordination, and entrepreneurial collaboration skills. In this sense, it is both a pedagogical support and a developmental opportunity.

3) Dialogic Questioning and Supportive Cold-Calling

A third enabler is dialogic questioning, including the supportive use of cold-calling during conceptual discussion. In online environments, it is easy for students to become passive listeners, especially during theoretical explanation. Yet design thinking requires learners to articulate understanding, respond to prompts, justify choices, and engage in critique. Dialogic questioning helps sustain cognitive engagement by requiring students to process ideas actively rather than absorb them passively.

When used supportively rather than punitively, cold-calling can function as a pedagogical prompt that increases attentiveness, encourages preparation, and normalises participation. It also helps maintain a two-way communication culture, which is essential for preserving the interactive character of design thinking in online spaces.

4) Artefact-Based Accountability

The fourth enabler is artefact-based accountability, whereby student participation and learning are evidenced through the production of visible collaborative outputs. These may include shared slides, structured canvases, low-fidelity prototypes, stage-based templates, or presentation artefacts. In the framework, artefacts are not only learning products; they are also participation traces that make contribution visible.

This mechanism is especially powerful in compulsory online courses because it supports fairness, transparency, and alignment between learning activity and accountability. It also strengthens the authenticity of the pedagogical experience by ensuring that students are evaluated through what they build, explain, or refine, rather than through isolated attendance records.

5) Structured Breakout Room Cycles

A fifth enabler is the use of structured breakout room cycles aligned with the stages of design thinking. Rather than delivering all theoretical content first and releasing students into unsupervised group work, the framework advocates iterative movement between instructor-led input and breakout-based application. This sequencing mirrors the rhythm of studio pedagogy and preserves the experiential logic of the learning process.

Breakout cycles should therefore be tied to specific stages or sub-tasks, such as empathy exploration, problem definition, idea generation, or prototype

refinement, so that students repeatedly return to collaborative application in manageable segments. This reduces cognitive overload, improves pacing, and keeps theoretical concepts connected to immediate practice.

6) *Pre-Class Cognitive Readiness Activities*

The sixth enabler is pre-class cognitive readiness, which ensures that students enter the session with at least a baseline conceptual familiarity with design thinking. In compulsory cross-disciplinary courses, students may have highly varied prior exposure to innovation-related concepts. Pre-class reading, short prompts, or introductory questions can therefore help reduce cognitive disparity and allow more in-session time to be devoted to application rather than initial orientation.

This mechanism is conceptually aligned with flipped learning principles, but in the proposed framework it is specifically used to strengthen the quality of in-class experiential engagement. Students who arrive with preliminary conceptual awareness are more likely to contribute meaningfully during the early stages of the design thinking cycle.

7) *Pitch-Based Closure and Authentic Demonstration*

The final enabler is pitch-based closure, in which groups conclude the learning cycle by presenting, pitching, or demonstrating their proposed solution or prototype. This serves multiple pedagogical functions: it requires synthesis, reinforces accountability, provides an authentic audience for learning, and creates a natural point of reflection and feedback.

Pitch-based closure is especially valuable because it completes the experiential cycle. It ensures that learning does not stop at ideation or isolated group discussion, but culminates in a visible act of communication and justification. In compulsory online settings, this also reinforces a sense of completion, responsibility, and shared achievement.

Taken together, these methodological enablers form the mediating layer of the framework. They translate the pedagogical core into a lived online experience and help ensure that design thinking remains active, visible, iterative, and accountable at scale. Without them, online design thinking risks becoming fragmented, overly tool-dependent, or reduced to symbolic participation.

E. Layer 3: Expected Learning Outcomes

The expected outcomes of the framework may be understood as comprising proximal pedagogical outcomes (e.g., behavioural, cognitive, and collaborative engagement) and distal developmental

outcomes (e.g., design thinking application, early-stage innovation capability, and transferable transversal competencies).

The third layer of the framework concerns the expected learning outcomes that the pedagogical system is designed to support. Importantly, in this conceptual paper these outcomes are presented as intended and theoretically grounded outcomes, not as empirically confirmed results. Their inclusion serves to clarify the educational logic of the framework and to show how the proposed design architecture aligns with broader goals of higher education innovation pedagogy.

The first category of outcomes involves multidimensional student engagement. Because the framework is built around active, visible, and collaborative participation, it is expected to support at least three forms of engagement:

1. Behavioural engagement - visible participation in activities, discussions, collaborative tasks, and artefact development
2. Cognitive engagement - deeper attention, reasoning, reflection, and conceptual processing during design thinking stages
3. Collaborative engagement - active contribution to group interaction, peer coordination, and shared problem-solving

These forms of engagement are foundational because design thinking pedagogy cannot operate meaningfully without them. In the proposed framework, engagement is not treated as a by-product of motivation alone, but as an outcome actively shaped by methodological design.

The second category of outcomes concerns design thinking application capability. Students are expected to develop familiarity with the process logic of design thinking and the ability to apply it in a structured way. This includes identifying user-centred concerns, framing problems, generating ideas, developing visible solution representations, and responding to feedback. In cross-disciplinary settings, this capability is especially valuable because it provides a common innovation language that can be used across different academic backgrounds.

The third category involves early-stage innovation capability. The framework is designed to support students in moving beyond conceptual discussion toward the development of preliminary solution forms, low-fidelity prototypes, or early-stage innovation artefacts. At this level, the emphasis is not on fully commercialised or technically complete outputs, but on helping students experience the movement from insight to solution logic. This can be understood as an early foundation for innovation readiness and entrepreneurial problem-solving.

A fourth category involves transferable transversal competencies. Because the design thinking process requires empathy, communication, teamwork, critical reflection, and iterative adaptation, the framework is also expected to support broader capability development relevant beyond the immediate course. These include collaborative communication, structured problem-solving, confidence in dealing with ambiguity, and the ability to work productively across disciplinary perspectives.

Finally, the framework assumes that these learning outcomes contribute to a broader institutional goal: the development of future-ready graduates who are better equipped for innovation-oriented, uncertain, and interdisciplinary work environments. In this sense, the framework is not only a model for course design; it is also a proposed mechanism for supporting wider graduate capability agendas in higher education.

F. Scalability Conditions

Conceptually, these scalability conditions can be understood as contextual enabling constraints that shape whether the pedagogical and methodological architecture can be enacted consistently and sustainably across institutional settings. A distinctive feature of the proposed framework is the inclusion of scalability conditions, which recognise that pedagogical quality alone is insufficient if a model cannot be implemented consistently across large institutional contexts. Many design thinking initiatives remain effective only in small or specialised settings because they depend heavily on exceptional facilitation, intensive resources, or niche student populations. For a compulsory cross-disciplinary online course, however, the framework must also be operationally sustainable and institutionally transferable.

The first scalability condition is platform ecosystem compatibility. While the framework explicitly argues against platform determinism, it also recognises that digital tools matter insofar as they must support synchronous interaction, collaborative artefact production, and manageable group coordination. The key issue is not whether a platform is “best” in absolute terms, but whether it fits the institution’s broader digital ecosystem and can support the pedagogical functions required.

The second condition is facilitator capability. Scalable online design thinking depends on lecturers or facilitators being able to manage active learning, collaborative dynamics, stage-based pacing, and engagement monitoring in real time. This implies that staff development should focus not only on technical tool usage, but also on facilitation strategies,

interaction design, and pedagogical decision-making.

The third condition is standardised templates and learning artefacts. Large-cohort implementation benefits from reusable structures such as shared slides, prototype canvases, guided prompts, and stage-based activity templates. These help reduce ambiguity, support consistency across groups, and make participation more visible and manageable.

The fourth condition is institutional system integration, especially with learning management systems, enrolment records, and communication channels. When the pedagogical model aligns with existing institutional systems, it becomes easier to manage logistics, support accountability, and sustain implementation over time.

The fifth condition is cost sustainability. Large public universities must often balance pedagogical ambition with budgetary realities. A scalable framework therefore needs to be feasible within existing or reasonably accessible digital infrastructure rather than dependent on highly specialised or expensive platforms. This is particularly relevant in resource-conscious higher education contexts.

The sixth and final condition is replicability across disciplines and cohorts. Because compulsory design thinking involves students from diverse academic backgrounds, the framework must be flexible enough to accommodate varied problem themes and disciplinary perspectives while still preserving a coherent pedagogical structure. This requires a model that is sufficiently standardised to scale, yet sufficiently adaptable to remain meaningful across contexts.

Together, these scalability conditions reinforce the paper’s central argument: effective online design thinking is not simply a matter of good pedagogy or good technology in isolation. It is the result of a coherent alignment between pedagogical intent, methodological design, and institutional feasibility. This alignment is what transforms design thinking from an isolated teaching innovation into a potentially sustainable model for mainstream higher education.

The proposed framework is intended primarily for compulsory or large-enrolment undergraduate contexts in which design thinking is delivered synchronously or in blended-online form across heterogeneous disciplinary cohorts. It is particularly relevant for institutions seeking scalable, resource-conscious innovation pedagogy within mainstream curriculum structures. The framework is less directly applicable to highly specialised studio-based design programmes, small voluntary innovation labs, or settings where advanced physical prototyping and

extended project incubation are central to the learning model. Clarifying these boundary conditions is important because the framework is designed for institutional scalability and pedagogical transferability, rather than for all possible forms of design thinking education.

G. Conceptual Propositions

To strengthen the framework's analytical clarity and support future empirical testing, this paper advances a set of conceptual propositions derived from the relationships outlined across the three framework layers and associated scalability conditions. These propositions are not presented as hypotheses in the positivist sense, but as theory-informed claims that can guide subsequent design-based, comparative, or mixed-method empirical inquiry.

Proposition 1 (Pedagogy over platform):

In compulsory large-scale online design thinking contexts, pedagogical effectiveness is shaped more strongly by the coherence of methodological enablers than by the sophistication of digital platform features alone.

Proposition 2 (Engagement-based accountability):

Engagement-based attendance and artefact-based accountability are more likely than presence-based administrative attendance mechanisms to strengthen behavioural and collaborative engagement in online experiential learning environments.

Proposition 3 (Iterative sequencing):

The iterative interweaving of conceptual input and immediate collaborative application is more likely than front-loaded lecture sequencing to preserve the experiential integrity of online design thinking pedagogy.

Proposition 4 (Distributed coordination):

Structured peer leadership and visible collaborative roles are likely to reduce participation asymmetry and strengthen group coordination, accountability, and collaborative engagement in cross-disciplinary online cohorts.

Proposition 5 (Institutional transferability):

The alignment of pedagogical core, methodological enablers, and scalability conditions increases the transferability and institutional viability of online design thinking models across diverse higher education settings.

These propositions extend the paper beyond descriptive synthesis by clarifying the causal logic implied by the framework and by establishing a clearer agenda for future empirical validation. In doing so, they position the framework not only as a conceptual contribution, but also as a testable and refinable pedagogical theory-in-use. To further clarify the mediating logic of the framework, Table 3 maps each methodological enabler to its primary pedagogical function and the intended dimensions of student learning it is designed to support.

Table 1: Mapping of Methodological Enablers to Pedagogical Functions and Expected Outcomes

Methodological Enabler	Primary Pedagogical Function	Primary Learning Dimension Supported	Indicative Expected Outcome(s)
Engagement-based attendance verification	Reframes attendance as visible and sustained participation rather than passive presence	Behavioural engagement	Reduced silent attendance; stronger active participation across the session
Peer leadership and distributed group coordination	Clarifies responsibility and strengthens local group accountability	Collaborative engagement	Improved group coordination; reduced free-riding; stronger peer responsibility
Dialogic questioning and supportive cold-calling	Sustains active cognitive processing during conceptual discussion	Cognitive engagement	Greater attentiveness; stronger conceptual articulation; improved reflective reasoning
Artefact-based accountability	Makes learning visible through shared outputs and participation traces	Behavioural and collaborative engagement	Transparent contribution evidence; stronger alignment between activity and accountability
Structured breakout room cycles	Preserves the iterative rhythm between conceptual input and collaborative application	Cognitive and collaborative engagement	Better pacing; reduced cognitive overload; stronger stage-based application
Pre-class cognitive readiness activities	Establishes baseline conceptual readiness before intensive collaborative activity	Cognitive readiness and cognitive engagement	Reduced conceptual disparity; more efficient in-session participation
Pitch-based closure and authentic demonstration	Completes the experiential cycle through synthesis, communication, and visible demonstration	Collaborative engagement and applied capability	Stronger solution articulation; visible closure; enhanced accountability and reflection

5. DESIGN PRINCIPLES FOR SCALABLE ONLINE DESIGN THINKING IMPLEMENTATION

Building on the proposed conceptual framework, this section translates the model into a set of design heuristics intended to guide institutions seeking to implement design thinking as a compulsory, cross-disciplinary online learning experience. In the design-based educational research tradition, design heuristics function as transferable, theory-informed principles for enactment rather than fixed procedural rules. They are not presented as universal “best practices,” but as adaptable pedagogical logics derived from the alignment between the pedagogical core, methodological enablers, and scalability conditions outlined in the preceding sections. In this sense, the principles below operationalise the framework while remaining open to contextual refinement in future institutional implementations.

A. Principle 1: Prioritise Pedagogical Architecture over Platform Sophistication

The first design principle is that institutions should prioritise pedagogical architecture rather than platform sophistication when designing online design thinking courses. While digital platforms provide the infrastructure for synchronous meetings, collaboration, and artefact sharing, they do not in themselves guarantee meaningful learning. The literature reviewed in this paper consistently indicates that the quality of online learning depends more on instructional design, interaction sequencing, and facilitation than on the mere availability of advanced digital features.

Accordingly, institutions should avoid overemphasising platform comparisons as the central determinant of success. Instead, they should focus on whether the selected digital ecosystem can support the pedagogical functions required by the course: structured interaction, stage-based collaboration, shared artefact production, timely feedback, and visible participation. This principle is particularly relevant for large public universities operating under cost and access constraints. A simpler, institutionally integrated platform can be pedagogically sufficient if the learning design is coherent and intentionally structured.

5.2. Principle 2: Sequence Theory and Practice Iteratively, Not Sequentially

The second design principle is that design thinking should be taught through iterative sequencing rather than through a front-loaded theoretical model. In many online teaching contexts, there is a tendency to deliver conceptual content in extended lecture blocks before asking students to apply ideas independently. For design thinking, this approach is pedagogically

weak because it disrupts the experiential cycle that underpins the learning process.

Instead, instructors should interweave conceptual explanation with immediate application. After introducing a design thinking stage or concept, students should be given structured opportunities to practise it collaboratively, reflect on it, and return for clarification or feedback. This principle preserves the studio-like rhythm of experiential learning and reduces the cognitive distance between knowing and doing. It is especially important in compulsory cross-disciplinary settings, where students may be unfamiliar with innovation processes and therefore benefit from guided, staged application.

B. Principle 3: Reframe Attendance as Demonstrated Engagement

A third design principle is that attendance in online design thinking should be reconceptualised as demonstrated engagement rather than passive presence. Conventional attendance methods, such as one-time sign-ins, login records, or static forms, are poorly aligned with experiential and collaborative pedagogies. They may confirm access, but they do not indicate whether meaningful learning participation has occurred.

In scalable online design thinking, participation should be evidenced through visible engagement across the session: discussion responses, artefact contributions, collaborative outputs, stage completion, peer interaction, and presentation activity. This principle aligns administrative accountability with pedagogical intent, reducing the gap between “being present” and “participating in learning.” It also supports fairness and transparency in large compulsory classes where silent attendance and disengaged presence are otherwise difficult to detect.

C. Principle 4: Build Structured Peer Accountability into Group Work

The fourth principle is that online collaborative learning should be supported through structured peer accountability, rather than assuming that group work will self-regulate effectively. Design thinking requires students to coordinate ideas, negotiate meaning, divide tasks, and progress through multiple stages of problem solving. In large and diverse online cohorts, these demands can easily result in uneven participation if coordination roles are not made explicit.

Institutions and instructors should therefore consider the deliberate use of peer leadership structures, such as group leaders, rotating coordinators, or stage-based role assignments. These roles help maintain momentum, reduce diffusion of

responsibility, and create clearer local accountability within groups. Importantly, this principle is not only about task management; it also creates opportunities for students to develop leadership, coordination, and collaborative decision-making capabilities that are themselves relevant to innovation and entrepreneurship education.

D. Principle 5: Use Artefacts as Both Learning Products and Accountability Evidence

The fifth principle is that online design thinking should rely on artefact-centred learning, in which shared outputs function simultaneously as learning products and participation evidence. Because design thinking is fundamentally iterative and externally oriented, it benefits from making student thinking visible through problem statements, idea maps, sketches, low-fidelity prototypes, canvases, or short presentation decks.

These artefacts should not be treated merely as end-of-class submissions. Rather, they should be used throughout the learning cycle as evidence of progress, contribution, and collective sense-making. This approach supports authentic assessment, strengthens transparency, and reduces reliance on disconnected administrative measures. It also helps instructors monitor progress more effectively in large classes by anchoring participation to visible collaborative outputs rather than to informal observation alone.

E. Principle 6: Design Breakout Sessions as Pedagogical Cycles, Not Technical Features

A sixth principle is that breakout rooms should be conceptualised as pedagogical cycles rather than as technical features. In many online courses, breakout rooms are used as generic discussion spaces without sufficient task clarity, pacing, or reintegration. For design thinking, such loose use of breakout rooms can lead to confusion, superficial talk, or fragmented group work.

Instead, breakout rooms should be deliberately aligned with specific design thinking stages or sub-tasks. Each breakout cycle should have a clear objective, a visible output, and a reintegration moment in which students return to the main session for synthesis, clarification, or feedback. This transforms breakout rooms from passive discussion spaces into structured sites of experiential learning. It also helps preserve momentum, reduce cognitive overload, and maintain alignment between conceptual instruction and collaborative application.

F. Principle 7: Establish Cognitive Readiness Before Intensive Application

The seventh principle is that institutions should establish baseline cognitive readiness before students

enter intensive online design thinking sessions. In compulsory cross-disciplinary contexts, learners often begin with uneven levels of prior exposure to design thinking, innovation processes, or human-centred problem solving. If this disparity is not addressed, in-session collaboration may become inefficient, with stronger students carrying the conceptual burden while others struggle to participate meaningfully.

Short pre-class readings, introductory videos, guided prompts, or basic comprehension checks can help create a shared starting point. This does not require heavy preparatory workload, but it does ensure that students enter the session with a minimal conceptual foundation. By reducing initial uncertainty, cognitive readiness mechanisms free more in-session time for higher-value collaborative application and iterative experimentation.

G. Principle 8: End with Authentic Demonstration and Reflective Closure

The final principle is that online design thinking should culminate in authentic demonstration, such as a short pitch, prototype presentation, or solution walkthrough. This provides a meaningful endpoint to the learning cycle by requiring students to articulate what they developed, why it matters, and how it responds to the identified problem or user need.

Pitch-based closure is pedagogically powerful because it integrates synthesis, accountability, communication, and reflection. It also mirrors the outward-facing orientation of design thinking, where ideas are meant to be shared, tested, and improved through feedback. In large compulsory online settings, this final demonstration can reinforce completion, create a sense of shared accomplishment, and ensure that the course concludes with visible evidence of learning rather than unfinished group activity.

Taken together, these eight principles operationalise the framework into a set of actionable yet transferable design heuristics. They offer institutions a practical way to preserve the experiential integrity of design thinking while also responding to the realities of scale, cost, and digital delivery. Importantly, these principles are not intended as fixed procedural rules. In line with design-based educational research, they should be treated as adaptable guides that can be refined through implementation and future empirical study.

6. IMPLICATIONS FOR HIGHER EDUCATION PRACTICE AND POLICY

The proposed conceptual framework and associated design heuristics carry implications at multiple levels of higher education analysis:

pedagogical, curricular, institutional, and policy-oriented. These implications extend beyond the immediate question of how design thinking can be taught online. More broadly, they speak to how universities can design scalable experiential pedagogies that remain educationally meaningful under conditions of mass participation, digital mediation, and resource constraint. In this regard, the framework contributes not only to design thinking pedagogy, but also to wider debates on online learning quality, innovation education, and the pedagogical dimensions of institutional digital transformation.

A. Implications for Teaching and Curriculum Design

At the teaching level, the framework suggests that design thinking should not be approached as a one-off workshop technique or an isolated creativity exercise. Instead, it should be treated as a structured pedagogical model that requires intentional alignment between learning outcomes, interaction design, accountability mechanisms, and collaborative activity. This implies that lecturers need support not only in understanding design thinking conceptually, but also in designing the online learning architecture that allows students to experience it meaningfully.

For curriculum designers, the framework highlights the importance of embedding design thinking in ways that move beyond symbolic inclusion. If design thinking is positioned as a compulsory cross-disciplinary course, its value depends on how it is sequenced, scaffolded, and integrated into broader graduate capability development. Institutions should therefore consider how design thinking aligns with employability agendas, innovation capability frameworks, entrepreneurship education, and interdisciplinary learning strategies. In this sense, design thinking can serve as a curricular bridge between disciplinary knowledge and broader future-ready competencies.

B. Implications for Online Pedagogy and Academic Development

The framework also contributes to the growing conversation on online pedagogy in higher education. A key implication is that online experiential learning is possible, but only when institutions move beyond content transfer and invest in pedagogical redesign. This means that staff development programmes should not focus solely on digital platform operation or technical troubleshooting. They should also build academic capability in areas such as active learning design, online facilitation, peer accountability structures, authentic assessment, and the sequencing of

collaborative interaction.

This is particularly important for large public universities, where the scalability of online learning often creates pressure for efficiency and standardisation. The proposed framework suggests that standardisation is not inherently problematic if it is applied at the level of design structure rather than pedagogical simplification. Shared templates, common artefacts, and structured breakout cycles can help scale experiential learning without necessarily reducing educational quality. This insight is highly relevant for institutions seeking sustainable ways to deliver high-impact learning at scale.

C. Implications for Institutional Digital Transformation

At an institutional level, the framework offers a more nuanced perspective on digital transformation in higher education. Universities often equate digital transformation with platform adoption, system integration, or technological upgrading. While these are important, the present paper suggests that the more meaningful transformation lies in the development of pedagogically intelligent digital learning models.

In this sense, the framework reframes digital transformation from a technology-centred agenda to a pedagogy-centred institutional capability. The question is not simply whether an institution has access to digital tools, but whether it can design and sustain online learning experiences that remain interactive, accountable, and capability-building. For universities seeking to strengthen innovation education without excessive dependence on costly or highly specialised platforms, this provides a strategically valuable perspective.

D. Implications for Innovation and Entrepreneurship Education

The framework also has implications for innovation and entrepreneurship education, especially in contexts where institutions seek to develop entrepreneurial mindsets across the wider student population rather than within business schools alone. Design thinking is particularly well suited to this objective because it introduces students to user-centred opportunity recognition, collaborative ideation, iterative experimentation, and solution communication, capabilities that are central to entrepreneurial action. In resource-conscious university ecosystems, early-stage innovation capability should be understood not only as ideation capacity but also as the ability to move toward structured value articulation and translational readiness, which is increasingly relevant in broader innovation, commercialisation, and intellectual asset

development agendas [1].

However, the framework emphasises that these outcomes do not emerge automatically from exposure to design thinking terminology. They depend on whether the course design creates meaningful opportunities for students to enact entrepreneurial ways of thinking. In this sense, the methodological enablers proposed in this paper, peer leadership, pitching, artefact-based accountability, problem framing, and iterative refinement, also function as mechanisms for strengthening the applied relevance of design thinking within entrepreneurship and innovation education.

E. Policy Implications for Large Public Universities and National Higher Education Systems

At the policy level, the framework is particularly relevant for large public universities and national systems seeking mainstream innovation capability as part of graduate development. In many policy contexts, universities are increasingly expected to produce graduates who are adaptive, collaborative, digitally capable, and innovation-ready. Yet policy aspirations often outpace the availability of scalable pedagogical models.

This paper contributes to that gap by proposing a model that is both educationally grounded and institutionally feasible. For policymakers and university leaders, the implication is that innovation-oriented graduate development does not necessarily require elite laboratories, highly selective programmes, or costly technology ecosystems. With appropriate pedagogical design, large institutions can create scalable and transferable models that broaden access to innovation learning across faculties and student groups.

Taken together, these implications suggest that the proposed framework is not only a contribution to design thinking education literature, but also a broader contribution to debates on how universities can build scalable innovation pedagogy under real institutional constraints.

A limitation of the present paper is that it offers a theory-building and framework-development contribution rather than an empirical test of the proposed model. Accordingly, the framework should be interpreted as a conceptual architecture grounded in literature synthesis and contextual pedagogical reasoning, not as a validated causal model. This limitation is deliberate and methodologically appropriate for the paper's purpose, but it also underscores the importance of subsequent empirical work to examine the relative effectiveness, contextual sensitivity, and transferability of the proposed design heuristics.

7. CONCLUSION

This paper has proposed a conceptual framework for scalable online design thinking pedagogy in compulsory cross-disciplinary higher education settings. Responding to a clear gap in the literature, the study has argued that existing work on design thinking education remains heavily concentrated on elective, small-scale, discipline-specific, or face-to-face implementations, with limited conceptual guidance for institutions seeking to embed design thinking as a mainstream, fully online learning experience across large and diverse student populations.

Drawing on scholarship in design thinking education, online learning, active learning, collaborative learning, and design-based educational research, the paper advances a pedagogy-first model that shifts attention away from platform-centric thinking and toward the deeper question of how design thinking can be structured as a coherent, scalable educational system. The proposed framework comprises three interdependent layers: the pedagogical core, centred on the five-stage design thinking process and experiential learning logic; the methodological enablers, which translate pedagogical intent into visible, iterative, and accountable online learning practices; and the expected learning outcomes, which include multidimensional engagement, design thinking application, and early-stage innovation capability. These layers are further supported by a set of scalability conditions that acknowledge the institutional realities of large public university implementation.

A key contribution of the paper lies in its reframing of methodological elements, such as engagement-based attendance, peer leadership, artefact-based accountability, dialogic questioning, structured breakout cycles, and pitch-based closure, as pedagogically meaningful design mechanisms rather than mere delivery logistics. This conceptual move is important because it highlights that the success of online design thinking depends not simply on access to digital tools, but on whether the learning environment is deliberately designed to preserve experiential integrity, collaborative accountability, and applied learning at scale.

The paper also contributes a set of design principles intended to guide institutions in implementing online design thinking more effectively. These principles emphasise the importance of prioritising pedagogical architecture over platform sophistication, sequencing theory and practice iteratively, reconceptualising attendance as engagement, building structured peer accountability,

and using artefacts as both learning outputs and evidence of participation. Together, these principles offer a practical yet theoretically grounded basis for institutional adaptation.

From a scholarly perspective, the principal contribution of this paper lies in repositioning scalability as a pedagogically constitutive condition rather than a logistical concern external to learning design. In doing so, the paper reframes online design thinking not simply as a matter of digital delivery or platform adaptation, but as a problem of preserving experiential integrity under conditions of compulsory participation, large enrolment, and cross-disciplinary diversity. The framework therefore extends existing discussions of design thinking in higher education by showing that the educational value of design thinking depends less on tool availability than on the methodological architecture through which engagement, accountability, and iterative application are made visible and sustainable.

From a practical and institutional perspective, the framework offers universities a structured way to mainstream innovation-oriented learning without requiring highly specialised or resource-intensive ecosystems. This is especially relevant for large public universities seeking scalable approaches to graduate

capability development, entrepreneurship-oriented learning, and cross-disciplinary innovation education within real operational constraints.

As a conceptual and methodological paper, this study does not claim empirical validation of the proposed framework. Its contribution lies instead in offering a theory-informed and implementation-sensitive architecture that can guide future design-based refinement and empirical inquiry. Subsequent research should test the framework across different institutional contexts, examine the relative strength of specific methodological enablers, and compare its performance across online, blended, and hybrid delivery models. Comparative multi-site studies may also help determine which design heuristics are robust across contexts and which require local adaptation.

In conclusion, if higher education is to move beyond symbolic commitments to innovation, creativity, and entrepreneurship, it requires pedagogical models that can remain meaningful under conditions of scale. This paper argues that design thinking can serve that role, but only when it is treated not as a workshop format or digital toolset, but as a deliberately designed pedagogical system for scalable experiential learning

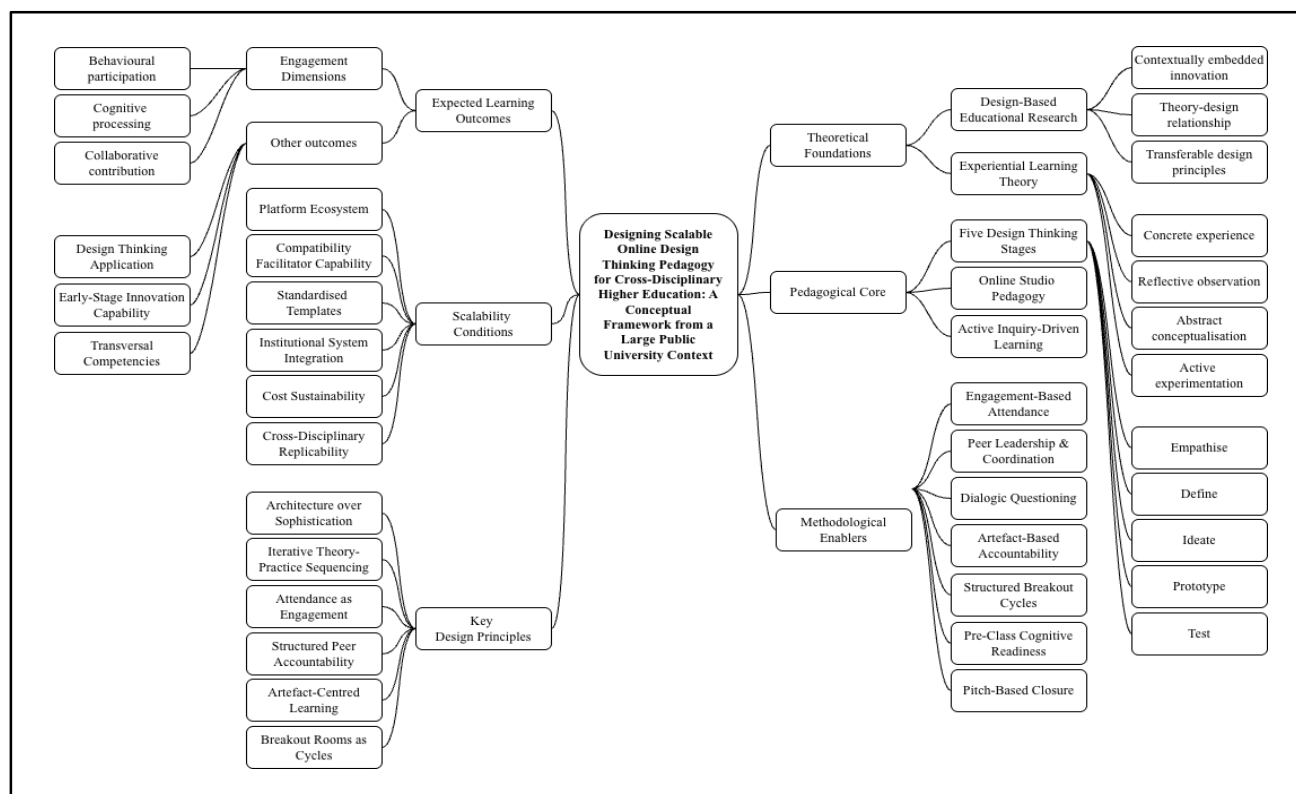


Figure 1: Proposed Conceptual Framework of Scalable Online Design Thinking Pedagogy

Caption: The framework conceptualises methodological enablers as mediating mechanisms between the pedagogical core (design thinking stages and experiential learning logic) and a set of proximal

and distal learning outcomes. Scalability conditions function as contextual enabling constraints that shape institutional feasibility, consistency, and transferability across large public university settings.

Table II: Literature Gaps Addressed by the Present Study

Gap Dimension	Common Focus in Existing Literature	Underexplored Area	Contribution of This Paper
Contextual gap	Elective, discipline-specific, small-scale, or face-to-face implementations	Compulsory, cross-disciplinary, large-cohort online implementation	Reframes design thinking as a scalable mainstream pedagogical model
Pedagogical gap	Tool-centred or operationally descriptive online delivery	Methodological architecture for sustaining experiential learning online	Proposes methodological enablers as pedagogically meaningful design mechanisms
Theoretical gap	Design thinking as method or workshop	Design thinking as institutionally scalable educational system	Develops a theory-informed conceptual framework
Practical gap	Isolated case examples	Transferable design principles for large public universities	Provides implementation-oriented design principles

Table III: Design Principles for Scalable Online Design Thinking

Design Principle	Core Purpose	Implication for Practice
Prioritise pedagogical architecture over platform sophistication	Focus on learning design, not tool prestige	Choose institutionally feasible platforms that support core pedagogical functions
Sequence theory and practice iteratively	Preserve experiential learning rhythm	Alternate conceptual input with immediate application
Reframe attendance as demonstrated engagement	Align accountability with learning	Use participation traces and artefact contributions instead of static attendance
Build structured peer accountability	Reduce free-riding and strengthen collaboration	Appoint group leaders or rotating coordinators
Use artefacts as learning products and evidence	Make thinking visible and assessable	Require shared slides, canvases, prototypes, or stage-based outputs
Design breakout rooms as pedagogical cycles	Ensure purposeful collaborative application	Assign stage-specific tasks with reintegration moments
Establish cognitive readiness before intensive application	Reduce uneven starting points	Use short pre-readings, videos, or pre-class prompts
End with authentic demonstration	Reinforce synthesis and closure	Require short pitches, solution presentations, or prototype walk-throughs

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