frontiers in Education

TYPE Hypothesis and Theory
PUBLISHED 13 February 2026
DOI 10.3389/feduc.2026.1726937

OPEN ACCESS

EDITED BY
Ramon Ventura Roque Hernández,
Universidad Autónoma de Tamaulipas,
Mexico

REVIEWED BY
Basma N. El-Mowafy,
Port Said University, Egypt
Qusai Anteet,
King Saud University, Saudi Arabia

*CORRESPONDENCE
Porntip Ruengtam
porntip.r@msu.ac.th

RECEIVED 17 October 2025
REVISED 31 December 2025
ACCEPTED 26 January 2026
PUBLISHED 13 February 2026

CITATION
Ruengtam P (2026) Reframing flipped studio learning for transformative pedagogy in architecture and built environment education.
Front. Educ. 11:1726937.
doi: 10.3389/feduc.2026.1726937

Reframing flipped studio learning for transformative pedagogy in architecture and built environment education

Porntip Ruengtam*

Faculty of Architecture, Urban Design, and Creative Arts, Mahasarakham University, Maha Sarakham, Thailand

Flipped learning has been widely recognized for promoting active and self-directed learning across higher education, yet its theoretical grounding within architecture and built environment education remains fragmented and underdeveloped. This study employs a conceptual–analytical methodology, combining a narrative literature review and analytical mapping to studio pedagogy, to develop a discipline-specific conceptual–operational framework for Flipped Studio Learning. The framework identifies four adoption drivers—pedagogical design, technological readiness, learner engagement, and institutional support—which interact through the mediating construct of perceived effectiveness and are influenced by contextual factors such as discipline type, class size, and prior learning experience. The study yields three major theoretical outcomes: (1) a theoretically grounded model explaining how flipped learning aligns with studio-based education; (2) measurable constructs and operational indicators that translate the framework into testable variables; and (3) three conceptual propositions (P1–P3) that guide subsequent empirical validation through methods such as SEM, case studies, or longitudinal research. Theoretically, the study integrates constructivism, experiential learning, and reflective practice with the epistemology of studio pedagogy, repositioning flipped learning as a reflective pedagogical ecosystem rather than a delivery technique. Practically, it offers actionable pathways for curriculum renewal, studio orchestration, and institutional policy—advancing technology-enhanced, student-centered design education.

KEYWORDS
architecture and built environment education, conceptual–operational framework, design pedagogy, Flipped Classroom, reflective practice, studio-based learning, technology-enhanced learning

1 Introduction

The Flipped Classroom reconfigures the conventional sequence of lecture and practice by shifting the initial exposure to course content outside the classroom, reserving in-class time for interactive, problem-based activities. Across higher education, systematic reviews and meta-analyses consistently report improvements in learner engagement, autonomy, and academic performance, along with enhanced peer interaction and formative feedback (O'Flaherty and Phillips, 2015; Akçayır and Akçayır, 2018; Hew and Lo, 2018; Bond, 2020; Farmus et al., 2020). Recent research indicates that flipped learning has evolved beyond an instructional method into a multidimensional pedagogical ecosystem. Zhang (2024) mapped this evolution and identified four key research streams: learner-centered design, technological mediation, assessment innovation, and contextual adaptation. These developments suggest that flipped learning functions less as a delivery technique and more as a framework for cultivating adaptive and evidence-based learning cultures. This broader trajectory underpins the present study's attempt to theorize how flipped learning can be contextualized within design-based learning environments, where creativity, reflection, and iterative inquiry are fundamental.

In architecture and built environment education, learning typically combines lectures, design studios, and experiential projects. Such environments emphasize critique, collaborative problem-solving, and project-based inquiry—conditions that align closely with flipped pedagogy (Jack et al., 2025; Sosa and Narciso, 2019; Triantafyllou and Timcenko, 2014). Moving lecture components to pre-class formats creates space for deeper studio critique and collaborative exploration—activities often constrained by traditional timetabling (Mason et al., 2013). Yet, the adoption of flipped approaches in design education remains limited. Most empirical evidence comes from STEM and health disciplines, while few studies examine how flipped pedagogy interacts with studio culture, spatial reasoning, or creativity—the defining attributes of design learning (Lo and Hew, 2017). This limitation constrains the development of theoretically grounded and evidence-informed models of technology-enhanced design pedagogy.

Furthermore, only a small body of research has explored how flipped learning aligns with the core educational theories underpinning architecture and design education—such as andragogy (Knowles, 1980), experiential learning (Kolb, 1984), and reflective practice (Schön, 1984). Studio pedagogy, grounded in iterative making, reflection, and self-directed inquiry (McLean et al., 2016; Newmann et al., 1996), naturally resonates with these principles. Yet, in the absence of a discipline-specific framework, current implementations remain fragmented and difficult to sustain across curricula. Consequently, the field lacks a coherent model that translates the philosophical foundations of design learning into an operational pedagogy suited to technology-enhanced environments.

This paper addresses this gap by theoretically synthesizing interdisciplinary literature and theoretical perspectives to develop a conceptual–operational framework for Flipped Studio Learning in architecture and built environment education. The framework connects pedagogical design with studio realities, providing direction for curriculum innovation and laying the groundwork for future empirical inquiry and policy development.

The study contributes to the field in four ways:

- It consolidates interdisciplinary literature to construct a framework tailored to design education.
- It explicitly connects flipped pedagogy with adult learning, constructivism, and experiential-reflective theories within studio-based contexts.
- It identifies four adoption drivers—pedagogical design, technological readiness, learner engagement, and institutional support—embedded within discipline-specific ecosystems.
- It establishes a theoretical foundation for future empirical research by articulating key constructs, processes, and expected outcomes for sustainable integration.

This paper is structured as follows. Section 2 reviews literature on flipped learning and studio pedagogy. Section 3 outlines the research gap and objectives. Section 4 details the conceptual methodology. Section 5 presents the framework. Section 6 discusses implications, and Section 7 concludes with contributions and future research directions. Figure 1 provides an overview of the manuscript structure and the analytical logic guiding the development of the conceptual–operational framework.

2 Background and literature review

The Flipped Classroom has gained growing recognition as an alternative to traditional lecture-based instruction. By shifting initial content exposure to pre-class settings, it enables in-class time to be dedicated to active, collaborative, and problem-based learning. A substantial body of evidence from STEM and health sciences indicates its effectiveness, with systematic reviews reporting improvements in learner engagement, autonomy, and academic performance (Akçayır

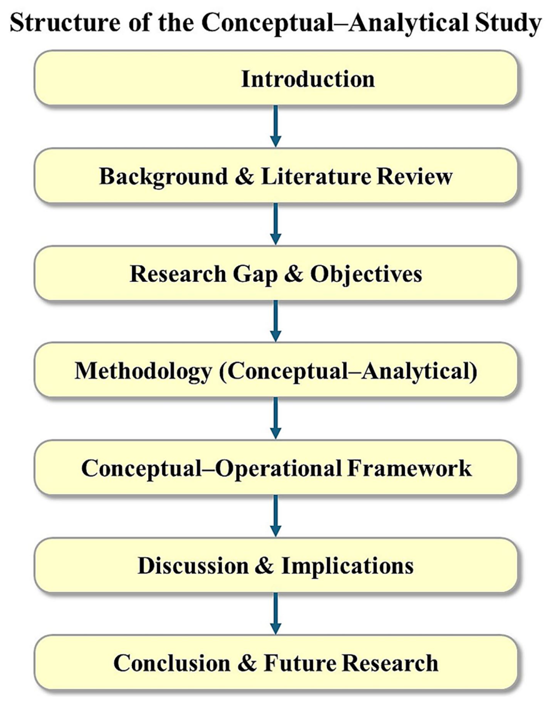

FIGURE 1
Manuscript structure of the article. This figure presents the overall structure and analytical progression of the manuscript. The article begins with an introduction, followed by a background and literature review that synthesizes key scholarship on flipped learning and studio pedagogy. It then delineates the research gap and objectives, which inform the conceptual–analytical methodology adopted in the study. Based on this methodology, a conceptual–operational framework for flipped studio learning is developed and elaborated. The manuscript subsequently discusses the theoretical, pedagogical, and institutional implications of the framework, and concludes with a summary of contributions and directions for future research.

Abbreviations: LMS, Learning Management System; SDGs, Sustainable Development Goals; SEM, Structural Equation Modeling; STEM, Science, Technology, Engineering, and Mathematics.

and Akçayır, 2018; Betihavas et al., 2016; Bishop and Verleger, 2013; Bond, 2020; Hew and Lo, 2018; O'Flaherty and Phillips, 2015).

Taken together, these studies suggest that, when intentionally designed, flipped learning enhances both the cognitive and social dimensions of learning. However, in architecture and built environment education, adoption remains limited despite its natural alignment with studio-based pedagogy—an educational model characterized by iterative critique, hands-on inquiry, and experiential learning (Sosa and Narciso, 2019). This discrepancy highlights a key gap: existing flipped learning models require reinterpretation through a discipline-specific lens that reflects the pedagogical, spatial, and institutional dynamics of design education.

To address this gap, the following sections review the literature through the lens of four interrelated adoption drivers—pedagogical design, technological readiness, learner engagement, and institutional support—which form the theoretical foundation for the conceptual–operational framework proposed in this study.

2.1 Studio pedagogy and theoretical foundations of design learning

Studio-based pedagogy is the cornerstone of architectural and design education. Unlike lecture-driven instruction, the design studio operates as a complex learning ecosystem that integrates making, thinking, reflecting, and critiquing into a continuous process of knowledge construction. It is not merely a physical space but an epistemic environment where design knowledge is produced, tested, and negotiated through iterative acts of creation and reflection (Cuff, 1992; Dorst, 2004). Design problems are typically ill-structured (Newell and Simon, 1972), lacking definitive solutions and requiring students to frame problems, explore alternatives, and justify decisions—making design learning fundamentally different from disciplines where knowledge is transmitted and reproduced rather than critically constructed.

Schön's (1984) concept of the reflective practitioner is central to understanding this epistemology. He distinguishes between reflection-in-action, where students adjust their thinking while sketching or modeling in response to emerging constraints, and reflection-on-action, where decisions are analyzed retrospectively during critiques or reviews. These critiques—whether informal desk discussions or formal juries—serve as structured spaces where tacit reasoning becomes explicit through dialogue.

Kolb's (1984) experiential learning cycle further explains why the design studio embodies constructivist learning. His four stages—concrete experience, reflective observation, abstract conceptualization, and active experimentation—are inherently embedded within studio practice. Students experiment with materials or spatial configurations (experience), observe feedback and peer work (reflection), extract design principles (abstraction), and revise their work (experimentation). This cyclical process parallels the iterative rhythm of studio culture.

Salama (2021) advances this understanding by framing studio pedagogy as transformative, fostering not only technical proficiency but also ethical judgment, spatial sensitivity, and socio-cultural awareness. He identifies four interdependent dimensions of studio learning:

- Cognitive—structuring problems, reasoning spatially, integrating theory and practice.
- Operative—utilizing analog and digital tools to translate ideas into form.
- Reflective—internal critique, peer feedback, and self-assessment.
- Socio-cultural—engaging users, contexts, and communities.

Similarly, Oxman (2004) emphasizes the cognitive dimension of design learning, arguing that studios cultivate design reasoning—skills such as visual thinking, precedent analysis, pattern recognition, and form generation. This positions the studio as a space where unique cognitive schemas of design expertise are formed.

From these perspectives, the studio emerges as a constructivist, dialogic, and inquiry-based environment that aligns naturally with principles of andragogy (Knowles, 1980), active learning, experiential learning, and reflective practice. In principle, this makes the studio a receptive setting for flipped learning, as the model relocates passive content delivery to pre-class formats and optimizes in-class time for higher-order tasks such as critique, collaboration, and iterative experimentation.

However, this alignment is not automatic. Studio learning depends on tacit knowledge, embodied interaction, and spontaneous dialogue, which risk being diminished if pre-class content is oversimplified or if digital tools substitute rather than enhance reflective discourse. This challenge leads to a critical question addressed in the next section: How can flipped learning be adapted to preserve—and strengthen—the reflective, iterative, and collaborative nature of studio pedagogy?

2.2 Evolution of flipped learning and major research streams (2010–2025)

Since its introduction in the early 2000s, the Flipped Classroom has evolved from a simple reversal of lecture and homework into a multidimensional pedagogical framework. In its most basic form, students engage with instructional content prior to class—typically through videos or assigned readings—while classroom time is devoted to application, discussion, and collaborative problem-solving. Meta-analyses consistently indicate that when intentionally designed, flipped learning enhances learner engagement, autonomy, academic performance, and peer interaction (Akçayır and Akçayır, 2018; Bishop and Verleger, 2013; Bond, 2020; O'Flaherty and Phillips, 2015).

More recent scholarship argues that flipped learning has progressed beyond a delivery technique toward a broader educational paradigm that supports active, evidence-informed, and collaborative learning cultures (Hew and Lo, 2018; Zhang, 2024). Through a longitudinal review of literature from 2010 to 2025, Zhang (2024) identified four dominant research streams that illustrate this intellectual evolution. These streams—summarized in Table 1—demonstrate how flipped learning has shifted from content transmission toward systemic learning design:

- Learner-centered design
- Technological mediation
- Assessment and feedback innovation
- Contextual and disciplinary adaptation

Together, these streams reflect a shift from "flipping videos" to "redesigning learning ecosystems." They emphasize that successful

TABLE 1 Four dominant research streams of flipped learning and their key scholarly contributions.

Research stream	Core focus	Examples
1. Learner-centered design	Cognitive load, scaffolding, pre-class preparation	Bishop and Verleger (2013), Abeysekera and Dawson (2015) and Thai et al. (2017)
2. Technological mediation	LMS platforms, interactive tools, digital equity	Betihavas et al. (2016) and Farmus et al. (2020)
3. Assessment and feedback innovation	Formative assessment, peer evaluation, analytics	Bond (2020) and O'Flaherty and Phillips (2015)
4. Contextual and disciplinary adaptation	Implementing flipped models in STEM, health, arts, architecture	Hew and Lo (2018) and Sosa and Narciso (2019)

Source: Author's compilation (2025).

implementation depends on balancing three interdependent components:

- Pre-class cognitive preparation,
- In-class active knowledge construction, and
- Post-class reflection and feedback.

However, the majority of flipped-learning research has been conducted in STEM and health sciences—contexts where learning outcomes are structured, measurable, and scalable. Far fewer studies address disciplines such as architecture and the built environment, where learning is open-ended, iterative, and socially mediated through critique, spatial reasoning, and tacit knowledge (Lo and Hew, 2017). This reveals a critical theoretical gap: although flipped learning aligns conceptually with constructivism and experiential learning, its adaptation to studio-based pedagogy has not yet been sufficiently theorized.

This gap leads to the central question explored in the next section: How can the flipped model be reinterpreted—rather than merely transferred—to protect and enhance the reflective, collaborative, and improvisational nature of studio pedagogy?

2.3 Contextual and institutional factors in design and studio-based education

Recent studies also demonstrate the emergence of hybrid and reflective studio pedagogies that integrate digital pin-up platforms, post-pandemic studio restructuring, and collaborative critique (Günay and Coşkun, 2023; Kassem et al., 2023; Süner-Pla-Cerdà, 2025). However, these studies remain fragmented and lack a discipline-specific conceptual–operational model that connects flipped learning with the epistemology of studio pedagogy. This study responds to that gap by proposing a framework tailored to architecture and built environment education.

The effectiveness of Flipped Classroom implementation varies considerably across disciplines, class formats, and learner profiles. In architecture and built environment education, these contextual dynamics become even more complex, as learning is not only cognitive but also spatial, visual, and collaborative. Studio-based education depends on iterative critique, peer dialogue, and one-to-one mentoring—activities that require time, physical space, and social interaction. In large studio classes, maintaining meaningful participation and personalized feedback becomes difficult, which partly explains the growing interest in flipped learning as a strategy to redistribute instructional time more efficiently (Akçayır and Akçayır, 2018; Sosa and Narciso, 2019).

However, challenges extend beyond class size. Many students entering design programs have limited experience with self-directed or active learning approaches. When pre-class preparation is inconsistent or superficial, in-class critique and discussion become less productive, making instructors hesitant to rely fully on flipped methods. Additionally, students' digital literacy and access to reliable technological infrastructure—particularly for streaming high-resolution visual content or design tutorials—significantly influence the success of flipped delivery.

From an institutional perspective, these conditions highlight the need for systemic rather than individual adoption. Flipped learning becomes sustainable only when it is aligned with curriculum structures, studio timetables, spatial resources, and workload policies. Institutional culture therefore acts as both an enabler and a constraint: universities with clear digital strategies, LMS support, and professional learning communities are more likely to sustain flipped integration, whereas isolated efforts led by individual instructors often remain temporary and fragmented (Bond, 2020; O'Flaherty and Phillips, 2015).

In design education—where learning occurs at the intersection of tacit knowledge, material experimentation, and reflective dialogue—institutional support must also include studio-equipped classrooms, digital pin-up systems, visual documentation platforms (e.g., Miro, Mural, Padlet), and faculty training for facilitating hybrid critique sessions. These interdependencies justify the inclusion of institutional support as a core structural dimension within the proposed conceptual–operational framework for Flipped Studio Learning.

2.4 Gaps in theory and practice for architecture and built environment education

Although the literature widely confirms the benefits of flipped learning in higher education, its application to architecture and built environment disciplines reveals several unresolved gaps—both theoretical and practical.

2.4.1 Theoretical gaps

Previous studies seldom connect flipped pedagogy with discipline-specific theoretical foundations of design education, such as Schön's reflective practice (1984), Kolb's experiential learning (1984), and Salama's transformative studio pedagogy (2021). Consequently, flipped learning is often treated merely as a content delivery technique rather than as part of a design culture driven by iteration, critique, tacit knowledge, and reflective dialogue.

2.4.2 Methodological gaps

Most existing studies rely on perception-based surveys, descriptive case studies, or general satisfaction metrics. Very few translate flipped pedagogy into a conceptual–operational model that defines measurable constructs related to studio outcomes—such as reflective competence, design reasoning, collaborative critique, or creative fluency. This lack of operational clarity hinders empirical validation and replication.

2.4.3 Contextual gaps in studio practice

While flipped learning has been extensively studied in STEM and health sciences, its adaptation to studio-based pedagogy remains underdeveloped. Design studios operate through ill-structured problems, iterative making, peer critique, and embodied interaction—processes fundamentally different from linear problem solving. Yet, core studio practices such as desk critiques, pin-up reviews, and iterative feedback cycles are rarely incorporated into flipped learning models.

2.4.4 Institutional and cultural gaps

Most implementations of flipped learning in design education are driven by individual instructors rather than institutional strategies. Consequently, critical studio-specific challenges—such as large cohort sizes, limited critique time, inadequate digital infrastructure for visual work, and minimal faculty training—remain unaddressed. This results in fragmented, short-lived adoption rather than systemic transformation.

2.4.5 Validation and applicability gaps

Even when conceptual frameworks are proposed, few studies clarify how key variables can be operationalized or empirically tested. Indicators for design performance, reflective learning, critique quality, or studio engagement are seldom defined, limiting scalability across architecture schools and design programs.

In summary, addressing these gaps requires a discipline-specific conceptual–operational framework that bridges flipped pedagogy with the epistemology and practice of design studios. This need forms the foundation for the framework proposed in the following sections.

2.5 Toward sustainable integration of flipped studio learning

The synergy between flipped learning and studio pedagogy holds significant potential for educational transformation in architecture and the built environment. However, sustainable integration requires more than replacing lectures with pre-class videos or introducing digital tools. It demands the embedding of flipped principles into the pedagogical logic, institutional systems, and cultural practices that define architectural education.

2.5.1 Pedagogical alignment

At the instructional level, flipped learning must complement rather than interrupt the studio workflow—particularly iterative critique, reflective practice, and design development. When pre-class materials introduce theoretical knowledge, design methods, or precedent studies, in-class time can be reallocated to desk critiques, collaborative synthesis, and one-to-one mentoring (Mason et al., 2013; Sosa and Narciso, 2019). This aligns with Schön's (1984) concept of the reflective practitioner and supports the studio as a site of "knowing-in-action," where learning emerges through situated inquiry and reflection.

2.5.2 Institutional support and infrastructure

Sustainability also depends on institutional commitment. Flipped studio learning must be integrated into curriculum structures, studio timetables, workload policies, and quality assurance frameworks. Without such support—access to LMS platforms, digital pin-up systems, high-resolution display tools, and staff development—flipped initiatives remain isolated efforts by individual educators (Bond, 2020; O'Flaherty and Phillips, 2015). Digital platforms such as Miro, Padlet, or collaborative pin-up tools further enable hybrid critique, visual dialogue, and documentation of design iterations.

2.5.3 Cultural transformation

The flipped studio model challenges traditional hierarchies of master-to-apprentice teaching. Its sustainability relies on a cultural shift toward self-preparation, peer critique, co-creation of knowledge, and continuous reflection. This shift aligns with Salama's (2021) transformative pedagogy, positioning studio learning as socially constructed rather than solely instructor-driven.

2.5.4 Systemic and societal relevance

When embedded systemically, flipped studio learning contributes not only to teaching innovation but also to broader educational goals—particularly SDG 4 (quality and inclusive education) and SDG 9 (innovation and infrastructure). However, without institutionalization, it risks remaining experimental and unsustained.

Therefore, this study proposes a conceptual–operational framework that integrates flipped pedagogy with studio culture, technological inclusion, institutional policy, and measurable learning outcomes. This framework addresses the gaps identified earlier and forms the foundation for research objectives and conceptual propositions presented in Section 3.

3 Research gap and objectives

3.1 Research gap

Although flipped learning has well-demonstrated empirical effectiveness in STEM, health sciences, and general higher education—enhancing academic performance, autonomy, and learner engagement—it remains insufficiently theorized within architecture and built environment education. This is paradoxical because the pedagogical principles of flipped learning align closely with studio culture, which values reflection, iteration, collaboration, and self-directed inquiry.

Existing frameworks (e.g., Bishop and Verleger, 2013; O'Flaherty and Phillips, 2015) offer valuable foundations for understanding flipped learning at a general level; however, they remain theoretically under-specified with respect to the epistemic and pedagogical characteristics of design education, such as desk critiques, visual and spatial reasoning, tacit knowledge transmission, and the iterative nature of studio-based inquiry. Consequently, flipped implementations in architecture often appear fragmented, instructor-dependent, and lacking theoretical coherence.

From this review, three interrelated gaps emerge:

- Theoretical gap—Flipped learning has not been meaningfully connected to foundational theories in design education—such as Schön's reflective practice (1984), Kolb's experiential learning (1984), or Salama's studio pedagogy (2021). As a result, it is still treated as a delivery model rather than a reflective, inquiry-driven system.
- Methodological and operational gap—Few studies articulate measurable constructs that capture studio-specific outcomes (e.g., critique quality, reflective competence, design reasoning). There is no conceptual–operational framework that can be empirically tested or replicated across institutions.
- Institutional and sustainability gap—The long-term integration of flipped studio learning is constrained by lack of curriculum alignment, workload recognition, digital infrastructure, and institutional policy—leading to isolated and unsustained adoption.

Therefore, despite its potential, flipped learning in architecture remains under-theorized, under-operationalized, and under-supported. This limits its scalability, empirical validation, and contribution to evidence-based reform in design education. These gaps indicate that progress in this field is constrained not by lack of implementation, but by the absence of a theory-driven, operationally defined framework capable of generating testable propositions.

3.2 Research objectives

In response to the theoretical, methodological, and institutional gaps identified above, this study aims to:

- Synthesize interdisciplinary literature on the Flipped Classroom and examine its compatibility with principles of active learning, experiential learning, and reflective practice.
- Critically analyze the pedagogical characteristics of architecture and built environment education—including studio culture, iterative critique, reflection, peer dialogue, visual–spatial reasoning, and collaborative exploration—that both enable and challenge the adoption of flipped learning.
- Develop a discipline-specific conceptual–operational framework for Flipped Studio Learning that:

  o integrates flipped pedagogy with studio-based design education;
  o identifies four adoption drivers—pedagogical design, technological readiness, learner engagement, and institutional support;
  o defines measurable variables and relationships to support future empirical validation (e.g., survey instruments, studio observation protocols, SEM models);
  o and provides a structured foundation for curriculum innovation, policy formulation, and sustainable pedagogical transformation.

4 Methodology

This study adopts a conceptual–analytical research design appropriate to a Hypothesis and Theory article, aiming to develop a discipline-specific framework for the adoption of Flipped Studio Learning in architecture and built environment education. Instead of collecting empirical data, the methodology focuses on systematically synthesizing existing scholarship, analytically mapping it to studio pedagogy, and constructing a conceptual–operational model as a necessary precursor to subsequent empirical investigation. The framework did not emerge arbitrarily; it was derived through a deductive synthesis of established flipped classroom models (Bishop and Verleger, 2013; O'Flaherty and Phillips, 2015) and their analytical alignment with the epistemology of studio learning (Schön, 1984; Oxman, 2004).

This process unfolded in four interrelated stages.

4.1 Narrative and thematic literature review

A structured narrative review was conducted using Scopus and ERIC databases, covering literature published between 2010 and 2025. Search terms included "flipped classroom," "flipped studio," "design education," and "architectural pedagogy."

Unlike a systematic review, this approach prioritized theoretical relevance over exhaustive coverage. The review focused on:

- Core definitions, mechanisms, and models of flipped learning;
- Reported outcomes across cognitive, affective, and collaborative domains (Bishop and Verleger, 2013; Akçayır and Akçayır, 2018; Bond, 2020);
- Studies linking flipped learning with experiential, constructivist, and studio-based pedagogies (Lo and Hew, 2017; Sosa and Narciso, 2019);
- Structural challenges related to technological readiness, student preparedness, and institutional support.

Peer-reviewed English-language publications were prioritized, while K–12 studies and non-design disciplines were excluded unless they offered transferable theoretical insight.

4.2 Analytical mapping to design studio pedagogy

Insights from the literature were then mapped against the distinctive features of architecture and built environment education, focusing on:

- Iterative critique and desk reviews;
- Project-based collaboration and peer learning;
- Tacit knowledge, visual reasoning, and reflection-in-action;
- Hybrid and digitally mediated studio environments.

This analytical mapping identified both synergies (e.g., active learning, critique culture, reflective practice) and tensions (e.g., uneven student preparation, workload intensification, digital inequality). The results were organized into thematic matrices, which revealed four recurring adoption drivers—pedagogical design, learner engagement, technological readiness, and institutional support—forming the foundation of the proposed framework. This analytical connection between literature, studio pedagogy, and the four adoption drivers is visualized in Figure 2.

4.3 Framework construction: from concepts to operations

In the third stage, conceptual insights were translated into a structured conceptual–operational framework. This involved:

- Structuring the flipped process into pre-class, in-class, and post-class phases;
- Positioning four adoption drivers as the independent construct;

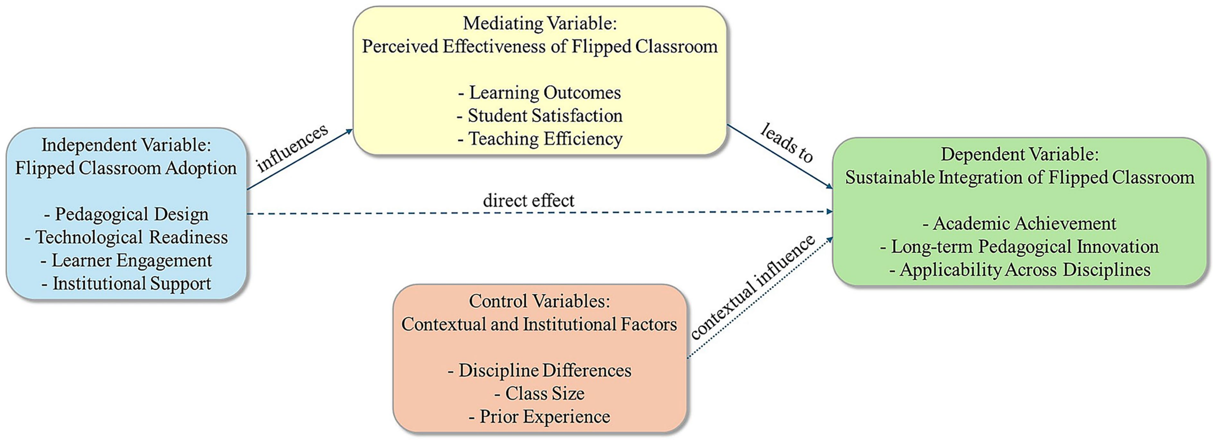

FIGURE 2
Conceptual–operational framework of flipped studio learning adoption in architecture and built environment education. This figure illustrates how four adoption drivers—pedagogical design, technological readiness, learner engagement, and institutional support—collectively form the construct of flipped studio learning adoption. These drivers influence perceived effectiveness, which acts as a mediating variable linking adoption conditions to sustainable integration. Contextual and institutional conditions (e.g., discipline type, class size, digital readiness, and prior exposure to active learning) serve as control or moderating variables that affect these relationships. The framework highlights how pedagogical, technological, learner-centered, and institutional dimensions interact to support long-term innovation in studio pedagogy, reflective practice, and curriculum development.

- Introducing perceived effectiveness as a mediating variable and sustainable integration as the long-term outcome;
- Incorporating contextual and institutional conditions as control variables;
- Formulating three conceptual propositions (P1–P3) explaining how adoption drivers influence perceived effectiveness and sustainability.

This framework moves beyond abstract theorization by outlining measurable constructs and operational pathways that can guide empirical testing and curriculum design.

Although this study is conceptual in nature, the framework has been deliberately designed for future empirical validation. Each construct—pedagogical design, technological readiness, learner engagement, institutional support, perceived effectiveness, and sustainable integration—has been clearly operationalized through measurable indicators. These constructs can be examined using quantitative methods (e.g., SEM) and/or qualitative approaches such as studio-based observation and critique analysis. The detailed empirical pathways are outlined in Section 7.1.

Taken together, these disciplinary characteristics indicate that architecture education differs fundamentally from content-driven or procedure-oriented disciplines. Because architectural learning is grounded in studio-based pedagogy, ill-structured design problems, iterative critique, and tacit visual–spatial reasoning, flipped learning in this context cannot be treated as a simple inversion of content delivery. Instead, the pedagogical framework must be designed to support continuous reflection-in-action, dialogic feedback, and iterative knowledge construction across design cycles.

Consequently, the proposed framework prioritizes reflective sequencing, studio-specific interaction patterns, and adaptive facilitation roles, positioning flipped studio learning as a discipline-specific pedagogical ecosystem rather than a transferable instructional technique. This disciplinary alignment constitutes a key theoretical milestone of the proposed framework and the present study.

5 Conceptual–operational framework

The proposed framework (Figure 3) explains how Flipped Classroom pedagogy can be meaningfully adopted, evaluated, and sustained within architecture and built environment education. It is structured across three interrelated layers—input, process, and output—which link theoretical foundations to measurable constructs, enabling future empirical validation.

5.1 Input layer: pedagogical and institutional drivers

The adoption of Flipped Classroom pedagogy in architecture and built environment education is shaped by four interdependent drivers: pedagogical design, technological readiness, learner engagement, and institutional support. Each dimension functions as both a theoretical construct and an operational condition that determines whether flipped learning can be meaningfully implemented in studio-based contexts.

- Pedagogical design—Refers to the intentional structuring of pre-class, in-class, and post-class learning experiences so that they align with studio outcomes. This includes the way design briefs or theoretical concepts are introduced before class, how critique, co-creation, and problem-solving are facilitated during class, and how reflective documentation (e.g., journals, portfolios, peer feedback) is incorporated afterward.
- Technological readiness—Involves the availability, accessibility, and usability of digital platforms and tools supporting flipped delivery. In studio environments, this includes learning management systems (LMS), digital pin-up and collaboration platforms, video repositories, screen-sharing applications, and both students' and instructors' digital literacy.
- Learner engagement—Encompasses behavioral participation, cognitive investment, and affective motivation. Observable elements include pre-class preparation, peer critique contribution,

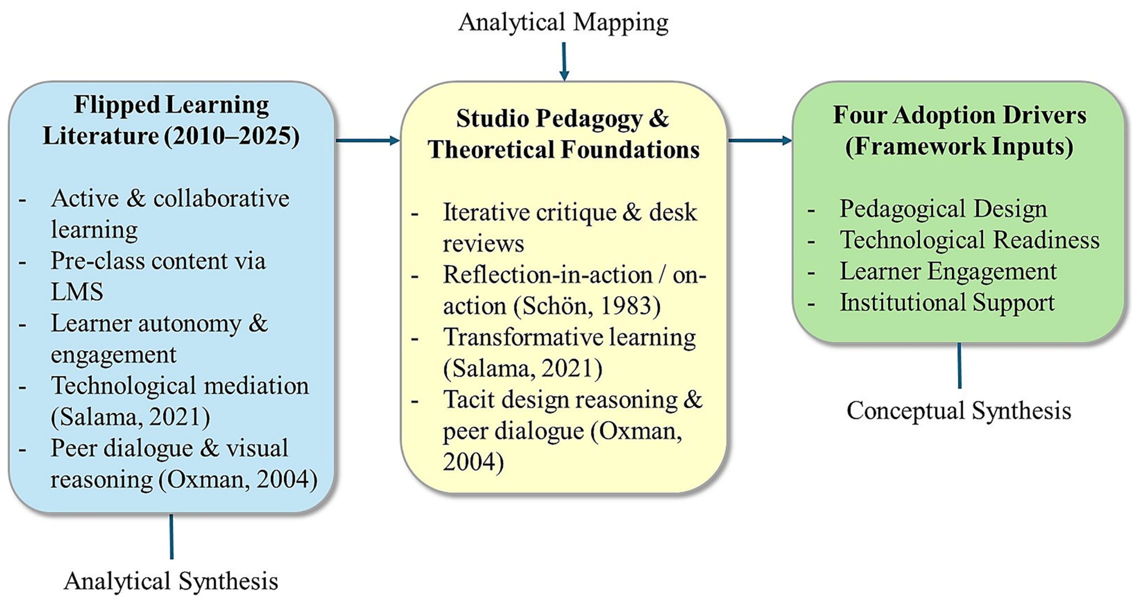

FIGURE 3
Analytical mapping of flipped learning literature to studio pedagogy. This figure illustrates the analytical process used to derive the four adoption drivers of flipped studio learning. Insights from flipped classroom literature (e.g., learner-centered design, technological mediation, assessment innovation, and contextual adaptation) were systematically mapped against core characteristics of studio-based architectural education, such as iterative critique, project-based collaboration, reflective practice, and tacit knowledge development. The outcome of this mapping produced four discipline-specific adoption drivers—pedagogical design, technological readiness, learner engagement, and institutional support—which form the foundation of the proposed conceptual–operational framework.

collaborative work during studio sessions, and the ability to reflect on design decisions throughout the process.
- Institutional support—Covers curriculum alignment, studio scheduling, workload recognition, faculty development, policy structures, and provision of technological infrastructure. Without institutional scaffolding, flipped initiatives remain isolated and unsustainable.

These drivers do not operate in isolation. Institutional support enables pedagogical innovation, pedagogical design shapes learner engagement, and technological readiness ensures equitable access and participation. Together, they form the enabling conditions of the framework's input layer.

5.2 Process layer: flipped studio learning dynamics

The process layer illustrates how the four adoption drivers are enacted through the cyclical nature of Flipped Studio Learning. Instead of a linear transmission of knowledge, the process follows an iterative Pre–In–Post studio loop that reinforces design cognition, experimentation, and reflection.

- Pre-class phase—Students engage with foundational resources such as video lectures, precedent studies, theoretical concepts, or case analyses. This preparation shifts cognitive processing outside the classroom, enabling students to arrive with conceptual readiness for higher-order thinking during studio sessions.
- In-class phase (Studio phase)—Studio time is dedicated to collaborative critique, peer review, sketching, modeling, and iterative design development. Tutors adopt facilitative and dialogic roles—guiding reflection-in-action rather than delivering content—consistent with Schön's (1984) reflective practitioner model.
- Post-class phase—Learning is reinforced through reflective journals, iterative project revisions, peer commentary, digital portfolios, and revisiting recorded critique sessions. This stage supports reflection-on-action and transforms studio feedback into personal knowledge construction.

Recent cross-institutional studies (Bintz et al., 2024) confirm that the success of flipped learning depends not merely on pre-class content delivery, but on the deliberate orchestration and alignment of all three phases. Accordingly, this framework conceptualizes the process as an iterative pedagogical loop, rather than a linear progression—mirroring the feedback-driven, reflective culture of studio pedagogy.

This cyclical process forms the mechanism through which the input drivers influence perceived effectiveness, ultimately contributing to sustainable integration of flipped learning in design education.

5.3 Output layer: learning outcomes and impact

The output layer of the framework captures the outcomes generated when flipped pedagogy is systematically embedded in studio-based education. These outcomes emerge at three interconnected levels: learner, instructor/institution, and broader societal impact.

- Learner-level outcomes—Students are expected to develop higher levels of design competence, reflective thinking, creative problem-solving, autonomy, collaboration, and digital literacy (Thai et al., 2017). Through iterative critique and active participation in studio

dialogue, learners transition from passive recipients of knowledge to self-directed designers capable of articulating and defending their decisions.
- Instructor and institutional outcomes—For educators, flipped adoption enables more meaningful use of studio time for critique, feedback, and dialogic teaching, while reusable digital materials support improved teaching efficiency. At the institutional level, the framework contributes to curriculum renewal, faculty capacity-building, and the evolution of a reflective and innovation-oriented teaching culture. Over time, these changes support the transition from isolated pedagogical trials to systemic integration aligned with accreditation standards and quality assurance mechanisms.
- Societal and strategic relevance—Beyond classroom transformation, the framework aligns with global educational priorities such as SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), and SDG 9 (Industry, Innovation and Infrastructure). It positions architecture and built environment education within a broader agenda of inclusive, technology-enhanced, and future-ready professional training.
- Operationalization and measurability—The relationships between adoption drivers, perceived effectiveness, and sustainable integration are operationalized in Table 2, which formalizes how input conditions translate into educational outcomes and long-term pedagogical innovation. These constructs are intentionally designed to be measurable, enabling future research through survey instruments, observation protocols, or Structural Equation Modeling (SEM).

To demonstrate how the framework can be empirically applied, Table 3 provides sample measurable indicators for each construct—translating abstract dimensions into observable variables suitable for questionnaires, studio assessments, or mixed-method evaluation.

5.4 Conceptual propositions

Drawing on the relationships illustrated in Figure 3 and operationalized in Table 2, this study proposes three conceptual propositions (P1–P3). These propositions explain how adoption drivers shape perceived effectiveness and, in turn, lead to sustained integration of flipped studio pedagogy in architecture and built environment education.

5.4.1 P1—direct effects of adoption drivers on perceived effectiveness

> P1: *Pedagogical design, technological readiness, learner engagement, and institutional support are positively associated with the perceived effectiveness of Flipped Studio Learning.*

These four dimensions constitute the foundational conditions for effective adoption. When pre–in–post activities are coherently structured (pedagogical design), supported by accessible digital platforms (technological readiness), reinforced by active preparation and participation (learner engagement), and legitimized by policies and resources (institutional support), both students and instructors are more likely to perceive flipped learning as improving design competence, satisfaction, and teaching efficiency.

5.4.2 P2—mediating role of perceived effectiveness

> P2: *Perceived effectiveness mediates the relationship between flipped studio adoption drivers and the sustainable integration of flipped pedagogy.*

This proposition emphasizes that adoption drivers alone do not guarantee long-term institutionalization. Sustainable integration emerges

TABLE 2 Conceptual–operational framework of flipped studio learning.

Variable type	Description	Operational indicators & examples
Independent variable Flipped studio learning adoption	Degree to which flipped pedagogy is systematically integrated into studio education	• Pedagogical Design—alignment of pre–in–post activities with studio outcomes, rubric-based critique, explicit reflection tasks • Technological Readiness—LMS accessibility, device/internet reliability, digital equity, technical support • Learner Engagement—completion rates of pre-class materials, frequency of peer critique, reflective journal entries • Institutional Support—workload recognition, faculty training, policy inclusion, digital infrastructure
Mediating variable Perceived effectiveness	Learners' and instructors' perception of how flipped studio learning improves design learning and teaching processes	• Design Learning Outcomes—creativity, problem solving, reflective ability • Student Satisfaction & Motivation—survey responses, participation consistency • Instructional Efficiency—time saved for critique, feedback quality
Control variables	Structural or contextual conditions affecting implementation	• Discipline type (Architecture, Interior, Landscape) • Class size & studio format • Prior exposure to active or digital learning
Dependent variable Sustainable integration	Extent to which flipped learning becomes a long-term pedagogical culture	• Student design achievement & project quality over time • Curriculum revision incorporating flipped components • Faculty adoption across multiple cohorts and semesters • Inclusion in policy/accreditation standards

Source: Author's compilation (2025).

TABLE 3 Sample measurable indicators for future empirical validation.

Framework dimension	Sample measurable indicator (5-point Likert)	Possible data source
Pedagogical design	"Pre-class materials clearly support my understanding of studio design tasks."	Student survey
	"In-class critiques effectively connect with assigned pre-class content."	Observation sheet/rubric
Technological readiness	"The LMS and digital pin-up tools are reliable and easy to access during studio work."	Student/instructor survey
	"I feel confident using digital platforms to prepare for studio sessions."	Self-assessment
Learner engagement	"I regularly complete pre-class preparation before attending studio sessions."	LMS analytics + self-report
	"I actively contribute to peer critique and reflect on feedback received."	Peer-review logs/observation
Institutional support	"My institution provides adequate resources and time to implement flipped studio teaching."	Instructor survey
	"Flipped teaching efforts are recognized in performance evaluation / workload allocation."	Faculty feedback
Perceived effectiveness	"The flipped studio format enhances my creativity and design problem-solving."	Student survey
	"Class time in this model is used more efficiently than in traditional studio teaching."	Instructor survey
Sustainable integration	"I believe the flipped studio approach should be continued in future courses."	Student + faculty interviews
	"This model can be adapted to other design studios or disciplines."	Curriculum committee report

Source: Author's compilation (2025).

only when stakeholders perceive clear value—such as enhanced design outcomes, creativity, reflective depth, and efficient use of studio time. Perceived effectiveness thus acts as a psychological and pedagogical bridge that transforms initial adoption into ongoing curriculum reform.

5.4.3 P3—moderating role of contextual and institutional factors

> P3: *Contextual and institutional factors—such as discipline type, class size, and prior exposure to active or digital learning—moderate the strength of the relationships proposed in P1 and P2.*

This acknowledges that flipped studio learning unfolds in diverse environments rather than standardized conditions. Small studio cohorts, digitally mature institutions, or students familiar with self-directed learning may reinforce positive relationships, whereas large class sizes, weak infrastructure, or teacher-centered cultures may attenuate or disrupt them. These moderating dynamics explain why implementation success varies across institutions and regions.

Together, these propositions establish a testable theoretical pathway for future empirical investigations. Researchers may operationalize these constructs using Structural Equation Modeling (SEM), mixed-method case studies, or longitudinal evaluation to validate the robustness and applicability of the Flipped Studio Learning Framework.

6 Discussion

6.1 Contribution to literature

This study contributes to flipped learning and design education in three major ways.

6.1.1 Reframing theoretical positioning

Although flipped learning has been widely validated in STEM and health sciences (Betihavas et al., 2016; Thai et al., 2017), its application in architecture remains under-theorized and weakly contextualized. Prior reviews focus on efficiency and engagement (O'Flaherty and Phillips, 2015), but rarely connect these outcomes to studio pedagogy, where learning is iterative, reflective, and grounded in critique (Schön, 1984; Oxman, 2004). This study repositions flipped learning as a studio-based pedagogical paradigm rather than a generic instructional technique.

6.1.2 Synthesizing pedagogy, theory, and design cognition

The study integrates reflection-in-action (Schön, 1984), experiential learning (Kolb, 1984), and andragogy (Knowles, 1980) with contemporary flipped learning theory (Hew and Lo, 2018). It conceptualizes flipped studio learning as a reflective cycle—pre-class exploration, in-class critique, and post-class reflection—offering a discipline-specific interpretation missing in existing discourse.

6.1.3 From abstraction to operational clarity

Beyond theory, the study provides an operationalized framework (Figure 3; Table 2) with measurable constructs—pedagogical design, technological readiness, learner engagement, institutional support—linked to perceived effectiveness and sustainable integration. These are formalized through propositions (P1–P3), enabling empirical testing using surveys, SEM, or mixed-method designs.

In summary, this work situates flipped learning within the reflective and iterative nature of design studios and advances it with a testable conceptual–operational model.

6.2 Comparison with prior studies

Most flipped classroom studies examine student performance, autonomy, and engagement in general education, STEM, or health sciences (Bishop and Verleger, 2013). They focus on the shift of content to pre-class time, creating space for collaboration during class. However, these models follow linear lecture–practice logic and do not reflect the epistemic nature of design education, which relies on iteration, critique, and reflection.

Unlike frameworks that view flipping as a reversal of teaching sequence (O'Flaherty and Phillips, 2015), this study reconceptualizes it as a reciprocal loop between pre-class conceptualization and in-studio creative synthesis. This aligns with design education research (Triantafyllou and Timcenko, 2014; Mason et al., 2013), which shows that design competence develops through critique, dialogue, and making.

The proposed model comprises input drivers (pedagogical design, technology, engagement, institutional support), process mechanisms (Pre–In–Post studio cycle), and outcomes (design competence, reflection, innovation). While existing studies report motivation or satisfaction (Bond, 2020; Thai et al., 2017), few operationalize studio-specific variables such as critique quality or reflective capacity. This study addresses that gap by defining measurable constructs and testable propositions (P1–P3), making flipped studio learning theoretically coherent and empirically applicable.

Hybrid and digitally mediated studios have emerged as viable extensions of reflective studio culture (Günay and Coşkun, 2023; Kassem et al., 2023). These approaches further support the notion that studio learning can be restructured through blended or flipped formats, yet they still lack a coherent conceptual–operational model tailored to architecture—a gap this study aims to fill.

6.3 Practical insights for educators

The framework provides practical guidance for adapting flipped learning to studio-based education. It emphasizes that flipped pedagogy is not an add-on technology but an ecosystem supporting iterative design, critique, and reflection. Five strategies are proposed:

6.3.1 Pre-class for conceptual readiness

Move beyond passive video content to include design briefs, precedents, or reflective prompts to prepare students for critique and exploration.

6.3.2 Use studio time for co-construction

Prioritize experimentation, dialogue, and iterative critique—consistent with Schön's (1984) notion of reflection-in-action—rather than content delivery.

6.3.3 Make learner responsibility visible

Use pre-class rubrics, peer-review protocols, reflective journals, or digital trackers to strengthen accountability.

6.3.4 Ensure institutional readiness

Sustainable adoption requires curriculum alignment, workload recognition, digital pin-up tools, and faculty training—not isolated efforts (Zainuddin and Halili, 2016).

6.3.5 Evaluate with mixed evidence

Combine qualitative studio artifacts (critiques, journals, process sketches) with quantitative measures such as participation rates or LMS activity (Bond, 2020; Farmus et al., 2020).

To demonstrate contextual applicability, a hypothetical Thai case is included: a third-year design studio of 40 students piloted a blended flipped–studio model. Pre-class micro-lectures (8–10 min) introduced concepts via LMS; studio time shifted to rotating desk critiques; post-class reflection was recorded through 200-word journals on platforms like Miro or Padlet. This scenario shows how flipped principles can enhance critique engagement, iteration frequency, and learner autonomy in large studio settings. Such digitally mediated workflows also align with recent hybrid studio models proposed in contemporary literature (Günay and Coşkun, 2023; Süner-Pla-Cerdà, 2025).

6.4 Limitations

This study adopts a conceptual rather than empirical design, and as such, it privileges theoretical synthesis over data-driven validation. While this approach enables the development of a discipline-specific framework grounded in studio pedagogy and educational theory, it also introduces several limitations.

First, the framework is derived entirely from secondary literature and analytical interpretation. Although narrative and thematic mapping were systematically employed, the relationships among constructs—particularly those articulated in Propositions P1–P3—remain hypothetical until tested through empirical research.

Second, the scope of this study is confined to architecture and built environment programs in higher education. The transferability of the framework to adjacent design disciplines (e.g., interior design, landscape architecture, product design, visual communication) has not yet been verified. Implementation may also be influenced by contextual differences such as studio size, institutional culture, technological infrastructure, and regional pedagogy.

Third, while Tables 2, 3 translate conceptual constructs into measurable indicators, these operational variables have not been tested for reliability, validity, or cross-institutional applicability using methods such as Structural Equation Modeling (SEM), observational analysis, or longitudinal tracking.

To address these limitations, future research should include pilot studies in real studio settings, mixed-method validation, and comparative case studies across institutions. Longitudinal investigations would further clarify whether flipped studio pedagogy produces sustainable curriculum innovation rather than short-term instructional change.

6.5 Policy and institutional implications

The sustainable adoption of flipped studio learning requires more than individual instructional effort; it demands alignment with institutional policy, curriculum structures, and quality assurance mechanisms. In architecture and built environment education, where critique, iteration, and reflective practice shape learning culture, policy must support these studio-specific characteristics—not just generic student-centered learning.

First, flipped studio pedagogy must be formally recognized within academic policy. Institutions should allocate teaching hours for pre-class material development, facilitation of critiques, and post-class feedback, and incorporate these activities into workload models, performance evaluations, and promotion criteria. Without formal recognition, innovative teaching risks remaining voluntary and unsustained.

Second, digital infrastructure should be regarded as a strategic investment. Stable LMS platforms, digital pin-up or critique environments (e.g., Miro, Padlet), audiovisual systems, and IT support are essential for pre-class access, synchronous feedback, and documentation of studio work. This directly reinforces the driver of technological readiness in the framework.

Third, institutional policy must include structured professional development. Faculty require training in hybrid studio teaching, digital critique facilitation, and assessment of reflective or collaborative learning. Peer mentoring, communities of practice, and interdisciplinary teaching teams can help educators shift from content delivery toward facilitation of reflective dialogue and data-informed instruction.

Fourth, curriculum policy should support multi-year integration rather than isolated course-level initiatives. Embedding flipped studio learning across foundation, intermediate, and advanced studios enables longitudinal development of design reasoning, reflective competence, and collaborative critique. Such alignment facilitates coherence between studio courses, lecture modules, accreditation standards, and learning outcomes.

Finally, system-level alignment with national and international agendas—such as SDG 4 (Quality Education) and SDG 9 (Innovation and Infrastructure)—can strengthen institutional legitimacy and long-term adoption. When flipped studio pedagogy is embedded in strategic plans, digital transformation policies, and quality assurance frameworks, it shifts from being an experimental practice to an institutional paradigm.

7 Conclusion and implications

This study develops a discipline-specific conceptual–operational framework for Flipped Studio Learning in architecture and built environment education. It addresses the gap between generic flipped classroom models and the epistemic nature of studio pedagogy—where learning is iterative, reflective, and shaped by critique, visual reasoning, and design inquiry.

Theoretically, the framework advances flipped learning by embedding it within the philosophical foundations of design education—constructivism, experiential learning (Kolb, 1984), reflective practice (Schön, 1984), design cognition (Oxman, 2004), and transformative studio pedagogy (Salama, 2021). Flipped learning is therefore reframed not as a method of content delivery but as a reflective system of inquiry that supports thinking-through-making.

Practically, the framework identifies four measurable adoption drivers—pedagogical design, technological readiness, learner engagement, and institutional support—which interact through the mediating construct of perceived effectiveness to determine sustainable integration. These constructs provide a pathway for:

- Curriculum renewal in design studios and lecture-based courses,
- Faculty development and workload policy reform,
- Institutional alignment with digital transformation and quality assurance,
- Strategic contributions to SDG 4 (Quality Education), SDG 8 (Decent Work & Economic Growth), and SDG 9 (Innovation & Infrastructure).

Future research is encouraged to validate the proposed propositions (P1–P3) using structural equation modeling (SEM), mixed-method case studies, and longitudinal analysis of studio curricula. Such empirical work will test construct validity, refine operational indicators, and document how flipped studio pedagogy evolves in real design settings.

Ultimately, this study argues that the success of flipped learning in architecture depends not on technology alone, but on cultivating an institutional culture of reflection, critique, evidence-based teaching, and sustained policy support. When these conditions align, flipped studio learning can move from isolated innovation to a systemic model for transformative design education. To ensure the framework moves beyond theoretical abstraction, a clear pathway for empirical testing is provided in the following subsection.

7.1 Pathway for empirical validation

Although this study is conceptual, it is explicitly designed for empirical extension. Future research can operationalize the framework using measurable indicators such as:

- Learner engagement—pre-class preparation, critique participation, peer collaboration, reflective journals;
- Institutional support—policy mechanisms, workload recognition, digital infrastructure, staff training;
- Perceived effectiveness—student satisfaction, teaching efficiency, design learning outcomes;
- Sustainable integration—curriculum renewal, long-term adoption, faculty uptake, cross-disciplinary transferability

A mixed-method approach is proposed:

- Quantitative—Structural Equation Modeling (SEM) to test the relationships among constructs;
- Qualitative—Case studies and studio observations to capture reflective narratives, critique interactions, and contextual influences.

This dual-phase strategy ensures continuity between conceptual reasoning and empirical validation, bridging theory and practice in design education. Such validation will help refine construct relationships, enhance generalizability, and strengthen the legitimacy of Flipped Studio Learning as a transformative pedagogical paradigm. To demonstrate operational readiness, sample survey items and a prototype coding plan are included in Appendix.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

This study received ethical approval from the Mahasarakham University Ethics Committee for Research Involving Human Subjects (Approval No. 462-509/2025). The study was classified as a conceptual analysis with no direct involvement of human or animal participants; therefore, ethical review and informed consent requirements were waived in accordance with institutional guidelines and the Declaration of Helsinki.

Author contributions

PR: Conceptualization, Formal analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing.

Funding

The author(s) declared that financial support was not received for this work and/or its publication.

Acknowledgments

The author gratefully acknowledges institutional support received during the course of this study.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that Generative AI was used in the creation of this manuscript. The author used ChatGPT (OpenAI GPT-5) to assist in proofreading, grammar checking, and improving clarity of expression. The AI tool was not used to generate scientific ideas, analysis, or data. The author reviewed and verified all content to ensure accuracy and integrity of the manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2026.1726937/full#supplementary-material

References

Abeysekera, L., and Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: definition, rationale, and a call for research. *High. Educ. Res. Dev.* 34, 1–14. doi: 10.1080/07294360.2014.934336

Akçayır, G., and Akçayır, M. (2018). The flipped classroom: a review of its advantages and challenges. *Comput. Educ.* 126, 334–345. doi: 10.1016/j.compedu.2018.07.021

Betihavas, V., Bridgman, H., Kornhaber, R., and Cross, M. (2016). The evidence for "flipping out": a systematic review of the flipped classroom in nursing education. *Nurse Educ. Today* 38, 15–21. doi: 10.1016/j.nedt.2015.12.010

Bintz, G., Müller, A., Rossi, L., and Chen, W. (2024). Components of the flipped classroom in higher education. *Front. Educ.* 9:1412683. doi: 10.3389/feduc.2024.1412683

Bishop, J. L., and Verleger, M. A. (2013). "The flipped classroom: a survey of the research" in Paper presented at the ASEE annual conference & exposition (Atlanta, GA, United States: American Society for Engineering Education (ASEE)).

Bond, M. (2020). Facilitating student engagement through the flipped learning approach in K–12: a systematic review. *Comput. Educ.* 151:103819. doi: 10.1016/j.compedu.2020.103819

Cuff, D. (1992). Architecture: the story of practice. Cambridge, MA: MIT Press.

Dorst, K. (2004). On the problem of design problems—problem solving and design expertise. *J. Des. Res.* 4, 185–196. doi: 10.1504/JDR.2004.009841

Farmus, L., Cribbie, R. A., and Rotondi, M. A. (2020). The flipped classroom in introductory statistics: early evidence from a systematic review and meta-analysis. *J. Stat. Educ.* 28, 316–325. doi: 10.1080/10691898.2020.1834475

Günay, A., and Coşkun, A. (2023). "Realising a hybrid design studio in basic design" in Learn X design 2023: the 7th international conference for design education researchers – Futures of design education. eds. D. Jones, N. Börekçi, V. Clemente, J. Corazzo and N. Lotz (London: Design Research Society), 640–651.

Hew, K. F., and Lo, C. K. (2018). Flipped classroom improves student learning in health professions education: a meta-analysis. *BMC Med. Educ.* 18:38. doi: 10.1186/s12909-018-1144-z

Jack, E., Bock, M., Alexander, C., Muegge, R., and Villejo, S. (2025). Flipped learning in statistics. University of Glasgow – School of Mathematics & Statistics. Available online at: https://www.gla.ac.uk/myglasgow/learningandteaching/activelearning/casestudies/flippedlearning/ (Accessed January 10, 2025).

Kassem, A., Farghaly, Y., and Hany, N. (2023). The role of active pedagogies in architectural design studios: post-pandemic adaptation. *F1000Res* 12:1582. doi: 10.12688/f1000research.139457.1

Knowles, M. S. (1980). The modern practice of adult education: From pedagogy to andragogy. Revised & updated Edn. Cambridge: The Adult Education Company.

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. Englewood Cliffs, NJ: Prentice-Hall.

Lo, C. K., and Hew, K. F. (2017). A critical review of flipped classroom challenges in K–12 education: possible solutions and recommendations for future research. *Res. Pract. Technol. Enhanc. Learn.* 12, 4–22. doi: 10.1186/s41039-016-0044-2

Mason, G. S., Shuman, T. R., and Cook, K. E. (2013). Comparing the effectiveness of an inverted classroom to a traditional classroom in an upper-division engineering course. *IEEE Trans. Educ.* 56, 430–435. doi: 10.1109/TE.2013.2249066

McLean, S., Attardi, S. M., Faden, L., and Goldszmidt, M. (2016). Flipped classrooms and student learning: not just surface gains. *Adv. Physiol. Educ.* 40, 47–55. doi: 10.1152/advan.00098.2015

Newell, A., and Simon, H. A. (1972). Human problem solving. Englewood Cliffs, NJ: Prentice-Hall.

Newmann, F. M., Marks, H. M., and Gamoran, A. (1996). Authentic pedagogy and student performance. *Am. J. Educ.* 104, 280–312. doi: 10.1086/444136

O'Flaherty, J., and Phillips, C. (2015). The use of flipped classrooms in higher education: a scoping review. *Internet High. Educ.* 25, 85–95. doi: 10.1016/j.iheduc.2015.02.002

Oxman, R. (2004). Think-maps: teaching design thinking in design education. *Des. Stud.* 25, 63–91. doi: 10.1016/S0142-694X(03)00033-4

Salama, A. M. (2021). Transformative pedagogy in architecture and urbanism. London: Routledge.

Schön, D. A. (1984). The reflective practitioner: how professionals think in action. New York, NY: Basic Books.

Sosa, M. J., and Narciso, D. (2019). The impact of the flipped classroom in higher education: a case study. *Aloma: Revista de Psicologia, Ciències de l'Educació i de l'Esport* 37, 15–23. doi: 10.51698/aloma.2019.37.2.15-23

Süner-Pla-Cerdà, E. (2025). Towards an integrative model of blended design studios: findings from 12 departments across 6 universities. *Educ. Inf. Technol.* doi: 10.1007/s10639-024-12873-y

Thai, N. T. T., De Wever, B., and Valcke, M. (2017). The impact of a flipped classroom design on learning performance in higher education: looking for the best "blend" of lectures and guiding questions with feedback. *Comput. Educ.* 107, 113–126. doi: 10.1016/j.compedu.2017.01.003

Triantafyllou, E., and Timcenko, O. (2014). "Introducing a flipped classroom for a statistics course: a case study" in 2014 IEEE global engineering education conference (EDUCON) (Istanbul, Turkey: IEEE), 299–305.

Zainuddin, Z., and Halili, S. H. (2016). Flipped classroom research and trends from different fields of study. *Int. Rev. Res. Open Distrib. Learn.* 17, 313–340. doi: 10.19173/irrodl.v17i3.2274

Zhang, F. (2024). The landscape of flipped classroom research. *Front. Educ.* 9:1165547. doi: 10.3389/feduc.2024.1165547

Appendix

Appendix A: Sample survey items (5-point Likert Scale)

The following sample items illustrate how the proposed constructs can be operationalized in future empirical studies. Each item is rated on a 1–5 Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

Construct	Sample items
Reflective competence	1. I critically reflect on feedback received during studio critiques. 2. I revise my design ideas based on self-evaluation and peer comments.
Critique participation	1. I actively contribute constructive feedback during peer critiques. 2. I feel confident discussing design decisions with tutors and classmates.
Perceived effectiveness	1. The flipped–studio format helps me improve my design outcomes. 2. Studio time is used more efficiently compared to traditional teaching.

These items demonstrate the measurability of key constructs such as reflection, critique engagement, and perceived effectiveness. Full-scale instruments may be developed and validated in future empirical research.

Appendix B: Prototype coding scheme for studio critique analysis

To capture qualitative evidence from studio discussions, a preliminary coding plan is proposed for analyzing 5–10 min critique dialogues:

Code	Description	Example indicator
Evidence-based justification	Student provides reasons supported by theory, precedent, or user needs	Refers to design precedent or user data
Iterative refinement	Student modifies design based on feedback or self-reflection	References version 2/3 of design with changes
Peer-to-peer feedback	Student critiques or builds on peers' ideas constructively	Offers alternative suggestion, not only receiving feedback
Tutor scaffolding	Tutor guides thinking rather than giving solutions	Asks probing questions ("What if…?," "Why did you…?")

Each utterance can be coded for frequency and depth (0 = absent, 1 = present–surface, 2 = present–in-depth). This illustrates how reflective and collaborative learning can be empirically observed in studio environments.